The incorporation of education for sustainable development in Technology Education for an indigenous context

by

Princess Blose

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DECLARATION

Name: Blose P

Student number: 56712715

Degree: PhD in Education (Technology Education)

The incorporation of education for sustainable development in Technology Education for an indigenous context

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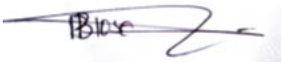

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SIGNATURE DATE

DEDICATION

I would like to dedicate this research study to my aunt Selinah Madonsela as well as my two cherished angels, Tholokwakhe and Lethokuhle.

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ABSTRACT

The United Nations Conference on “Environment and Development” emphasised the significance of the concept of sustainable development (SD). The concept's development has revealed difficulties with implementation in schools. The Curriculum and Assessment Policy Statement (CAPS) emphasises the recognition of indigenous knowledge systems (IKS) in Technology Education (TE). However, CAPS is silent about Education for Sustainable Development (ESD), therefore adding to teachers not considering ESD in their teaching. Hence, in this context, this study aimed to explore ways that can promote ESD in the teaching of Technology, particularly within an indigenous context. Adopting a constructivist paradigm, the study used a qualitative research approach. A descriptive case study was chosen as appropriate for the study. Eight (8) Senior Phase Technology teachers and a Curriculum Subject Advisor (CSA) for the General Education and Training Band at Ehlanzeni District, Mpumalanga Province participated in the study. The findings revealed that, while Technology teachers understand the concepts of SD and ESD, they are still not teaching Technology in a way that promotes ESD. The interpretation of the CAPS in relation to sustainability in the subject was identified as a challenge. The findings revealed that the way Technology is taught further jeopardises IKS which could otherwise be used to promote ESD; so, Technology teaching is still Westernised to a great extent. The findings of the study also revealed that collaboration and teamwork, along with social constructivist-related aspects such as Community of Practices, *Ubuntu*, culture, and so on, would facilitate the teaching of ESD in the TE curriculum. Hence, a framework for incorporating ESD into the Technology curriculum in an indigenous context was developed in the study. The findings have implications for future research on the incorporation of ESD in the TE curriculum, as well as for practice by Technology teachers and curriculum implementers on ESD teaching in Technology.

Keywords: Sustainable development; education for sustainable development, Technology Education; Technology curriculum; constructivism; social constructivism; collaborative approach; teamwork; *Ubuntu*.

SICAPHUNO

INgcungcutsela Yenhlangano Yetive "ngeMvelo kanye neNtfutfuko" igcizelele kubaluleka kwemcondvo wentfutfuko lesimeme (i-SD). Kutfutfukiswa kwalomcondvo kuvete bumetima bekuphumelelisa etikolweni. Sitatimende Senchubomgomo Yeluhlelo Lwetifundvo Nekuhlola (i-CAPS) sigcizelela kwemukelwa kwetinhlelo telwati lwendzabuko (i-IKS) Kutimfundvo Tetheknoloji (i-TE). Nanobe kunjalo, i-CAPS ayisho lutfo ngeMfundvo Yentfutfuko Lesimeme (iESD), ngako-ke yengeta kubothishela labangayicabangi i-ESD ekufundziseni kwabo. Ngako-ke, kulendzikimba, lolucwaningo luhlose kuhlola tindlela letingatfutfukisa i-ESD ekufundziseni iTheknoloji, ikakhulukati ngekhatsi kwendzikimba yemdzabu. Kwamukela i-constructivist paradigm, lucwaningo lusebentise indlela yelucwaningo lwekhwalithi. Lucwaningo loluchazako lwakhetfwa njengalolufanele kulolucwaningo. Bothishela Labasiphohlongo (8) Besigaba Lesisetulu Setheknoloji kanye neMeluleki Wetifundvo (i-CSA) we-General Education and Training Band Esigodzini sase-Ehlanzeni, Esifundzeni saseMpumalanga bahlanganyele kulolucwaningo. Lokutfolakele kuvete kutsi, nanobe bothishela beTheknoloji bavisisa imicondvo ye-SD ne-ESD, basengakafundzisi iTheknoloji ngendlela letfutfukisa i-ESD. Kuhunyushwa kwe-CAPS macondzana nekusimama esifundvweni kubonwe njengensayeya. Lokutfolakele kuvete kutsi indlela iTheknoloji ifundziswa ngayo kubeka engcupheni i-IKS lebeyingahle isetjentiselwe kutfutfukisa i-ESD; ngako-ke, kufundziswa kweTheknoloji kusentiwa ngesiNshonalanga ngekwelizinga lelikhulu. Lokutfolakele kulolucwaningo kuphindze kwaveta kutsi kusebentisana nekubambisana, kanye netinhlangotsi letitsintsa i-social constructivist njenge-Community of Practices, *Ubuntu*, emasiko, nalokunye, kutawenta kube lula kufundziswa kwe-ESD eluhlelweni lwetifundvo lwe-TE. Ngako-ke, luhlaka lwekufaka i-ESD eluhlelweni lwetifundvo teTheknoloji esimweni semdzabu lwatfutfukiswa elucwaningweni. Lokutfolakele kunemitselela elucwaningweni lwesikhatsi lesitako ngekufakwa kwe-ESD eluhlelweni lwetifundvo lwe-TE, kanye nekutetayeta kubothishela beTheknoloji nebaphumelelisa beluhlelo lwetifundvo ekufundzisweni kwe-ESD kuTheknoloji.

Emagama lamcoka: Intfutfuko lesimeme; imfundvo yentfutfuko lesimeme, Imfundvo YeTheknoloji; luhlelo lwetifundvo teTheknoloji; i-constructivism; i-social constructivism; indlela yekusebentisana; kubambisana; *Ubuntu*.

KAKARETŠO

Khonferentshe ya Ditšhabakopano ya “Tikologo le Tlhabollo” e gateletše bohlokwa bja kgopolo ya tlhabollo ya go ya go ile (SD). Tlhabollo ya kgopolo ye e utolotše mathata a phethagatšo dikolong. Setatamente sa Pholisi ya Kelo le Kharikhulamo (CAPS) se gatelela temogo ya mekgwa ya tsebo ya setlogo (IKS) ka go Thuto ya Theknolotši (TE). Le ge go le bjalo, CAPS e homotše mo tabeng ya Thuto ya Tlhabollo ya go ya go ile (ESD), ka fao e tlaleletša go barutiši bao ba sa naganego ka ESD mo go ruteng ga bona. Ka fao, mo seemong se, maikemišetšo a nyakišišo ye e be e le go nyakišiša ditsela tšeo di ka tšwetšago pele ESD mo go ruteng Theknolotši, kudukudu ka gare ga seemo sa setlogo. Ka go amogela mokgwa wa bokhonsetrakethibise (constructivist), nyakišišo e šomišitše mokgwa wa nyakišišo wa khwalithethifi. Kheisesetati ya tlhalošo ye e hlalošago e ile ya kgethwa bjalo ka yeo e swanetšego nyakišišo. Barutiši ba seswai (8) ba Theknolotši ya Kgato ya Godimo le Moeletši wa Dithuto tša Kharikhulamo (CSA) wa Sehlopha sa Thuto le Tlhahlo ya Kakaretšo Seleteng sa Ehlanzeni, Profentsheng ya Mpumalanga ba tšeere karolo nyakišišong ye. Dikutullo di utolotše gore, le ge barutiši ba Theknolotši ba kwešiša dikgopolo tša SD le ESD, ba sa dutše ba sa rute Theknolotši ka tsela yeo e tšwetšago pele ESD. Tlhathollo ya CAPS mabapi le go tšwela pele mo tabeng ye e lemogilwe bjalo ka tlhohlo. Dikutullo di utolotše gore tsela yeo Theknolotši e rutwago ka yona e bea IKS kotsing gape yeo e kago šomišwa go tšwetša pele ESD; ka fao, Theknolotši e sa ntše e rutwa ka mokgwa wa Bodikela bogolo bja yona. Dikutollo tša nyakišišo ye di utolotše gape gore tirišano le mošomo wa sehlopha, gammogo le dikarolo tše di amanago le bokhonsetrakethibise bja leago go swana le Sehlopha sa go Abelana Tshedimošo (Community of Practice), *Botho*, setšo, bjalobjalo, di tla nolofatša go rutwa ga ESD ka kharikhulamong ya TE. Ka fao, tlhako ya go akaretša ESD ka gare ga kharikhulamo ya Theknolotši ka gare ga seemo sa setlogo e hlamilwe ka nyakišišong. Dikutullo di na le ditlamorago go dinyakišišo tša ka moso ka ga go akaretšwa ga ESD ka gare ga kharikhulamo ya TE, gammogo le go šomišwa ke barutiši ba Theknolotši le baphethagatši ba kharikhulamo ka ga go ruta ga ESD ka go Theknolotši.

Mantšu a bohlokwa: Tlhabollo ya go ya go ile; thuto ya tlhabollo ya go ya go ile, Thuto ya Theknolotši; Kharikhulamo ya theknolotši; bokhonsetrakethibisemo

(constructivism) go aga; bokhonsetrakethibisemo bja leago; mokgwa wa tirišano; mošomo wa sehlopha; *Botho*

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF ACRONYMS

TE	–	Technology Education
IKS	–	Indigenous Knowledge Systems
IK	–	Indigenous Knowledge
ESD	–	Education for Sustainable Development
SD	–	Sustainable Development
STEM	–	Science, Technology, Engineering and Mathematics
UN	–	United Nations
AU	–	African Unions
CSA	–	Curriculum Subject Advisor
GET	–	General Education and Training
FET	–	Further Education and Training
IDMEC	–	Investigate, Design, Make, Evaluate and Communicate
CAPS	–	Curriculum and Assessment Policy Statement
EE	–	Environmental Education
SDGs	–	Sustainable Development Goals
UNESCO	–	United Nations; Education, Scientific and Cultural Organisation
DBE	–	Department of Basic Education
UNECE	–	United Nations Economic Commission for Europe
TSE	–	Technology, Society, and the Environment
PEE	–	Progressive Era of Education
SE	–	Sustainable Education
ZPD	–	Zone of Proximal Development
CoP	–	Community of Practice
LPP	–	Legitimate Peripheral Participation
NFSD	–	National Framework for Sustainable Development
DESD	–	United Nations Decade of Education for Sustainable Development
UNDRIP	–	UN Declaration on the Rights of Indigenous Peoples
MDGs	–	Millennium Development Goals
TEK	–	traditional ecological knowledge

UNFCCC	–	United Nations Framework Convention on Climate Change
AR4	–	Kyoto Protocol, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
ACIA	–	Arctic Climate Impact Assessment
SS	–	Social Sustainability
AEC	–	Architecture, Engineering, and Construction

CHAPTER 1

ORIENTATION INTO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The study is a descriptive case study purposing to explore technology teachers' views about education for sustainable development (ESD) to suggest an enabling framework to realise the importance of ESD, especially with the local dynamics in teaching. ESD forms part of the millennium goals set by United Nations Education, Scientific and Cultural Organisation (UNESCO) which drives the charter for the development of guidelines that would provide understanding and skills to aid environmental challenges (Kopnina 2020:1). ESD is education that emphasises change in knowledge, skills, values, and attitudes which enables a more sustainable and unbiased society for all (UNESCO 2018:7). These intended outcomes should be achieved in the education of learners. However, studies conducted on ESD show that the development of ESD has been slow especially in higher education (Bosselmann 2001; Everett 2008; Velazquez, Munguia, Platt, & Taddei 2006; Wals 2012; Anđić 2020). Similarly, other studies show that the implementation of SD and ESD issues are still minimally addressed in schools and discrepancies are realised in some areas of education, different types of documents, federal states, and the depth and quality of the contextualisation of ESD and related concepts (Urbańska, Charzyński, Gadsby, Novák, Şahin & Yilmaz 2021; Holst, Brock, Singer-Brodowski & de Haan 2020). More so, there are implicit and explicit tensions and contradictions in sustainable development (SD) and the recent associated Sustainable Development Goals (SDGs) (Agbedahin 2019). Furthermore, this slowness has also been noticed in the pedagogical innovations (Armstrong 2011:1). This runs counter to the developmental goals of African Agenda 2030 (2017).

African Agenda 2030 (2017:20) recognises the implementation of SD and its development in the education sector. The development is through the provision

of educational inclusion and learning outcomes that would cater for all learners. However, Agenda 2063 has come up with a set of aspirations (1-4) and monitoring and evaluation mechanisms to check the progress from the regional level. In this instance, SADC and its member countries expedite the implementation of SDGs. The agenda comprises 20 goals that are packaged according to the aspiration levels. Each goal has a set of priority areas. In turn, each priority area has a set of targets. The level of the attainment of the targets under each priority area determines the extent to which that goal is being met, in this case the ESD. Unlike the SDGs where the goals are specific and serve as targets, Agenda 2063's goals are broader, and is the priority areas/targets that define them (Agenda 2063 2015:98). Education is understood as one of the fields that should ensure the provision of knowledge, skills, values, and attitudes that empower learners to contribute towards SD. The need for ESD is to instil the culture that will enable the current and future generations to meet their daily needs using integrated and balanced approach to the economic, social, and environmental dimensions of SD. This informs that all countries globally and locally are required to transform their curricula for the acquisition of understanding and skills towards addressing ESD. This encapsulates Technology Education (TE) curriculum as well.

The South African Department of Basic Education (DBE) adheres to the principles of social and environmental justice as stated in the National Curriculum Statements (NCS), currently known as Curriculum Assessment Policy Statement (CAPS) (Department of Basic Education [DBE] 2002; DBE 2011). Technology is one of the new subjects introduced in the South African curriculum since 1998. Technology, as it is named in South Africa, was introduced to contribute towards the production of engineers, technicians and artisans and a technologically literate population for the modern world (DBE 2011:8). The subject encourages learners to be critical thinkers and develop their critical thinking skills taking into consideration the issues affecting technology, society, and environment. One of the most important skills in coping with ESD-related problems is critical thinking (Taimur & Sattar 2019:6). As a result, critical thinking skills in the TE curriculum can encourage learners to consider the strategies which enhance sustainability. Similarly, according to UNESCO (2012:11), ESD provides learners with practical

skills that enable them to think critically about living a sustainable life. According to Koger and Winter (2010), critical thinking skills impact on changing the unsustainable way of life. As critical thinking is related to the higher order thinking, it can allow learners to critically explore ESD in their learning.

According to UNESCO (2003:28), the subject Technology involves systems which sometimes are very simple and very complex. Furthermore, UNESCO (2003) highlights that systems are human-developed subsystem organisations and/or modules that communicate to accomplish a goal; systems often use feedback to achieve their objective(s) better. Systems are hierarchical and operate in the sense of supra-systems that can also be considered to shape the system setting (UNESCO 2003:28). In South Africa, TE covers the scope on systems through systems approach and technological, societal, and environmental matters. Additionally, TE is committed to preparing learners for employment and/or continuing education opportunities by training them to contribute and function in a technological society by knowing, developing, creating, using, and managing the human world (DBE 2011:8). The concepts TE and Technology curriculum are used interchangeably throughout this study. It is in this context that I strongly think that the technology-society-environment aspect of the third specific aim in CAPS provides the opportunity to embrace and teach about ESD. This is, however, not happening currently. In this study, the systems approach would aid in the application of ESD and its achievement in the classroom as it involves human development. According to Pavlova (2011:49), the application of systems in Technology could assist learners in resolving various community issues. In this instance, community issues are also linked to the issues of sustainability. Critical in this case is the fact that learners can work in close collaboration with their communities and understand Technology in that light.

Internationally and regionally, there is a paradigm shift in Technology that promotes SD in its education (Owuor 2007; UNESCO 2012; Yadav 2016). For instance, in the Kenyan context, solutions to the technical challenges currently plaguing the African societies and communities should be based on an understanding of the dynamics in the local context (Owuor 2007:21). Hence, the

role of indigenous knowledge (IK) and practices in development processes is part of these dynamics (Angioni 2003; Dei 2002; Republic of Kenya 2005; UNESCO 2006), more so that issues of ESD raise debates about the role that IK can play in ensuring the sustained survival skills of the currently poverty-stricken indigenous communities whose environments have been disturbed by colonial invasions. The strategy, therefore, involves the implementation of an indigenous approach to education that includes the contextualisation of the school curriculum by incorporating indigenous knowledge systems (IKS) into formal education with other applicable and useful knowledge.

Consequently, TE needs to redefine and acknowledge the integration of IK for SD. In the Kenyan education context, for example, the existing dominant discourse on IK emerges from the awareness of the need to resolve developmental knowledge gaps that are formulated in Western contexts (Owuor 2007:21). Considering the incorporation of local information that is more relevant to the needs of indigenous people gives hope that it is possible to solve local issues effectively. The trajectory of history and the essence of human culture have been greatly influenced by technology. This can continue to do so but more meaningfully through the involvement of ESD. So, there is an interrelationship between the concepts IKS and ESD (Owuor 2007:21). In its instruction, ESD values cultural diversity. As a result, indigenous practices offer a significant deal of potential in the teaching of ESD. According to Dube and Lubben (2011:81), cultural practices can be used to integrate social and environmental concerns into science education. This also applies to TE curriculum. As a result, indigenous/cultural practices can be used to integrate components of ESD particularly the social and environmental aspects into the TE curriculum. Traditional technologies and crafts, according to Pavlova (2011:50), are vital components of TE classrooms. This demonstrates that ESD is culturally embedded in IKS. Furthermore, according to UNESCO (2012:39), “ESD teaches all spheres of sustainability, that is, the environment, society, and economy, with an underlying dimension of culture.”

The CAPS document describes Technology as the use of knowledge, skills, values, and resources to meet people’s needs and wants by developing practical

solutions to problems, taking social and environmental factors into consideration (DBE 2011:8). In this scenario, to solve technical challenges, learners would have an opportunity to build and apply unique design skills. In addition, in TE, the material and mechanism play a crucial role. As learners participate in design activities, they will be encouraged to employ unique design skills that would allow them to examine materials that prioritise sustainability and suitable mechanisms that would permit proper ESD implementation. Yadav (2016:83) suggests that for ESD to be successful, mechanisms must be put in place. UNESCO (2012:5) denotes that mechanisms are whole-institution approaches that necessitate the active participation of numerous actors in the collaborative redesign of basic operational processes and relationships in order to make significant progress toward sustainability. Furthermore, according to United Nations Economic Commission for Europe (UNECE) (2009:36), materials for ESD at all levels must be developed to aid in the teaching and learning of ESD. The learners, on the other hand, should also participate in projects dealing with themes such as processing, structures and systems and control in an integrated way, considering technical, social, and environmental issues (DBE 2011:10). This can be well attuned to ESD.

Hess (2002:32) shows that technology as a medium is used as a source of significance. Drees (2002:599) argues that technology is more than that and understands those technology dimensions as people tend to view technology as devices (gadgets) like a phone, car, or computer, representing material entities. Firstly, as no technology will work without them, infrastructures such as receivers and transmitters are known as the core elements of technology. Secondly, technology is often a social mechanism that applies to organisations offering specific services. Another factor that is as important as hardware is skills. As an attitude, technology refers to an aggressive attitude to evaluate issues to find realistic ways to fix them. Lastly, technology is much more than these already described measurements because it is also a culture (Drees 2002:600). Additionally, technology as culture speaks to our identity, our responsibilities, and our values (which include our hopes, dreams) (Drees 2002:597). Gumbo (2020:9) writes further about an alternative perspective that relates to TE and acknowledges the technological profundities that exist in indigenous contexts,

particularly those that exist in the living libraries, the elders. Furthermore, an important distinction is made between technology as architecture, which focuses on what technology experts do, and technology as culture, which includes technology and broader culture experiences (Drees 2002:603). In support of the foregoing, Gumbo (2017:11) proposes that Technology is the technical application of tangible and intangible aspects of human cultural products to create favourable life conditions in the natural and unnatural (human) world. Furthermore, Technology implies that no product is to be manufactured that should not undergo development through design. As a result, TE is an introduction to a variety of professions that function in comparable ways. The professions require the use of the design process as they develop solutions to problems, needs or wants. Therefore, Technology with the inclusion of SD would lay a proper foundation for the interaction of culture and technology. Therefore, the ESD incorporation in TE has the potential to be grounded on cultural perspective. Moreover, ESD places the priority on cultural traditions that impact its teaching. Addressing ESD through TE is significant because ESD may be explored in the context of environmental concerns while also considering social elements. In this idea, social aspects in addressing ESD refer to the aspects linked to social nature and consequently cultural diversity.

Pavlova (2006:41) argues that the concept of sustainability has been a part of international discourse since the early 1980s. Sustainability refers to growth that meets today's needs without undermining future generations' ability to meet their own needs (World Commission on Environment and Development the Brundtland Commission 1987). The balance between the national aspects of SD in terms of development priorities that sustain and enhance the quality of life for both present and future generations is different for individual countries (Pavlova 2006:43). In developed countries, emphasis is more on environmental issues while in developing countries it is on economic and social issues (Pavlova 2006:43). SD is largely understood in some developing countries in terms of environmental concerns, so education for SD is simply a new twist to the notion of environmental education (UNESCO 2001).

The emphasis on economic and social problems is seen as being more relevant in a developing world. The idea of sustainability can therefore once again be approached in various ways at the local level. Water protection could be the key problem for a certain culture, while preserving traditional dancing could be an evolving issue for another. With more focus on eco-design or cultural significance, the sustainability of goods designed for various contexts may also have a different nature. In this study, the focus was more on ESD in TE, addressing societal and environmental issues related to IK. Battiste (2005) views IK as similar to traditional knowledge, which suggests a body of relatively old data that have been handed down from generations to generations. IKS is defined as the local and traditional knowledge constructed in a local context for resolving local challenges in the environment (Maila & Loubser 2003:277). IK and IKS, in the context of this study, would allow learners to bring their cultural experiences to the learning of SD in TE curriculum. An expanded view of IKS which is not bound to time and includes Technological views is given according to Noyoo (2007:167-168) thus:

> IKS refers to the complex set of knowledge, skills and technology existing and developed around specific conditions of populations and communities indigenous to a particular geographic area. IKS constitute the knowledge that people in a given community have developed over time and continue to develop. It is the basis for agriculture, food preparation, health care, education and training, environmental conservation, and a host of other activities.

On the contrary, IK is the knowledge that is specifically adapted to the requirements of local people and conditions. Therefore, IK is used by local people to make a living in a particular environment (Langill 1999:3). So, in addition to Battiste's definition is the functional definition offered by Langill. According to Langill (1999), indigenous technical knowledge, traditional environmental knowledge, rural knowledge, local knowledge and farmers' or pastoralists' knowledge are all concepts that may also be used to refer to IK in the field of SD. Langill (1999) asserts that IK is creative and experimental and does accommodate the outside influences and inside innovations to meet new conditions as it progresses. Gumbo (2018) and Langill (1999) discuss about the mistake of thinking of IK as old-fashioned, backwards, static, or unchanging.

Kaya and Seleti (2013:31) consider IK to be the knowledge “applied to a variety of livelihood situations in Africa such as food security, environment conservation, health natural resource management, conflict transformation, education, governance and leadership, etc”. Kaya and Seleti (2013) connect this definition to IKS by asserting that they have been propagated to embrace non-western beliefs, practices, customs, worldviews, including informal forms of education and have been contrasted with global dominant western knowledge systems produced in research and academic institutions.

The latter definitions by Langill and Kaya and Seleti are important in this study as they view IK and IKS from the SD and livelihoods perspective. I also view IK as an element of IKS. Hence, IK and IKS are used interchangeably in this study considering their different scope.

In view of IK, South Africa’s curriculum emphasises the inclusion of IK (DBE 2011:4). For instance, DBE (2011:4) posits that incorporating IK into school subjects would allow for a variety of local approaches to the teaching. In a similar vein, Mboya (1999) writes that it is important to value indigenous culture in the education system than focusing more on the western values. Furthermore, Ortiz (1999) highlights that IK has an influence on how learners can solve practical problems related to the environment. I therefore hold a view that IK would have a great impact on the issues of ESD as it also resonates well with the issues of the environment, especially in the TE curriculum.

The inclusion of ESD in the national policy documents can be seen all over the world (Arjen & Geke 2010:12). However, it is notable that most countries' policy documents relating to the presence of ESD do not have a national policy or strategy that deals with ESD in their curriculum. This is evident in South Africa's curriculum. Singh-Pillay (2020:1936) raises the concern that although South African policies call for ESD-oriented teaching approaches, policy on paper does not always translate into practice. Singh-Pillay and Alant (cited in Singh-Pillay 2020:1936) emphasise that there is little research on how ESD-oriented methods are used in classrooms at teacher training institutions. This is a void that this

study hoped to fill by researching the incorporation of ESD into the TE curriculum. In line with the CAPS document, one of the curriculum general aims values IKS in teaching. The CAPS document specifically outlines that curriculum aims to ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives (DBE 2011:4). As a result, I contend that IKS can be used as one of the ways that may assist in implementing ESD in TE.

The definition of Technology encourages the use of knowledge, skills, values and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration (DBE 2011:8). Arjen and Geke (2010:13) posit that ESD is a vision of education that seeks to balance the human and economic well-being with cultural traditions and respect for the earth's natural resources. The subject Technology partly includes environmental education as well as design problems identified and dealt with in an environment. As a result, the foregoing definition is linked to the characteristics of ESD. This gives the idea that as Technology curriculum recognises IK in its content then ESD issues may be incorporated in the subject as well. In the same vein, Owuor (2007:21) writes, "it is hoped that local issues can be resolved effectively with the inclusion of local knowledge that is more relevant to the needs of indigenous communities". Dei (in Owour 2007:22) emphasises the call for the incorporation of IK as this call will enable sustainable models which will prevail the realities of local peoples, with all their societal, cultural, political, spiritual, moral, and ecological goals and aspirations". Mphahlele's (2002:96) interpretation of IK supports the notion that a Technology programme can facilitate the use of ESD. Mphahlele (2002) attests that "African culture is not a museum piece. It is a dynamic feature of our lives. By 'dynamic' we mean not static, having motive force, being active, potent, energetic, having influence'…we mean have to keep redefining it". Therefore, I strongly believe that effective utilisation of African culture in TE curriculum would provide practical reference in strengthening ESD teaching. Wiyarsi and Çalik (2019) provide evidence to support the assertion, stating that settings and challenges created by ESD should consider each country's or community's cultural, geographical,

and level of development. According to Wane (2013:96), new information is discovered when studying old knowledge, which is what makes IK more dynamic. The preceding ideas resonate well with the subject Technology and how ESD can be realised in the subject because Technology is engaged on our daily lives, which often include ESD issues. So, considering the richness of the subject Technology and the engagement of cultural diversity in its teaching this would lay a proper foundation for the implementation of ESD. Specifically, UNESCO (2005:18-19) states that:

> Technology should also be regarded broadly to include traditional use of materials and application of knowledge as well as manufactured items. Technology must be applied consistently with goals of sustainability; misapplication of science and technology can undermine efforts to simultaneously protect the environment and provide for people's economic and personal needs.

Renewable energy, sustainable use of natural resources and biodiversity depletion are all seen as essential concerns to be solved through TE. It is argued that African states would play a central role in guiding educational goals for SD. It is argued that if African states are to play a central role in directing the goals of ESD, then there is need to integrate the African perspectives of knowledge as a reciprocal body of knowledge to western education to ensure relevance and practicality in addressing local problems affecting societies (Pavlova 2012:396). The results of the study by Pavlova (2011:396) further demonstrate that African Technology Education academics understand the need to address SD through TE, putting an emphasis on the social development issues framed by environmental challenges. Value improvement is thought to be the most effective way to solve SD problems, followed by technical fix. As a result, various views underpin their interpretations of SD, which may include IKS.

1.2 RATIONALE FOR THE STUDY

ESD is contextual relevance in developing and developed contexts. SD is linked to citizenship actions and the belief is that the community is an important place for ESD transformation (UNESCO 2018:15). Elshof (2003) shows that TE can provide excellent learning opportunities for young people in the process of

developing and assessing the technological systems / products they experience in the wider world to explore value judgments of an economic, spiritual, aesthetic, social and technical nature. According to Elshof's (2003) opinion, Technology has a significant impact on the provision of ESD in its education since technical products interact strongly with the features of ESD and humanity. As a result, Technology teachers should ensure that the teaching of the subject allows learners to connect with their daily experiences and identify the ESD issues. The Technology teaching should therefore direct learners to their surroundings to identify such ESD issues.

The results of the study conducted by Agirreazkuenaga (2019) on embedding SD goals in education, entitled *Teachers' Perspective about Education for Sustainability in the Basque Autonomous Community* have shown that SD is perceived as something necessary that must be worked on, but teachers do not dedicate the necessary time to it. The role of each teacher's awareness or personal involvement is identified as one of the challenges. Furthermore, SD is only considered in recycling activities, which is an unfortunate limitation considering the indigenous knowledge is closely tied to SD. The results further revealed that despite knowing about ESD, teachers do not work on it in class. Therefore, this matter is not included in their school subject as teachers claim that they have no time for it (Agirreazkuenaga 2019:12). But teachers are ignorant about the relevance/implementation of ESD in their subject (ibid). The foregoing may be the case with Technology teachers. Hence, Technology teachers need to show knowledge and importance of ESD through IKS as stipulated in the CAPS document. Specifically, CAPS stipulates that learners should be made aware of the interrelationship between Technology, Society, and the Environment (TSE) (DBE 2011:10). Additionally, learners should be able to consider the impact of technology, both positive and negative, on people's lives (DBE 2011:10). Hence, if TE can be taught within the parameters of the interrelationship between technology, society and the environment as stated in CAPS, SD can be realised through the teaching of the subject. This shows that learners should not only be made aware of the TSE relationship but should be taught about it.

However, anecdotal evidence about teaching and learning in TE suggests that the TSE aspect of the subject is not fully considered by teachers despite the emphasis of IKS as stipulated in the CAPS document which would enable teaching towards SD. This lack of SD's recognition in TE would compromise and limit learners' access to the education that promotes ESD. Therefore, the study explored Technology teachers' views about ESD. So, a framework was developed to guide the incorporation of ESD considering the local dynamics that impact on the teaching of Technology (see details in Chapter 6 Section 6.5).

1.3 STATEMENT OF THE PROBLEM

DBE (2011:10) emphasises that wherever applicable, learners should be made aware of different coexisting knowledge systems. Ultimately, they should also learn how indigenous cultures have used specific materials and processes to satisfy needs and become aware of indigenous intellectual property rights. In addition, the Technology subject aims to provide learners with an opportunity to appreciate the interaction between people's values and attitudes, TSE (DBE 2011:8). The CAPS underscores the recognition of IKS in TE. However, the CAPS is silent about ESD, therefore adding to teachers not considering ESD in their teaching. Reid (2002) claims that the implementation challenge of ESD may be a lack of concrete direction – designers of CAPS did not consider the need to include ESD, hence no direction was given. In a similar vein, Klarin (2018:67) claims that the concept ESD has been adapting to the contemporary requirements of a complex global environment, but the underlying principles and goals, as well as the problems of their implementation, remained almost unchanged. This suggests the importance of considering ESD for teaching in the school curriculum, TE curriculum in this case. I, therefore, hold that as much as CAPS document recognises IKS, it also lacks concrete direction on the implementation of ESD through TE. This problem leads to the following research question:

How can ESD be incorporated in Technology Education in indigenous contexts? The sub-questions are stated as follows:

- What understanding do Technology teachers have about ESD?
- What opportunities do the TE curriculum present to teachers to teach for ESD?
- How can Technology teachers use IKS to incorporate ESD in their teaching?
- How can the TE curriculum be re-conceptualised so that it includes ESD?

1.4 AIMS AND OBJECTIVES OF THE STUDY

The study aimed to explore ways that can make the teaching of Technology promote ESD. The following objectives are stated subsequent to the aim:

- To examine Technology teachers' understanding of ESD.
- To establish opportunities presented by TE curriculum that teachers can use to incorporate ESD in their teaching.
- To determine ways Technology teachers can use IKS to teach for ESD.
- To develop an IKS framework for the inclusion of ESD in the TE curriculum.

1.5 MOTIVATION FOR THE STUDY

As a Technology lecturer, my interest in the topic inspired me to conduct a study on the implementation of ESD in Technology, specifically by valuing IKS in the implementation. The research is informed by the results of a few studies on SD problems, though the studies were mostly conducted outside of South Africa, as follows: Canada, UK and Russian on the Perception of Sustainable Development and Education for Sustainable Development by African Technology Education academics (Pavlova 2011) and Kenya by Owuor (2007) on integrating African IK in Kenya's formal education system. Few studies conducted in South Africa on ESD in TE mainly focus on higher education. Subsequently, I was inspired to undertake a study on ESD in TE curriculum which considers the facets of IKS in its implementation, which is influenced by the country's cultural diversity. As a result, I believe it would open new avenues for ESD in TE. Therefore, the foregoing gave the impression that ESD will be well implemented if IKS is considered.

Furthermore, the results inspired me to present a quick overview of the significance of introducing ESD within the TE curriculum. Also, my goal in performing the research is to overcome the existing gap that restricts the integration of ESD in the subject Technology. Additionally, this research will guarantee new methods that will support teaching that recognises the worth of cultural practices, allowing for proper ESD implementation. This will equip Technology teachers with pedagogical tools to employ in their teaching, as well as new knowledge that will allow them to use IKS for incorporation of ESD.

1.6 OVERVIEW OF RESEARCH METHODOLOGY

The study is based on the constructivist paradigm and employs a qualitative research approach. According to Silverman (2021:3), qualitative research is the type of research that investigates about people's experiences. In the same vein, Pathak, Jena and Kalra (2013:192) assert that qualitative method is used to understand people's beliefs, experiences, attitudes, behaviour, and interactions. A descriptive case study design is also used in the study to examine teachers' perspectives on incorporating ESD into their classroom instruction. According to Khairul (2008:1063), a descriptive case study is an attempt to describe, such as what happens when a product is launched. The study targeted Senior Phase Grade 7–9 Technology teachers and CSA at Ehlanzeni District (comprised of Mbombela, Nkomazi, and Bohlabela sub-districts). Technology teachers were selected from two circuits which are Mbombela and Mgwenya. The General Education and Training (GET) Band Curriculum Subject advisor (CSA) belonged to Bohlabela sub-district. Thence, the Senior Phase Technology teachers were chosen to allow them to intensify awareness of ESD benefits and its importance in Technology Senior Phase. This study employed non-probability sampling, with a focus on purposive sampling. Purposive sampling technique is defined as the deliberate choice of a participant owing to the qualities the participant possesses (Ilker, Sulaiman & Rukayya 2016:2). Furthermore, purposive sampling is a non-random technique that does not need underlying theories or a set number of participants (IIker et.al. 2016:2). Interviews, observations, and document analysis are used in the study as data gathering methods after which thematic

analysis is used to analyse the data. The details of the research methodology are given later in the methodology chapter.

1.7 DEFINITION OF KEY CONCEPTS

1.7.1 Education for sustainable development

ESD is commonly understood as education that encourages changes in knowledge, skills, values, and attitudes to enable a more sustainable and just society for all. Furthermore, ESD aims to empower and equip current and future generations to meet their needs using a balanced and integrated approach to the economic, social, and environmental dimensions of sustainable development (UNESCO 2018:7). This definition resonates well with the key elements of IKS stipulated in the CAPS document which are the social, environmental justice and human rights. In adopting IKS and definition of ESD, I therefore hold a view that TE is a noble subject that can promote ESD. To the contrary, despite the knowledge and opportunities provided by the subject, teaching ESD in this study remains a challenge.

(ESD), is, therefore, a response to address the dangers faced by the world and to maintain the natural environment, to sustain human socioeconomic demands as a going concern. According to Goodland (1998) (quoted in Babatunde, Laseinde and Oluwafemi 2020:645), there are three key acts of ESD delivery:

> Firstly, harvesting renewable natural resources at a rate which is maintainable or within regeneration. Secondly, generate wastes and pollution within the assimilative capacity of the environment without impairing it and lastly, reduce the depletion rate of non-renewable natural resources equal to the rate at which renewable substitutes can be created.

According to Kopnina and Meijers (2014:189), ESD is described as “an approach to teaching and learning based on the values and principles that underpin sustainability,” which includes key issues such as human rights, poverty reduction, sustainable livelihoods, climate change, gender equality, corporate social responsibility, protection of indigenous cultures in an integral way, and this constitutes a comprehensive approach to quality education and learning. The

main issues of ESD as a sustainable solution are associated to the issues of social, environmental, and indigenous cultures. This is properly related to TE because Technology also underpins issues of social, environmental, and indigenous cultures.

1.7.2 Sustainable development

The World Commission on Environment and Development (1987) stipulates that SD is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Leiserowitz, Kates and Parris (2005:23) identify two subcomponents to an understanding of SD, which are ‘sustainability’ and ‘development’. Gumbo (2019:15) further outlines these two subcomponents with reference to nature, support for life and community (cultures, groups, places) and states that development is about developing people, economics, and society. These definitions sit well with the fundamental principles of TE, therefore, valuing learners’ cultures, community, and society in their learning is crucial towards establishment of sustainable development. In contrast, the study’s findings presented numerous ways of teaching towards sustainable development.

1.7.3 Indigenous Knowledge Systems

Gumbo (2016:39) posits that IKS are a reality characterising the philosophy and survival of indigenous communities. Bitzer and Menkveld (2004:227) define IKS as a combination of knowledge systems encompassing technology, philosophy, social, economic, learning/education, legal and government systems. Msila (2016:60) asserts that these systems are embedded in the culture and history of people including their civilisation. Agrawal (2002:287) points out that IK has a positive impact on development and environmental conservation. In relation to the foregoing, I argue that IKS place the teaching and learning in a better position to advance the ideals of ESD. Therefore, in relation to the study, the context of IKS showed that learning of ESD may be recognised as its application is more relevant to the TE content.

1.7.4 Indigenous knowledge

IK, as a component of IKS, is a multifaceted body of knowledge, practices and representations that are maintained and developed by peoples with long histories of close interaction with the local natural environment. IK is a process of learning and sharing social life, histories, identities, economic and political practices unique to each cultural group (Owour 2007:23). This reflects the uniqueness of ways that specific societies make meaning of the world and how such forms of knowledge address local problems and solutions that are context specific. Owour (2007:23) posits IK is framed as the complex set of activities, values, beliefs, and practices that have evolved cumulatively over time and is active among communities and groups who are its practitioners. It remains so as long as the groups and communities who are its practitioners are committed to sustaining, creatively developing and extending its potential enrichment within a specific setting. The pattern of IK is like the collective thinking of a place or region based on natural phenomena that incorporate human and non-human thought integration, such as the scientific knowledge rooted in the local culture (Alessa, Kliskey, Gamble, Fidel, Beaujean & Gosz 2016:92). IK relates to the people's cognitive and wise legacy because of their interaction with nature in a common region (Hart 2010:3). The definitions of IK described above imply the aspects of the environment and society which are considered in TE. Therefore, IK would promote the aspects of ESD in the subject. As a result, a framework was developed to give a foundation on ESD teaching within an indigenous context.

1.7.5 Technology

According to Ndlovu (2012:7), the Technology subject refers to the explicit curriculum taught in a school or other educational institution and seeks to develop knowledge, skills, values, and attitudes associated with the body of knowledge and activities of Technology. Indiana Technology Education Curriculum Standards (in Gumbo 2019:4) defines technology as a body of knowledge and action used by people to apply resources in developing, producing, using, and assessing products, structures, and systems to control and modify the natural and human-made (modified) environment. Gumbo (2016:7) views technology as pragmatic as it is more action-based to help humans to interact with the

environment of which they form an integral part. Moreover, Gumbo (2016:40) posits that technology is any human-made or culture-generated devices, formulations, or organisations utilisable for producing or creating needed goods and services. The adopted foregoing definitions are well attuned to ESD – technology is about people's daily activities for survival.

1.7.6 Technology Education

According to Mapotse (2012:16), TE involves understanding the use of technology and its impact on the individual and society. It is ultimately designed to enable and equip learners to perform effectively in the technological environment in which they live and to stimulate them to contribute to its improvement. According to DBE (2011:8), TE concerns technological knowledge and skills, as well as technological processes, and involves understanding the impact of technology on both the individual and society. Gumbo (2018:130) points out that TE provides learners with the opportunities to acquire technological knowledge and skills as they engage in problem-solving processes. The foregoing definitions of TE resonate well with the study because they contain the critical aspects that can help promote ESD, e.g. impact on society, technological environment and problem solving.

1.8 OVERVIEW OF CHAPTERS

Chapter 1 comprises the background, rationale, problem statement, research questions, aim and objectives, motivation for the study as well as the definition of key terms.

Chapter 2 outlines the theoretical framework for the study.

Chapter 3 presents the review of scholarly literature on the identified problem.

Chapter 4 discusses and motivates the research methodology used in the study.

Chapter 5 presents data analysis and findings of the study.

Chapter 6 discusses the findings of the study.

Chapter 7 concludes the study by summarising the findings, drawing relevant conclusions, and making recommendations.

CHAPTER 2

THEORETICAL FRAMEWORK FOR THE STUDY

2.1 INTRODUCTION

The theoretical framework that guided the study is discussed in this chapter. As a theoretical lens, the study used constructivism theory. The reason for selecting the constructivism theory is that it connects well with perspectival teaching and learning in TE, giving learners the opportunity to learn to combine thinking and doing in a way that connects abstract concepts to concrete knowledge in context. According to Liu and Matthews (2005:387), constructivist knowledge is actively built within the restrictions and offerings of the learning environment rather than being mechanically obtained. In this regard, the constructivist theory would serve as the foundation for the study. Therefore, this chapter discusses and motivates the social constructivism theory models guiding the study. In addition, the chapter explains how this theory is applied in the study.

2.2 THE CONSTRUCTIVIST THEORY

Constructivism is a philosophy that gained its popularity in the 1980s as the leading metaphor of human learning as interest in behavioural and information processing perspectives (Mayer 1996:151). The theory is used by many theorists and mostly across disciplines (Bruner 1960; Vygotsky 1962. Furthermore, Piaget (1954) is regarded as the pioneer of constructivism who emphasised in his writings such as the child's conception of the world, stage theory of cognitive development, the child's construction of reality. Subsequently, Dewey (1963) and Vygotsky (1978) expanded on the constructivist theory and its application in the classroom. They both agree that constructivism is a theory that outlines how individuals construct and modify knowledge because of social experiences.

Constructivism, according to Warrick (2001:1), is a centuries-old concept and therefore a popular educational theory that has been used as a teaching tool in

a variety of ways. According to Jia (2010:197), constructivism, like any other theories, has a foundation and a history. Consequently, philosophy and psychology have played a role in its development. For instance, Gordon (2008:324) argues that constructivists believe that what is deemed knowledge is always informed by a particular perspective and shaped by a specific ideological stance. On the contrary, Von Glasersfeld (1989:3) asserts that “the human mind can only know what the human mind has made.” According to Banerjee and Bhattacharya (2019:244), constructivism is a theoretical foundation that is characterised by the normative aspects of human consciousness in social life. Similarly, Hashmi, Wishal and Kiyani (2021:6) describe constructivism as a vibrant and self-motivated coaching paradigm that entails the formation of new academic concepts based on the learners' prior educational experiences. In addition, constructivism, according to Roya and Hanieh (2015:9), is a learning and thinking-based theory. Therefore, constructivism addresses how learners can make meaning of the material as well as how the subject may be taught effectively.

Roya and Hanieh (2015:9) argue that constructivism is an educational philosophy that teachers may explore to determine what learners know so to allow their own knowledge. Moreover, Fleming (2011:9) notes that the constructivist approach views learning as constructing new meaning based on existing information rather than accumulating knowledge. The constructivist theory is examined from various angles such as knowledge construction and social learning processes. Hence, there are various definitions; some scholars regard constructivism as a theory of knowledge, others as a theory of learning, and yet others as a philosophy of pedagogy (Roya & Hanieh 2015:10). In this study, however, constructivism is regarded as a theory of knowledge which can be useful for incorporating ESD into the TE curricula.

In the present study, constructivism emphasises the social interaction and learners’ prior knowledge. This supports ESD which considers learners’ cultural aspects such as language, tools, and communal resources. Therefore, IK and culture would potentially contribute positively to the teaching of ESD through TE. This notion supports Wheeler’s (2013:41) claim, who posits that SD requires

enormous changes in the way that things are currently done; this accounts for IK recognition. Hence, in this study, constructivism implies that IK would play an important role towards the incorporation of ESD in TE. Boon and Henz (2007) catalogued rich information about IKS, which may assist towards the incorporation of SD in Africa. This gives the impression that IKS connects well with the ancient land use and the agricultural practices which may be of importance in addressing the aspects of ESD. This idea supports Tharakan (2015:53)'s idea, who writes that IKS are always local-based and rooted to a particular place and set of experiences, as well as are generated by the people living in those places. Furthermore, Gadgil, Berkes and Folke (2021:967) argue that the wider recognition of IK is a positive development in today's way of living. Moreover, Tharakan (2015) posits that IKS addresses critical quality-of-life and standard-of-living issues. Therefore, IK highly implicates the need to integrate ESD in TE.

According to Cajete (2020:3), indigenous people have a strong connection to the land, and many still rely on it for a living in order to survive catastrophic crises such as diseases, extreme weather events, droughts, floods, wars, colonisation, and so on. In the case of climate change, there is evidence that indigenous leaders, through their inclusion, are realising that addressing basic sustainability factors, such as ensuring freshwater supplies, securing food supplies, and mitigating the impact on key plant and animal species, also necessitates attention to practiced forms of community (Cajete 2020:5). As stated by Cajete (2020:5), the incorporation of ESD necessitates the reformation of traditional eco-knowledge as well as the exercise of sovereignty at all levels.

Cajete (2020) argues that to address the basic sustainability factors, individuals should plan locally and collaborate with the neighbouring communities or tribes and educational institutions, non-governmental organisations and government agencies. Similarly, Gadgil et al. (2021:967) argue that if we want to calm the angry earth, we should look to the wisdom, knowledge, traditions, and practices of the ecosystem people. Therefore, the incorporation of IK in the setting of the study mixes well with the constructivist models or perspectives since the theory

can ensure that the design activities reflect the learners' history especially in the TE curriculum.

In support of the foregoing claims, Zindy (2021:8) asserts that in nations with diverse indigenous people such as Asia, different cultural knowledges have an influence on the ways of understanding about nature that compared to the Western modern perspective. The effect of IK originates through oral transmission from the ancestors, and it has generated the science-related knowledge or indigenous science. According to Zindy (2021:8), indigenous science can be understood in several ways, including traditional (native) knowledge (Stephens 2000), ethno-science (Fasasi 2017), and traditional ecological knowledge (Snively & Williams, 2016). Indigenous science and scientific perspectives on nature differ at various degrees across the human communities around the world. Indigenous science is made up of the local wisdom that is generally founded on a sacred reverence for nature as a form of responsibility and the indigenous peoples' interaction with nature (Knudtson & Suzuki 1993). Consequently, learning indigenous science may assist learners to recognise the strong relationship between humans and nature in their local environment's culture. This could be useful in the study of ESD in TE because the curriculum informs the integration of IKS in its topics, resulting in an opportunity to execute the notion through IK.

2.3 CONSTRUCTIVIST THEORETICAL PERSPECTIVES

Constructivism is categorised into three perspectives, namely, endogenous, exogenous, and dialectical constructivism (Hardianti, Ahmad & Hermansyah 2021; Moshman 1982; Veenman, Denessen, Van den Oord & Naafs 2003). The three points of view are thoroughly described in the sub-sections that follow.

2.3.1 Orientation into the constructivist theoretical perspectives

This sub-section discusses in detail the three perspectives in relation to the incorporation of ESD in TE in this study. ESD is one of the disciplines that have employed constructivism, conversely, dialectical constructivism (Armstrong 2011). Studies have explored the implementation of ESD in different fields such

as education, agriculture, health, etc., focusing on constructivism as an epistemological theory for ESD. Armstrong (2011:1) argues that the pedagogical predilections of ESD may be well understood through the exploration of the Progressive Era of Education's (PEE's) characteristics. These are mainly dialectical constructivism and learning that are characterised by active engagement and social interaction.

PEE is a new paradigm for education that arose with democracy as its tradition, whereas previously in education, traditionalists fought for a subject-centred curriculum. Therefore, the PEE's education with democracy comprised an individual and activity-centred curriculum emphasising real-world problem solving guided by a teacher in collaboration with the learners' own determination (Armstrong 2011:7). Consequently, most recently, Armstrong and LeHew (2013:5) argue that dialectical constructivism aligns with the pedagogical proclivities of ESD. The pedagogical philosophy of ESD is associated with high levels of social interaction (Armstrong & LeHew 2011:23).

Therefore, the aforementioned dialectical constructivist traits coincide with ESD's pedagogical proclivities. However, this study's focus is on the three perspectives of constructivism. These perspectives are discussed in detail in sub-sections 2.3.1.1-2.3.1.3. As a result, given that the aim of this study was to explore ways that can make the teaching of Technology promote ESD, I believe constructivist theory, with its three perspectives, is appropriate because the focus is to accommodate various learning contexts. According to Kara (2018:23), the use of multiple perspectives and multiple modes of learning makes learners see different aspects of the same content; this may also inform different knowledge.

Armstrong (2011) claims that the constructivist theory considers contextual factors such as social interaction and prior knowledge in knowledge formation. According to Armstrong, knowledge is more than just a reflection of one's mind; it is rooted in one's previous knowledge, values, beliefs, cognitive process, and surroundings. This implies that learners are groomed from their home contexts, bringing to the school environment packages of knowledge. According to Schunk (2008), the key assumptions of constructivists are that learners' activities lead to

the development of their own knowledge rather than mere acquisition of the same, and that truth is a dynamic foundation. Furthermore, Armstrong (2015:133) claims that constructivist pedagogical approaches to sustainable education (SE) are significantly connected. Hence, employing constructivism theory would inform a good framework for the implementation of ESD in the teaching and learning process as constructivism enhances learner engagement, social interaction, and the metamorphosis of the learner's beliefs (Armstrong 2011:8). When constructivism is considered as a pedagogical framework, the above characteristics provide the idea that ESD can be properly accommodated. Simpson (2002) (quoted in Armstrong 2011:8) avers that constructivism is a hypothesis about the nature of knowledge and how humans come at that information, which may inform the ESD educational practice.

Moreover, Khanum (2019:72) maintains that there are several pedagogical theories that are linked with ESD, emphasising the development of values, knowledge, and skills to support SD such as deep learning (Warburton 2003), active learning (Ellis & Weekes 2008), transformational learning (Kevany 2007), etc. Warburton (2003:46) argues that for a successful incorporation of ESD, teachers should provide a learning environment where learners would develop a strong personal interest towards sustainability. The learning of ESD should stimulate learners' interest to trigger deep learning, hence teaching should be inspired by transformative learning (Tillmanns 2020:14). This would enable learners to actively engage in learning of sustainability issues. Despite the pedagogical theories mentioned above, Khanum (2019:73) asserts that all the pedagogical theories associated with ESD embody the constructivist epistemology. In a similar manner, Fosnot (2013) argues that constructivism has enormous potential for the ESD integration. This implies that the Technology subject stands a great potential to incorporate ESD.

Therefore, Moshman (1982), in relation to knowledge construction in constructivism, outlined the three perspectives of ESD. According to Van Rooyen (2021:1), endogenous emphasises the coordination of previous organismic structures, exogenous emphasises the reconstruction of structures preformed in the environment and dialectical emphasises the construction of new structures

out of the organism and environmental interaction. Despite the points of view stated above, Armstrong believes that dialectical epistemology is the greatest philosophy for ESD as it promotes social interaction.

Conversely, Doolittle and Hicks (2003) (cited in Doolittle 2014:486) argue that knowledge construction is essentially an active process which could be both individually and socially shaped. The active process of generating knowledge is adaptive in the sense that the result is to improve the effectiveness of one's ideas and behaviours in relation to accomplishing one's goals. The individual and social interpretations of one's experience determine one's understanding of it. According to Doolittle (2014), the three constructivist perspectives allow for a considerable deal of variation in how knowledge is constructed. Moshman (1982) explains in detail the variety that is the continuum of knowledge formation, which comprises constructivism perspectives. Similarly, Doolittle (2014) has also used Moshman's continuum constructivism models (1982).

Doolittle (2014), on the other hand, highlights the three variations in light of today's perspective, which are commonly referred to as trivial constructivism, social constructivism and radical constructivism. These perspectives have offered justification for the inclusion of various varieties of constructivism (Table 2.1). According to Doolittle (2014), there is interdependence in the formation of knowledge. These perspectives are discussed in detail in 2.4.

Table 2.1: A Constructivist Continuum (adopted from Doolittle 2014:486)

Trivial Constructivism	**Social Constructivism**	**Radical Constructivism**
◄──────────	──────────	──────────►
• Exogenous Constructivism • Cognitive Constructivism • Information Processing Constructivism • Psychological Constructivism • Naïve Constructivism	• Dialectical Constructivism • Social Constructionism • Sociocultural Constructivism • Symbolic Interactionist Constructivism • Idea-based Social Constructivism	• Endogenous Constructivism • Schema-based Constructivism • Emancipatory Constructivism • Developmental Constructivism • Psychological Constructivism

In accordance with Table 2.1, knowledge acquisition is associated with exogenous constructivism in trivial constructivism because it is a representation of the external world. In radical constructivism, knowledge acquisition is internalised. Hence, radical constructivism and endogenous constructivism are related. Social constructivism, on the other hand, is centralised, with meaning influencing both trivial and radical constructivism. Subsequently, knowledge acquisition is influenced by one's sociocultural background, prior experiences, or culture because of interactions with others or direct instruction. As a result of its interactional nature, dialectical constructivism is related to social constructivism.

According to Malik (2021:15), constructivism is a collection of multiple perspectives rather than a single viewpoint. In the same light, Yilmaz (2008:163) points out that constructivism is not a single or unified theory; rather, it is distinguished by multiple and diverse perspectives. Philips' (1995) diverse theoretical perspectives explain various aspects of constructivism such as cognitive development, social characteristics, and the impact of context. In

addition to this, Malik (2021:1) views the concept as a situational action in which learners are active, are in control, and are at the centre of the learning. Hence, the constructivism theory towards ESD in TE could allow the use a variety of pedagogical styles or approaches that would foster a learning environment in which learners can study on their own. The variety of the pedagogical styles or approaches may lead to a creation of diverse activities that could allow learners' exploration that could enable them to go beyond the essential requirements of learning as viewed by traditional teaching methods.

By incorporating endogenous, exogenous, and dialectical constructivism, the use of pedagogical styles or approaches and the production of diverse activities might be better understood and practised. Hence, the three perspectives in this study intend to drive the incorporation of ESD in TE, allowing for a variety of the teaching approaches. These perspectives are discussed in-depth in the following sub-sections.

2.3.1.1 Endogenous constructivism

Endogenous learning emphasises the individual existence of each learner's knowledge-building process and sees the teacher's role as merely facilitating the occurrence of disequilibrium through the provision of acceptable experiences (Moshman 1982:374). The use of endogenous in this study would allow learners to interact with the material being offered to develop knowledge under the facilitation of the teacher. Moshman (1982 in Van Rooyen 2021:4) emphasises the individual nature of each learner's knowledge construction process and proposes that the teacher's role (in a pedagogical context) should be to act as a facilitator in providing experiences that are likely to result in challenging learners' existing models.

The endogenous puts emphasis on the teacher as a source of knowledge for learners. This could imply that the endogenous aspect enables teachers to ensure teaching that allows learners to discover new information based on the teacher's guide to discover indigenous ways that may aid in the understanding of the concept ESD during the process of teaching and learning in the TE curriculum. The training in the endogenous constructivism would emphasise a

pedagogy that would help teachers to provide experiences related to the notion of ESD. The discoveries in the study could enable the teacher to facilitate the learning process in a way that would pique learners' interest in exploring the topic with reference to the teacher's experiences. Velthuizen (2012:75) adopted the phrase endogenous knowledge, which has supplanted the term indigenous knowledge. The term ‘endogenous' refers to an idea that is generated, developed, grown, or discovered from within (Dalgarno 2002; Veltthuizen 2012). Therefore, this implies that local knowledge may be affected by contact with the surroundings or other influences. Furthermore, Velthuizen (2012) asserts that endogenous knowledge is influenced by specific social systems such as indigenous knowledge, external knowledge, cultural meaning-making, learning tools and technical tools. Hence, in the context of the study, it presented numerous opportunities that considered components of IK in order to develop ESD in the topic of Technology. Endogenous would place a strong emphasis on the use of cultural tools within surroundings, which would have a significant impact on the teaching and learning of the ESD idea. Learning is drawn from 'living campuses,' which are places where individuals live.

Consequently, IK in the context of ESD in Technology would contribute a wealth of knowledge as a distinctively African contribution to any body of knowledge that would aid in the integration of ESD into the curriculum. IK to ESD implementation would give meaning creation within a cultural context, and with the endogenous, the implementation would be viewed as equally essential as other knowledge inputs from a larger global society. Three identified contributions made endogenous constructivism outstanding, that is, it: (1) allows for the spread of information between cultures without supposing knowledge to be static, preference for African theorist and academics; (2) aids individuals to actively construct new knowledge from the existing one; and (3) is relevant to the development of learners from novices to the competent (Velthuizen 2012; Van Hover & Hicks 2017; Malik 2021). Therefore, in the context of the study, this may mean that through teacher’s interaction in the classroom would enable learners to continue to interact with their surroundings to further gain knowledge/access to the knowledge of ESD. Therefore, in this study, the endogenous perspective

would aid in determining teachers' comprehension or awareness of the topic ESD in TE.

2.3.1.2 Exogenous constructivism

Exogenous knowledge is "derived from one's surroundings" and is a "reconstruction of structures (empirical correlations, provided information, observed behaviour patterns, etc.) pre-formed in external reality" (Moshman 1982:373). In addition, exogenous constructivism, as defined by Van Rooyen (2021:4), is a constructivist perspective that holds that learning occurs because of an individual engaged in cognitive processes that relate prior knowledge to experiences. This implies that the learner interacts with the outside world to build on new information (Carroll, Sun & Beck 2019:37). Additionally, exogenous constructivism refers to the idea that knowledge is acquired by a reconstruction of structures that already exist (Moshman, as cited in Malik 2021:15). Hence, exogenous constructivism in ESD teaching would allow learners to interact with their surroundings to build on new SD channels.

When a teacher uses exogenous constructivism in his or her teaching, it indicates that the teacher would reflect on environmental structures that could motivate learners to interact with the topic. According to the study, the exogenous constructivism would channel the incorporation of indigenous traditions that can be used in TE to recognise ESD. Learning, according to Piagetian terminology, is primarily an adjustment of the organism's former structures to those imposed by its current environment. Though the creature (or its past knowledge) accomplishes some of the accommodating, the environment directs the accommodation by providing the structures to which the organism must adjust. Within this paradigm, knowledge is conceptualised mechanistically as a set of intricate, flexible, and open frames, scripts, networks, schemas, hierarchies, or production systems made up of discrete content-laden elements that operate in real-time and have no systematic properties other than those of the elements of which they are made up. The application of the exogenous constructivist approach would advocate for knowledge of opportunities about pedagogical tactics that teachers may utilise to teach ESD.

2.3.1.3 Dialectical constructivism

The role of social interaction in the learner's knowledge-building process is emphasised in dialectical constructivism, which contributes to a focus on cooperative and collaborative learning strategies. Dialectical constructivism also stresses the provision of instructor or professional guidance for learners and cooperation with peers as they perform tasks at the edge of their abilities. (Moshman 1982:375). Similarly, Vygotsky (1978) attests that what a child can do in collaboration today he will be able to do independently tomorrow. So, these perspectives have the undertones of cultural diversity and intercultural understanding in the teaching of Technology. Rathod (2013) asserts that cultural diversity is a central source of sustainable development for people, societies and countries and has a significant impact on ESD. Therefore, these perspectives practically inform a better implementation of ESD in the TE curriculum since the teaching of Technology is rooted in real-life situations.

The dialectician sees the source of all knowledge as the ongoing exchanges between organism and environment (Van Rooyen 2021), neither of which can impose itself on the other. New knowledge is a synthesis that resolves the unavoidable inconsistencies that arise throughout such encounters. In the context of the research, dialectical constructivism will place a greater emphasis on interactions between learners, their cultural backgrounds, and their surroundings. Dalgarno (2002:7) agrees that learning in groups allows for the development of conceptual understanding through a social learning process. As sustainability considers the realms of the environment, society, and economics, as well as the cultural dimension (UNESCO 2012:1), the aforementioned context suggests that the dialectical enrich learners learning of the concept ESD while taking societal knowledge into account. This could be based on the incorporation of cultural instruments that would enable the teaching and learning of ESD in TE.

In terms of cultural tools, they could offer learners knowledge that would allow them to know and comprehend ESD better. Specifically, the ancient techniques that were used can be examined to ensure environmental safety as they engage. In general, cultural diversity would create an atmosphere that would have an impact on the adoption of ESD in Technology curriculum. The application of

dialectical constructivism could create an atmosphere in which learners would interact with their surroundings to produce their own understanding of the idea. According to Carew and Mitchell (2008:4), SD is a socially created notion that considers both the factual and ethical sides. Essentially, the factual side has an awareness of the interrelationships between the human and environmental systems (Takala & Korhonen-Yrjänheikki 2019:171).

Finally, the ethical aspect is based on the fact that SD takes shape and relevance in a social discussion about what is valued and worth aiming for, i.e., what development is regarded to be (Blewitt 2008). Therefore, in support of the foregoing, Shrivastava, Smith, O'Brien and Zsolnai (2020:329) write that for earth sustainability science must engage with society and creatively employ all available sources of knowledge, in this case, may be IKS. Proportionately, dialectical constructivism could create situations in which a teacher can complement learners as they complete tasks. Moreover, Savaş (2016:905) posits that the social negation of understanding and meaning is emphasised in constructivism. Furthermore, the main purpose of constructivism is to stimulate learners to transfer their knowledge into real-life situations, the environment resulting in learning in the classroom should eventually be correspondent with the complexity of the target environment. Hence, constructivist teachers, according to Savaş (2016), have an important role in establishing constructivist learning environments. So, the integration of the three perspectives would have a significant impact in establishing a constructivist learning environment to further the application progress and understanding of the ESD concept in TE.

In addition, Barab, Evans and Baek (2013:201) posit that development cannot be isolated from its social and cultural context; so, the best way to investigate mental processes is by considering the mediation principle of Vygotsky, which made a breakthrough in understanding the development of learners. In addition, social contact with cultural objects is the most significant aspect of the psychological growth of the learner (Barab et al. 2013; Vygotsky 1962). This development would provide learners with an opportunity in TE to interact socially to have an enhanced understanding of SD. In support of the foregoing, Antonopoulou (2011:10) outlines artefacts as one of the key elements to what TE is about,

although there are different views on how artefacts relate to TE. All the items we use include these cultural artefacts or objects, from basic things such as a pen, spoon, or table, to more nuanced things such as language, rituals, values, arts, or science (Armstrong 2011; Vygotsky 1982).

Consequently, the knowledge and practices of technology are incorporated, routinely understood, and contextually linked to purpose and society. Therefore, technical activity is closely related to social circumstances and needs, and these conditions continue to change (Gumbo 2015; Harper 1987). A dialectical viewpoint would lead to an understanding of opportunities for teachers to teach ESD in the TE curriculum linked to social learning. So, the dialectical viewpoint would be useful in addressing the re-conceptualisation of the TE curriculum toward the framework of *Ubuntu* and acknowledgment of IKS.

According to Armstrong and LeHew (2013), the constructivist views vary primarily in the timing and amount of support provided to the learner as well as the sort of knowledge that is built. Therefore, the use of the three perspectives could lay a proper foundation for ESD in the subject as this would promote the employment of transformative approaches and critical constructivist learning for ESD.

2.4 PERSPECTIVES OF CONSTRUCTIVIST THEORY

There are different types of constructivism, i.e., social, radical, trivial, cultural, critical, and psychological constructivism (Abhilasha 2020:27). In addition, Brau (2020:20) claims that constructivism is divided into two camps, i.e., radical constructivism and social constructivism. Similarly, section 2.3 elaborated the three perspectives of constructivism, i.e., social, radical, and trivial constructivism as they are interdependent. Hence, Doolittle (2014) identifies dialectical constructivism as social constructivism, endogenous constructivism as radical constructivism, and exogenous constructivism as trivial constructivism. As a result, these three perspectives are further discussed in the following paragraphs.

Cheli (2018:1) describes the radical constructivism as an epistemological perspective that views knowledge as an agent's active and dynamic construction,

and its own value as created by its viability in the agent's world of experience rather than in comparison to external reality. Furthermore, in table 2.1, social constructivism falls between trivial and radical constructivism. This suggests that knowledge formation is the consequence of the learner's interaction with the environment, including other learners (Doolittle 2014). In addition, in social constructivism, knowledge is the consequence of the social experience influenced by one's socio-cultural history, resulting in a transformed representation of experience. In essence, external social experience leads to the construction of internal structures that are influenced by social, cultural, contextual, and activity-based factors (Doolittle 2014; Ernest 1998). Similarly, Vygotsky (1986) highlights that the individual's cognitive system is a result of communication in social groups, and it cannot be separated from his/her social life. Therefore, the social constructivism's emphasis is on learning through social interaction (Kukla 2000; Rannaikmae, Holbrook & Soobard 2020). Personal constructivism is another name for trivial constructivism (Abhilasha 2020:27). Furthermore, Abhilasha (2020) maintains that information under trivial constructivism is actively built by the learner rather than it is passively received from the environment.

Hence, social constructivism is relevant in this study because it focuses on social interactions. Also, it may play a significant role in determining how ESD might be included into TE curriculum in indigenous contexts. According to Shava, Zazu, Tidball, and O'Donoghue (2009:226), communities can gain the enhanced capacity to deal with future goals, which in this case could be ESD, through social learning processes. Furthermore, Rannaikmae et al. (2020:266) posit that social constructivism encourages collaboration and problem-solving in the pursuit of meaningful knowledge construction. Collaborative learning has a social constructivist meaning based on social relationships in a community of learners where learning is acculturated into knowledge networks and deeper in epistemological foundation (Abhilasha 2020; Rebecca 1997). Hence, the collaborative learning process takes place within a specific social context. Therefore, context and situated cognition are one of the other examples of social constructivist notions (Rebecca 1997). This means that learning in social constructivism is completely contextualised. Moreover, this implies that learners

learn while participating in the socio-cultural activities of their learning community, which transforms their knowledge and responsibilities as they do so (Rebecca 1997:448).

In this study, situated learning and culture relate to social constructivism and might play a significant role in ESD teaching and learning. According to Lave and Wenger (1991) (quoted in Chiou 2020:442), practical knowledge is placed in the relationships between practitioners, social organisations, and communities of practice (CoP). Therefore, knowledge and practice should be included in learning (Lave & Wenger 1991). According to Chiou (2020), knowledge and skills in the situated learning approach are entrenched in real-life contexts. As a result, the study is developed within the context of situated learning while taking legitimate peripheral participation (LPP) and CoP into account. LPP, CoP and culture are all factors that could play a significant role in integrating ESD into the TE curriculum. As a result, these topics are covered in depth in section 2.5.

2.5 THE ROLE OF SOCIAL CONSTRUCTIVISM IN TEACHING AND LEARNING OF ESD

In this study, the implementation of ESD is centred on social constructivism. According to Malik (2021:1), social constructivism is crucial in teaching and learning. The theory of social constructivism postulates that understanding, importance and meaning are produced in collaboration with other humans (Roya & Hanieh 2015:13). In this study, social constructivism would allow teachers and learners to promote the use of local knowledge for the incorporation of ESD within the topic of Technology. Given the foregoing, Vygotsky (1978) contends that cognitive development occurs first at the social level, and secondly, within the person. Vygotsky (1978) defines the Zone of Proximal Development (ZPD) as learner development toward knowledge construction through social interaction. According to Vygotsky (1978) (quoted in Armstrong 2015:133), ZPD is concerned with knowledge transformation through interactions between the learner and the environment.

The interactional character of knowledge is underscored by social constructivism. The interaction between the learner and the environment, including other learners, results in knowledge. Learning is the process of developing internal models or representations of external structures based on interactions with people, direct instruction, and modelling, as filtered through and impacted by one's beliefs, culture, prior experiences, and language. According to Derry (1999), social constructivism emphasises interaction on culture and context in explaining what happens in society and knowledge construction. Roth (2000) accentuates that before knowledge is internalised, the roots of an individual's knowledge can be discovered in their interactions with their surroundings and other people.

As a result, social constructivism places a focus on collaborative learning. Similarly, the subject Technology encourages collaborative learning and teamwork. Hence, these skills in the teaching and learning process may have an impact on the development of ESD since social constructivism enables learners to engage with their surroundings while learning. Consequently, learners could be able to construct knowledge as they learn. Parsons (2008:80) proposes that a school is an agency of socialisation, therefore helping to hold society together. Therefore, in the context of the study, this could mean that learners must be placed in a position to analyse a context that represents an ecological system, in which the various elements intersect as in an ecosystem.

In this form, learners can gain a more complex understanding of the interdependence between the organisation of social life and ecological problems. Prioritising the learners' locale in their learning means that the nature of social engagement provides learners with a variety of experiences. In this study, learners were studied within a particular social cultural context (classroom in this case) which supported the collaborative learning practices valuing the manifestations of knowledge in their actions during learning (Subban 2006). According to Beresford (2005) (cited in Gumbo 2019:33), social constructivism incorporates several ideas that encourage social learning, such as co-learning, learning commitment, cooperation, involvement, and so on. These concepts place a premium on communal learning.

The CoP would provide opportunities for teachers to discuss their previous experiences and the utilisation of common resources to implement ESD. Gumbo (2019:33) asserts that the community creates a setting that allows conversations concerning the communal setups in which human endeavours can be revealed. Moreover, the CoP considers cultural characteristics which connect well with social aspects since it supports teaching that recognises learners' background, cultural identity, language, and family structure, which they bring into their learning context. As a result, social constructivism, combined with communal practice, may better allow for the incorporation of the ESD in the subject Technology, as the subject recognises IKS in its teaching.

Hence, it would mean that teaching the ESD principles in the framework of CoP and social constructivism may promote teaching the ESD concepts in the context of *Ubuntu.* Education for *Ubuntu* in this study could provide learners with the prerequisites of characteristics and dispositions that are grounded in the communal understanding of personhood and humaneness towards addressing social and cultural difficulties in their society (Letseka 2013; Masolo 2010). Hence, teaching within the context of *Ubuntu* could aid in the reconceptualisation of TE curriculum to incorporate ESD.

Therefore, these would be an instruction that incorporates IK into its content. Hence, in articulating the concept of *Ubuntu*, Letseka (2013) draws on indigenous education. According to Letseka (2013), the components of IK should be valued in education. There are various components of IK (Gope, Behera & Roy 2017:891). The components, to mention a few, include a) culture which has to do with every member in a community considered for cultural transformation within a family structure; b) community-specific knowledge which means that IK is community oriented; c) agriculture because farming activities are done with the use of IK. According to Olaide & Omolere (2013:88), IK makes a significant contribution towards SD of local communities, as it is seen as a set of perceptions, information and behaviour that guide local community members on the use the land and natural resources. In addition, Gadgil et al. (2021:967) assert that IK for biodiversity conservation is as relevant today as it was in the past.

Similarly, Letseka (2013) believes that education is more than just schooling; it also includes the transmission of societal cultures from one generation to the next. Therefore, educating young people should include exposing them to cultures other than their own.

In the same vein, Adeyemi and Adeyinka (2002:223) posit that education in Africa before to colonisation was exclusively indigenous, known as indigenous education. Masolo (2010), for example, accentuates that in most traditional African communities, individuals were taught about the structure of their environment and their place within that structure through social education. From this vantage point, these may be related to the components of ESD such as social, environmental and economic considerations. Furthermore, according to Adeyinka and Ndwapi (2002), African schooling was communal. This means that the primary goal of African traditional education was to instil in the young people the spirit of *Ubuntu* so that everyone would regard herself/himself as part of the community, working and living together toward a common goal.

Khupe (2020:458) asserts that IKS is centred on indigenous people's priorities with space given for communal decision making, power, and knowledge sharing with local communities. As a result, the context of *Ubuntu* in ESD is critical since it would allow for a good assimilation of ESD informed by the three perspectives. The three views translate into types of constructivism that support the conception of constructivism; hence the three perspectives are linked to one another (Hardianti et al. 2021: 247). As a result, the interrelationships between these perspectives are well linked with the IKS elements and so, they play a significant role in understanding the theoretical framework of the study towards ESD inclusion in TE. In the next sections, these points of view are elaborated on in further details.

2.6 THE APPLICATION OF SOCIAL CONSTRUCTIVISM IN ESD

According to Gumbo et al. (2019:33), social constructivism as a subset of constructivism enlivens the curriculum by drawing on the learners' diverse experiences. Furthermore, as previously outlined, social constructivism

incorporates several theories that promote social learning. Hence, much emphasis on collaborative learning, with situated learning, collaborative inquiry, and problem-solving anchoring education and stimulating learners' interest in the constructivist classroom (Rannaikmae et al. 2020:266). In addition, Jha (2017:66), emphasises collective learning where the role of teachers, parents, peers, and other community members are helping learners and making learning fruitful. Therefore, the stated traits and three components of collaborative learning play an essential role in determining how ESD might be included in Senior Phase TE contents in indigenous contexts, particularly in the teaching of TSE. TSE could drive ESD within TE since the contents of TSE have a great potential to address the aspects of ESD such as social, environmental, and economic aspects. Learning in TE, particularly TSE, emphasises teaching that demonstrates the interrelationship between technology, society and the environment while recognising various indigenous cultures.

Therefore, social constructivism in this study may aid in establishing Senior Phase Technology teachers' understanding of ESD, identify the opportunities that TE curriculum has that teachers can use to teach for ESD, determine ways how Technology teachers can use IKS to incorporate ESD, and lastly how can the TE curriculum be reconceptualised so to include ESD. The features mentioned above stem from the objectives of the study. As a result, the components of social constructivism that are relevant to this study are discussed in the subsections that follow.

2.6.1 Collaborative learning

In a constructivist classroom, collaborative learning is anchored instruction and encourages learners' enthusiasm in their tasks (Rannaikmae et al. 2020:264). According to Zhu (2012:128), collaborative learning is a social interaction involving a community of learners and teachers in which individuals acquire and share experience or knowledge. Collaborative learning in this study acts as a guide for building relationships between learners, teachers, and communities as well as to produce meanings related to ESD in TE. According to Pritchard and Woollard (2010:7), learning in social constructivists classroom is a social process

in which social contact between and among people supports knowledge production and the formation of meaning in the context of solving authentic issues.

Consequently, Gumbo (2019) outlined that collaborative learning values situational learning, inquiry-based learning and problem-solving. Gumbo (2016:17) argues that TE provides learners with a variety of skills that they learn alongside knowledge, including designing, decision making, evaluation, communication, time management, cooperation, and problem-solving. The variety of skills could also be achieved through the social constructivist approach. Furthermore, social constructivism can well be located within a situated learning approach (Comas-Quinn, Mardomingo, & Valentine 2009:12). As a result, situated learning in this study may contribute to the incorporation of ESD in TE in an indigenous environment as the subject Technology is grounded in real-world processes. Situated learning, as discussed in section 2.4, informs learning that is related to the material, the social environment of the learning situation and the socio-cultural milieu (Gessler 2009:1622). According to Lave and Wenger (1991), situated learning is embedded in daily action, setting and culture, as well as fundamental social factors. Furthermore, situated learning is a process that occurs in CoP through legitimate peripheral participation (LPP). The CoP fits well within situated learning since it emphasises that learners learn with and from one another in practice (Lave & Wenger 1991). Additionally, Riel and Polin (2004) asserts that people co-construct knowledge by building on the ideas and practices of group members. Then, the situated learning constructs are described in the subsections following.

2.6.1.1 Legitimate peripheral participation (LPP)

According to Lave and Wenger (1991), the importance of relationships and exchanges between newcomers and old-timers or more knowledgeable others is emphasised by LPP. Müller (2022) connotes that LPP focuses on apprentices learning from masters as community practitioners through a situated learning activity. Orsmond, McMillan and Zvauya (2022) indicate that knowledgeability, knowledge formed by a person in practice changes as learners change through relational ongoing practice with diverse others participating differently. Similarly,

Urbanska et al. (2022) conclude that teachers are important transmitters of knowledge also in the context of sustainability. From an indigenous perspective, teachers may be beginners, whereas elders in the community may be familiar with cultural skills that can help with adopting ESD in indigenous situations. Conversely, the notion of Vygotsky's ZPD details what a person can learn when learning is supported by a more knowledgeable other. Hence, LPP in the context of the study would play a critical role in constructing a re-conceptualisation of the TE curriculum to include ESD, particularly TSE in its contents. Therefore, the LPP resonates nicely with the endogenous viewpoints outlined in sub-section 2.3.1.1.

2.6.1.2 Community of practice (CoP)

Gumbo (2019:33) views learning as a socially communal event that encourages knowledge co-creation. In the same vein, Wenger (1998:1) asserts that participation in social practice is the primary method through which we learn. In this study, CoP would provide contextual direction for the incorporation of ESD in TE topics because ESD would be taught in indigenous contexts. Wenger, Trayner and de Laat (2011:11) define CoP as a learning partnership among people who find it beneficial to learn from and with one another about a specific area. According to Hayes and Shea (2017:211), there are three principles that drive CoP, which are domain, community, and practice. Wenger (2004) defined the principles in detail as follows:

- **The domain:** Domain is about the area of knowledge that brings the community together, gives it its identity and defines the key issues that members need from a network of connections between people. The domain in the study would open new avenues for the provision of knowledge about the ESD issue in TE.

- **The community:** The community is about the group of people for when the domain is relevant, the quality of the relationships among members and the definition of the boundary between the inside and the outside. For a group of people to constitute a CoP, its members must come together around ideas and interest with each other to learn together. The teaching

of ESD would be contextualised within the CoP, resulting in community recognition.

- **The practice:** Practice is regarded as a body of knowledge, methods, tools, stories, cases, documents, which members share and develop together to address recurring problems in their specific contexts. In tackling ESD challenges within TE understanding of cultural tools, IK may play an essential role in ESD teaching and learning.

Hence, the above concepts were deemed relevant in this study because they would play an important role in the integration of IKS in the contents of TE to incorporate ESD. As a result, the learners' cultural backgrounds would play an important part in ESD implementation. Wenger (1998) identifies three interconnected elements that characterise CoP: (1) cooperative enterprise, (2) mutual engagement and (3) shared repertory. So, the aforesaid notions and dimensions of CoP are closely aligned with the elements of exogenous and dialectical viewpoints discussed in sub-section 2.3.1.2-2.3.1.3.

2.6.1.3 Culture

According to Kim (2001:2), social constructivism underscores the relevance of culture and context in comprehending what happens in society and developing knowledge based on this understanding. Culture is inextricably linked to social circumstance. Gyekye (1997:44) defines culture as "socially developed and maintained ideas that constitute the bigger share of our necessary social framework." Furthermore, Eisenhart and Borko (1993:43) define culture as a group's way of existence, which includes its specific adherence to certain values and subsistence patterns.

Hence, in this current study, culture would play an essential role in the adoption of ESD in TE through IKS. According to Sithole (2007:117), IK is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiences, and intimate understating of the environment in a given culture. Ultimately, the cultures considered in the study include isiSwati, siTsonga, and Sepedi because they are prevalent in the province of

Mpumalanga, particularly in the Ehlanzeni District. Furthermore, Aikenhead and Ogawa (2007:554) delineated that IK is a community-based tradition that has evolved over multiple generations, is usually passed down orally from one generation to the next, and employs rituals, ceremonies, and songs. According to Sithole (2007:118), IK is primarily tacit, embedded in the behaviours and experiences of those who hold it. Hence, African indigenous forms of knowledge have been conducted through various routes and have mostly been communal and participatory (Imenda 2017:10276).

Gumbo (2020:78) believes that Technology as a subject provides a platform for successful learning, which is especially important in indigenous environments. Hence, in this study, IKS is viewed as an important educational cultural tool that would play an important role in the implementation of ESD in the TE curriculum. According to Barnhardt and Kawagley (2005) (quoted in Naidoo 2010), IK is still effective today in solving SD concerns like underdevelopment, sickness, starvation, and so on. Furthermore, according to Ocholla and Onyancha (2005:247), IK is regarded as a dynamic archive of the sum of knowledge, skills and attitudes belonging to a community over generations and expressed in the form of action, object and sign languages for sharing. Hence, IKS is significant in this study because it would enable teaching that recognises learners' varied cultures in the TE classroom. These would therefore play an important part in ESD inclusion in TE topics, and IK would also play an important role in building pedagogical tools that Technology teachers might employ to teach for ESD.

In this case, IKS might create an environment that would embrace ESD within the context of *Ubuntu* as it is an accurate manifestation of Afrocentricity enshrined in activities of a tradition of collective engagement, experimental learning, demonstration and orality (Gumbo 2020; Mawunga-Zake 2010).

In a similar spirit, Murithi (2006:28) claims that *Ubuntu* can be found in a variety of forms in various African communities. According to Broodryk (2006), *Ubuntu* is a community way of living that believes society should be administered for the benefit of all, involving cooperation as well as sharing and compassion. As a result, in the context of the study, *Ubuntu* should play an important role in

determining how TE curriculum might be reconceptualised to embrace ESD in its contents. Furthermore, Wenger (1998:228) contends that the formation of communal learning is dependent on a dynamic combination of participation, imagination, and alignment. These means of identification correspond nicely with the main qualities of *Ubuntu*. Consequently, the modalities of identification would inform social involvement in ESD among teachers, learners, and the community in this present study. However, these features would be observed further during interviews and observation sessions.

2.7 SUMMARY

The chapter has established the study's theoretical framework, which is based on constructivism theory and the IK. The use of constructivism and IK has shed light on the fact that, if properly included, they can bring value in addressing the components of ESD in the study. Constructivism and IK suggested that there could be an atmosphere that would allow ESD to be incorporated into TE. Furthermore, the approaches can give learners an insight into how culture can influence their understanding of the notion of ESD. The viewpoints offer strategies for teachers to employ in incorporating and reconstructing valuable IK culture and/or local wisdom for ESD implementation. In conclusion, social constructivism and its constructs were discussed in detail. It is, therefore, concluded that the constructs of social constructivism in this present study play an important role in how ESD can be incorporated in TE curriculum in indigenous contexts. It is in this stance that the study saw a need to integrate IKS to incorporate ESD in the TE contents.

The study highlighted the three constructivist perspectives which are endogenous, exogenous, and dialectical constructivism. It is in this regard that these perspectives could have great potential towards the integration of ESD in the subject Technology as it correlates with the constructs of social constructivism thus: collaborative learning and culture. The study further outlined the aspects of collaborative learning embedded on situated learning that is LPP and CoP as an anchored for the instruction of ESD in the subject Technology. The aspects gave an insight on how the knowledge the other could have an

influence in knowledge construction. Hence, on the other side, CoP highlighted the impact of communal learning on ESD. The following chapter will explain the literature review, discuss the importance of ESD in TE, and explore variables impacting ESD's place in the Technology field.

CHAPTER 3

EDUCATION FOR SUSTAINABLE DEVELOPMENT

3.1 INTRODUCTION

Education is inextricably linked to sustainability (McKeown, Hopkins, Rizi & Chrystalbridge 2002:13), hence, the exploration of the concept education for sustainable development in Technology Education. The ESD concept is predicated on the execution of teaching and learning activities that are both regionally and culturally relevant. As a result, the study aims to explore ways that can make the teaching of Technology to promote ESD. Consequently, this scholarly literature review discusses the critical aspects of sustainable development for human capital development and the link between the TE curriculum for Senior Phase Grades 7-9, indigenous knowledge systems, and ESD relating to different policies on ESD. Furthermore, the chapter explores indigenous opportunities for ESD teaching and learning in TE.

3.2 SUSTAINABLE DEVELOPMENT FOR HUMAN CAPITAL DEVELOPMENT: POLICY IMPERATIVES

In the 21st century, interest in sustainability is growing (Di Fabio and Peiró 2018:1). According to McKeown et al. (2002:7), people across the world recognise that current economic development trends are unsustainable, and that public awareness, education and training are critical to shifting society toward sustainability. Furthermore, Emas (2015:3) asserts that the main goal of SD is long-term economic and environmental stability, which may be attained through the integration and recognition of economic, environmental, and social issues in decision making, hence the aim of the study as stated above. This chapter covers the pertinent literature and the views that are based on different policies towards SD, such as the United Nations (UN), the African Union (Agenda 2063), Agenda 2030, and the South African National Framework. This section focuses on the above policies.

According to Luetz and Walid (2019:307), SD is the notion that was initiated as an environmental concept. In contrast, the contemporary underlying framework of SD was formed between 1972 and 1992. However, its origins may be traced back to the 18th century (Luetz & Walid 2019). Nonetheless, interest in sustainability and SD grew in the 21st century because of new global economies characterised by acceleration and complexity, developing difficulties and resource consumption and exploration, and the associated hazards for future generations (Di Fabio & Peiro 2018:1). The notion of SD was initially endorsed by the UN General Assembly in 1987. Following that, the notion grew as debates about ESD issues were captured in Agenda 21, emphasising education, public awareness, and training.

Furthermore, the UN created a post-2015 development strategy with the goal of improving our world, i.e., the agenda 2030 for Sustainable Development (Field & Feldman 2015). Agenda 2030 advocates a rapid shift in the world's direction toward sustainability and resilience. This agenda considers the 17 SDGs; the targets are interwoven and indivisible and balance the three components of SD which are economic, social, and environmental concerns. On the contrary, a 50-year continental framework, Agenda 2063, was devised based on the African Union's (AU) vision of an integrated, wealthy, and peaceful Africa, driven by its own population, and representing a dynamic force in the world arena. The AU is a collaborative strategy framework for inclusive growth and long-term development.

Agenda 2030 and Agenda 2063 envision a world in which every country enjoys sustained, inclusive and sustainable economic growth, decent jobs, and quality education for all. South Africa then created a National Framework for Sustainable Development (NFSD). The framework's objective is to articulate South Africa's national vision for SD and to identify strategic measures to reorient its development path in a more sustainable direction. Then, by drawing on the above policies, it is assured that the South African curriculum recognises the implementation of SD. The framework also identifies the strategic priority areas for action and intervention that are required to achieve the desired condition of SD, including sustaining the ecosystems and using natural resources efficiently

(NFSD 2008:10). Subsequently, the United Nations Decade of Education for Sustainable Development (2005–2014), acronymised as DESD, offers an opportunity to explore and incorporate cultural diversity and intercultural dialogue viewpoints into learning and education systems. In the same vein, Agenda 21, the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), underscores the importance of indigenous peoples' rights to their lands, culture, and knowledge systems in relation to social justice and environmental sustainability (UN 2007: Chapter 26). This international platform could be the key to bridging the gap between cultural, socioeconomic, and environmental transformation, as well as allowing the culture lens to inform potential and development. Therefore, the following section sightsees into the cultural aspects of IK and IKS and their relationship to SD.

3.3 INDIGENOUS KNOWLEDGE UNDERSTOOD THROUGH SD

IK and IKS are terms used to describe the knowledge system that is specific to a culture (Chikaire, Osuagwu, Ihenacho et al. 2012). The study's context is framed within Langill (1999) and Kaya and Seleti's (2013) definition of the terms IK and IKS in relation to how the terms may aid in the establishment of SD as defined in chapter 1. IK and IKS could have a solid foundation towards understanding SD encapsulates issues in the teaching of the subject Technology. This is because IK and IKS are viewed from the perspectives of SD and livelihoods.

Similarly, Awuah-Nyamekye (2015) and Mawere (2014) maintain that given the rich and diverse patterns of beliefs, behaviour and values that pervade the continent and have persisted despite the epistemic violence associated with colonial encounters, the quest for SD in Africa necessitates a consideration of the various forms of knowledge available such as IKS, traditional knowledge, local knowledge, etc. Furthermore, Dei (2014) asserts that the constructions of education and development in Africa should begin with what African people and communities know. Their knowledge, which is referred to as IK, practices, and adaptations, combines a localised understanding of the ecological, social, political, economic, and historical environment (Mawere 2014). However, Leal Filho, Raath, Lazzarini, et al. (2018) indicate that the concept of ESD has not

been sufficiently integrated into the concept of transformation in the learning institutions. Therefore, the implementation of ESD in the curriculum indicates that different types of knowledge are required for different strategies of implementing ESD in teaching (Timm & Barth 2020). Glavič (2020) elucidates that ESD is recognised as a key element of quality education and a crucial enabler for SD. This supports the idea that ESD visionary is a balance between society, economy and environment while preserving the natural resources of the planet for future generations (Glavič 2020). Within this context, Pavlova (2011) suggests that TE provides an opportunity to incorporate the ESD through the development of sensitivity towards nature and an understanding that technological growth should be balanced through the application of design principles, technological knowledge, and critical and creative thinking skills to bring a human aspect. Correspondingly, Leal Filho, Manolas and Pace (2009) indicate that TE may be used as a tool in meeting the challenges of SD. On the other hand, a study by Egarievwe (2015) suggests that Science, Technology, Engineering and Mathematics (STEM) education has a fundamental role in advancing technology, medicine, sustainability, agriculture, national security, economy, and society. Therefore, according to Korkmaz and Yildiz (2017), ESD promotes an educational viewpoint that balances the economic well-being with environmental and cultural values.

Correspondingly, Mapira and Mazambara (2013:90), report that there has been a resurgence of interest in IKS since the end of colonial authority more than three decades ago, as they are seen as a source of pride, dignity, and potential solutions to some vexing problems. In this regard, IKS is defined as knowledge that contributes significantly to the SD of local communities (Iyoro & Ogungbo 2013:88). Local communities, therefore, generate the knowledge which enables them to make sense of who they are and to interact with their environment in ways that sustain life (Okpara & Ikokoh 2021:92). This way IK is a system of perceptions, facts and behaviours that guide the people of a local community in their use of land and natural resources (Iyoro & Ogungbo 2013). It is also regarded as a necessary resource in every human growth process. Consequently, IK primarily informs decision-making processes at all levels about social issues such as health, poverty agricultural production, and food security

(Sithole 2007:117). In addition, Flavier, et al. (1995:479) view IK as a society's information base, facilitating communication and decision-making. It is against this background that incorporating IK is critical to ESD successes. Gope et al. (2017), for example, contend that the success and sustainability of any development activity are heavily reliant on IK and practices.

Subsequently, Elias, Tran, Nakashima, and Shaw (2009) demonstrate in their study that IK is important in SD that throughout history and to this day, traditional local communities have relied heavily on IK to conserve the environment and deal with natural disasters. In this regard, Elias et al. (2009) argue that communities easily identify with IKS, which have allowed them to live in harmony with their environments for generations. As a result, indigenous scholars and advocates have enlightened interest in the contribution of IK to a better understanding of SD (Battiste 2005). To the contrary, Battiste's (2005) study of Canadian educational institutions reveals the widespread ignorance about IK and pedagogy in addressing SD issues. The evidence suggests that the teaching of SD relies more on Western pedagogies (Lenglet, Fadeeva & Mochizuki 2010). Ryan and Ferreira (2019) note that the South African national curriculum takes a predominantly Western scientific approach to the presentation of ESD, and teachers have reservations about IKS. Similarly, Glavič (2020) asserts that, owing to the rapid development of humanity in all the SD pillars (economic, social, and environmental), climate crises and emerging technologies and knowledge, education leaders and teachers are lacking modern and effective content for ESD. This may be owing to the Western teaching paradigms that dominate the conceptualisation of subjects and teaching. Breidlid (2009:141) posits that Western knowledge and science have played a hegemonic role in SD development efforts, whereas IK has been characterised as inefficient, old-fashioned, and non-scientific, and has been relegated to the realm of insignificance. According to Odora Hoppers (2002), the education system in South Africa has neglected IKS against the case for a holistic inclusion of IK. Meanwhile, Lebeloane (2017) and Masemula (2013) show that cultural and religious practices are worldviews considered along with the Western metaphysical, ecological, economic, and scientific fields. Considering the foregoing, Goosen, Kathan, Mlambo, et al. (2013: xxxii) argue that most

technologies used in the teaching of the subject Technology are modernised and use newer forms of technology while overlooking examples of technology that have been used for hundreds of years and continue to work successfully and make our daily lives easier.

More so, Hay and Dzerefos (2022) highlight the essence of infusing IKS practices related to the sacredness of nature into school subjects in both South Africa and Japan owing to an escalation of environmental degradation and excessive consumerism. Similarly, studies show that IK has a crucial impact on the issues of sustainability and has a place in the school curriculum (Bloom 2020; Hay & Dzerefos; Odora 2002). For instance, Odora Hoppers (2002) suggests a holistic inclusion of IK where cultural and religious practices such as the Vhavenda sacred places and rituals have the potential to infuse the IKS of sacredness into school subjects. On the contrary, Hay and Dzerefos (2022) claim that IKS can be effectively transferred in multifaceted ways into the school subjects thereby enriching the school curricula and perceptions of nature.

In addition, Throsby and Petetskaya's (2016:120) study highlights that little attention is paid to indigenous communities' sustainability. More so, Setumu (2015) argues that for centuries in South Africa, the richness of IKS has been transmitted only orally, resulting in a deficit of documentation thereon. However, sustainability principles are fundamental to the cultures of many of the world's indigenous peoples and must be considered in any discussion of desirable development paths for first peoples living on land that their communities have occupied for many generations. Furthermore, Throsby and Petetskaya (2016:124) maintain that incorporating social values and culture may help with understanding of SD. The nature of sustainability is therefore understood and experienced in terms of the relationships to land, language, and knowledge systems, which are IK (Throsby & Petetskaya 2016). In support of the foregoing, Breidlid (2009:142) claims that the terms "development" and "sustainable development" must be addressed from an indigenous perspective, thereby including other epistemological and cultural perspectives of what SD entails. Drawing from the preceding, Keast, Baker and Brown (2012:9) posit that SD emphasises social sustainability, thus social sustainability "builds on and extends

the notion of stakeholder engagement and argues for a better alignment between the physical infrastructure and local conditions and needs". Therefore, SD could be well understood by incorporating IK in the subject contents. Gumbo (2019:6) on the other hand, suggests that technology is linked to how communities to adapt the natural environment for desirable human living and sustainability from a cultural standpoint. In the same view, Seehawer and Breidlid (2021) write that learning to apply and combine knowledge is as an essential component of high-quality, long-term education in the 21st century.

Based on the foregoing scholarly contribution, Sithole (2007) asserts that the notion of IK has been applied in natural resource management and in solving societal issues such as health, poverty, agricultural production, and food security, among others for many years. Conversely, Mugabe (1998 cited in Masango 2010:74), emphasises that IK has the entirety of all information and practices that people hold and apply based on past experiences and observations. In a similar way, Classen (1999) believes that IK should be understood as knowledge that reminds individuals that information does not come solely from books, computers, and so on, but also from our perceptions of our environment. In this way, IK should be regarded as a point of reference for survival. Barnhardt and Kawagley (2005:11) see IK as a survival system in a similar way. So, it is in this stance the IK would be understood through SD. Furthermore, Mugambiwa (2020:131) asserts that IK is inextricably linked to Africans because it serves as their foundation or origins. Dipholo and Biao (2013:50) posit a view that IK is concerned with what local people know and do, as well as what local communities have known and done for decades. This conveys the impression that IK is based on experiences rather than theory. This also provides the idea that the usage of IK may enable sustainable living. Dipholo and Biao (2013), for example, maintain that indigenous people have a broad understanding of the ecosystems in which they live as well as methods of exploiting natural resources in a sustainable manner.

Dipholo and Biao (2013) further argue that the application of IK in various settings has the potential to develop means of survival for the people in those communities. Conversely, Nakashima, Rubis and Krupnik (2018:3) believe IK

involves the knowledge and expertise that have been gained through generations and that lead human civilisations in their numerous interactions with their surrounding environment. As a result, each subsequent generation transmits and renews the IK system of knowledge and traditional ecological knowledge. This means that IK is dynamic in the sense that it evolves with changing standards of life while maintaining the same perceptions. These knowledge systems support the well-being of people all over the world by providing food security through hunting, fishing, and other sources to cope with environmental oscillations and external forces of change (Nakashima et al. 2018). As a result, I believe that IK has the potential to push the incorporation of ESD in the contents of the TE curriculum because the subject enables reflections on learners' cultural backgrounds.

As outlined by Nakashima et al. (2018), IK is playing a new and essential role in resolving the world's most difficult challenges, such as social and environmental issues. Therefore, IK is linked to social capital for individuals because it is employed in a variety of activities such as food preparation, health care, education, natural resource management, and risk management. This information is highly valued because it is essential for numerous types of risk management. As a result, it is seen as important in the achievement of tackling the SD-related challenges at the current moment (Gope et al. 2013; Iyoro & Ogungbo 2013; Sithole 2007; Dipholo & Biao 2013). Furthermore, Mawere (2014:x) concurs that realising local knowledge as a critical and fundamental component might enable any country to attain environmental, social, and economic growth. As a result of the foregoing perspectives, IK has the potential to affect society's way of life toward SD. Hence, IK could contribute to the development of education for sustainability. In similar input, Breidlid (2009:142) claims that post-colonial Africa has exposed areas in which IKS are relevant and useful, e.g., in agriculture, forestry and medicine, therefore, fields of sustainability. Hence, educating for sustainability within the indigenous paradigm is essential.

3.4 EDUCATING FOR SUSTAINABLE DEVELOPMENT

SD was initially coined around 1980 (International Union for Conservation of Nature 1980). ESD is the term that is mostly used internationally and by UN (Rathod 2013:32). The notion of SD is prevalent in everyday life and was later adopted in numerous locations such as institutions and private businesses to encourage sustainable living. Despite its evolution, the concept is frequently misunderstood, and efforts are aimed at deviating from what would sufficiently qualify as a sustainable path (Blanchard & Buchs 2015). As a result, ESD was adopted as a fantastic chance for sustainable education. Draghici (2019:2) argues that ESD has been recognised as a critical plan for assisting and preparing the next generation for future environmental changes. Hence, according to Rathod (2013), Agenda 21 was the first international document to recognise education as an important instrument for achieving sustainable development and to highlight the areas of intervention in the field of education. ESD, therefore, focuses on quality education that is responsible for the dignity of the environment, economic viability and a culture that forms present and future generations. Korkmaz and Yildiz (2017:1), for example, assert that ESD promotes an educational viewpoint that balances the economic well-being with environmental and cultural values.

Over the past decades, ESD has evolved, particularly in the seventies and especially in the eighties of the last century (Klarin 2018:68). The growth was owing to humanity, which has contributed to wars and political and socio-economic turmoil, as well as increasingly unfavourable climate change and natural disasters. Therefore, humans have had a negative effect on the world by their actions, endangering the survival of the earth and future generations (Klarin 2018:67). Klarin (2018:68) argues that SD is a philosophy based on development (socio-economic development in line with ecological constraints), needs (resource allocation to ensure the quality of life for all) and future generations (the ability to use resources for future generations in the long term to ensure the requisite quality of life).

A study by Hoque, Yasin and Sopian (2022) shows that education is key to advancing a society that can achieve SDGs. Hence, an emphasis is that an awareness must be instilled among citizens at an early age (as early as secondary school) to motivate learners to pursue higher education and careers in renewable energy concepts and technologies. Correspondingly, Anyolo, Karkkainen and Keinonen (2018) highlight that many theorists envisage that ESD enhances the active involvement of learners in and out of school learning initiatives to acquire knowledge about SD issues.

According to Lenglet et al. (2010:93), ESD is about how individuals, groups, organisations, and communities can move towards greater sustainability of their social, cultural, and economic practices, relations, institutions, and arrangements through education and learning on a local, national, regional, and global scale through education and learning. Elshof (2005), Pitt and Luben (2009) and Pavlova (2009a), in their studies, show that teachers' perceptions of what is important and readiness to address issues related to SD, such as the sustainable use of natural resources, health and illiteracy are reflected in classroom practices. Consequently, Lenglet et al. (2010) maintain that ESD is a set of concepts, theoretical constructions, policy prescriptions, and practical approaches and tools that relate education and learning to the social, economic, and ecological components of SD in their dynamic interaction.

Therefore, TE has the potential to incorporate ESD because its curriculum relates teaching and learning to socio-economic factors. More so, the understanding of technology is about what humans want to achieve in the future, and it has the intent to produce useful products (Gumbo 2019). So, society and culture both influence and can be influenced by ESD and technology. As a result, TE has numerous curricula that can be used to integrate and implement the above dimensions. According to Aceska and Nikoloski (2017:567):

> ESD enables people to develop the knowledge, values and skills to participate in decisions how we do things individually and collectively, both locally and globally, that will improve the quality of life now without damaging the planet for the future.

The foregoing features of ESD provide the sense that there are objectives and intentions to teach about SD in TE curriculum. However, Shallcross and Wals (2005:2) found that, while people have a high level of comprehension about environmental values, these views and values are generally not reflected in their behaviours. On the contrary, de Andrade (2011:145) aver that some of the major ESD documents appear to carry a contradiction and while acknowledging patterns of production and consumption as the core of unsustainability, they appear to keep directing attention to the South, diverting attention away from the roots of problems and toward their symptoms. As a result, teachers have little time and space to consider these challenges from various angles, questioning practices, and ideas, and extending the dialogue. Corney (2006) indicates that teachers have difficulties in terms of understanding the complexity of SD issues, the nature, and the interrelations of its sub-concepts. On the other hand, Borg, Gricke, Hoglund and Bergman (2012) and Kang (2019) claim that the most common obstacles on sustainability teaching are that teachers lack inspiring examples on how to include SD in their teaching and the necessary expertise about SD.

Urbańska et al.'s (2021) study shows that the inability of teachers to interpret the education programme policy is widely recognised in the literature and is influenced by their cognitive skills. In addition, Hoque et al. (2022) indicate that there is a significant lack of curricula on renewable energy concepts and ESD in secondary schools, reflecting the low knowledge, interest in, and awareness of renewable and its concepts among learners. More so, teachers do not necessarily view themselves as future change agents, especially at a school or a higher level (Van der Heijden, Geldens, Beijaard & Popeijus 2015). However, Lotz-Sisitka (2011) acknowledges a positive move towards sustainability in schools although on an average level. That is, CAPS revealed that up to 50% of the content in some subjects is on environment or related to sustainability and that the environment and sustainability content pervades a wide range of subjects in line with a curriculum principle that seeks to ensure an environmentally literate citizenry. Despite the limitations, I believe that TE curricula offer a high potential for implementing ESD because the subject Technology encourages innovative,

creative, and critical thinking skills as stipulated in the CAPS document (DBE 2011).

In relation to the foregoing, the concept of SD has the essence of the triple bottom line concept, which means the balance between three pillars of sustainability, i.e., environment, society, and economy. Therefore, environmental sustainability is based on preserving the environmental quality that is essential for people's economic activities and quality of life, social sustainability aimed at ensuring human rights and equality, the protection of cultural identity, respect for cultural diversity, race and religion, and economic sustainability required to preserve the income and living standards of natural, social, and human resources (Klarin 2018:68). Therefore, SD contributes towards ESD to address issues embedded in the three pillars of SD. In relation to the prior statement, the DBE (2011:8) defines Technology as “the use of knowledge, skills, values, and resources to meet people’s needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration”. Therefore, TE curriculum and ESD connote fundamental similarities, specifically, social, human, and environmental factors which are embedded in the TE definition as stated earlier and through design activities. These factors, in their consideration, should assist in realising ESD in the teaching of the Technology content.

Anyolo et al. (2018) show that teachers have a positive sentiment toward the inclusion of ESD into the senior secondary school curriculum. The TE curriculum can promote learning about the issues of ESD. In support of the highlighted factors, Pavlova (2011) revealed that African Technology teachers understand the need to address SD through the subject, putting an emphasis on social development issues framed by environmental challenges. Similarly, Anyolo et al.’s (2020) study on ESD has shown that senior secondary school teachers perceive ESD in terms of knowledge acquisition about the environment to use its resources sustainably for the benefit of future generations. Therefore, within the context of the study, it is clear that the subject Technology has numerous opportunities for incorporating ESD into its teaching. This is because the subject emphasises the recognition of IKS in its topics more especially the third specific aim of CAPS document (DBE 2011). Furthermore, the CAPS Technology

document is premised on the fact that the subject Technology intends to teach learners how to deal with inclusivity, human rights, social, and environmental issues in their tasks (DBE 2011:9). Furthermore, one of the principles outlined in the NCS Grades R – 12 is the IKS (DBE 2011:5). As a result, it is concluded that the TE curricula have the fundamental similarities with ESD curricula because the subject in its teaching relates to the dimensions of ESD, namely social, economic, and environmental. Therefore, IKS incorporation could aid in the success of ESD in the TE curriculum, particularly in the Senior Phase. This could be the case when teaching ESD from an indigenous perspective in the Technology subject. Hence, the next section discusses in detail how the three aspects of TE curriculum, IKS and ESD are connected.

3.5 THE CONNECTION BETWEEN TE CURRICULUM, IKS AND ESD

The concept of SD is employed by people in everyday life, as well as by researchers, organisations, and private companies (Vergragt, Akenji & Dewick 2014). Following that, this section explores the concept of ESD through IKS in the TE curriculum. The subsections that follow provide an overview of how the concept is viewed in connection to IKS and its incorporation in the subject Technology.

3.5.1 TE curriculum

As shown in Chapter 1, TE harbours critical aspects which outline the use of technology and its impact to society and environment, thus, technological knowledge and skills (Mapotse 2012; Gumbo 2018). In comparison to several nations throughout the world, TE has emerged as a distinct subject on its own right (Ankiewicz 2021:940). The subject, on the other hand, emerged with the traditional fields of crafts and skill development being enlarged to encompass parts of design and concepts of technological literacy for all (Ankiewicz 2021). As a result, the TE curriculum aspires to produce learners who have a deeper conceptual understanding of technology and its role in society, and who can therefore grasp and evaluate new bits of technology that they may never have seen before (Ankiewicz 2021). In South Africa, on the other hand, the TE

curriculum originated as a subject that recognises the need to provide learners with an understanding of how engineers apply scientific ideas to practical situations. The subject's aim is to give learners the opportunity to solve practical problems through the design process. That is, the assessment should include practical projects involving a variety of technological skills (IDMEC) that cater for different learning styles, i.e., implying different knowledges (DBE 2011:9-10). IDMEC is the subject's backbone and should be used to structure the delivery of all learning aims, while it is applied malleably considering different methods and processes that indigenous people may apply compared to the Western notions. As a starting point, learners should be exposed to a problem, need, or opportunity in relation to how it is done in the real indigenous contexts. Furthermore, they should engage in a systematic process that allows them to develop solutions that solve problems, rectify design issues, and satisfy needs (DBE 2011:12). Simply put, the design process is used to structure teaching in the TE curriculum.

Hence, assessment in the Senior Phase should be in a form of practical work and written work wherein the assessment integrates knowledge and values with design process skills. For instance, in Grade 7, CAPS indicates that the design process skills should present learners with problems set in a locally relevant context, while in Grade 8, problems must be set in a nationally relevant context. Ultimately, in Grade 9, learners must identify a problem, need or opportunity from a given real-life context. In this instance, learners must understand the concepts and knowledge used in TE as they solve practical problems, considering people's values and attitudes, technology, society, and the environment, as specified in specific aim three.

Consequently, the teaching of the subject is interwoven within the three specific aims (i.e., 1, 2 and 3) of the Senior Phase. As a result, the TE curriculum would allow for the incorporation of IKS as the practical challenges connect to societal issues that affect communities. For example, the subject Technology allows learners to apply and engage with knowledge in a meaningful way as they solve technological problems (DBE 2011). This type of knowledge implies other types of knowledge, some of which may be IK. Okpara and Ikokoh (2021:92) define IK

as a body of knowledge shared by communities or ethnic groups and influenced by their culture, customs, and way of life.

Gope et al. (2017:887) claim that we are living in an information era. Power is much more important in this knowledge era for human resource development to satisfy the objectives of Millennium Development Goals (MDGs), and this knowledge is commonly referred to as community-centred knowledge. IK, or local knowledge, is another term for it. As a result, the Technology subject allows for the incorporation of knowledge from several perspectives in its teaching (DBE 2011:9). Iyoro and Ogungbo (2013:88) highlight that prior to the advent of technology, people relied on IK to regulate their activities, which in turn, enabled them to live in harmony among themselves as well as within their environment. IK, as practised then, encompassed all types of knowledge, including technology, expertise, skills, practices, and beliefs. As a result, the TE curriculum is well aligned with the above forms of knowledge. Therefore, IKS may permit the integration of ESD in TE.

TE is a potential contributor to the ESD implementation. The three bases for conceptualising SD are defined by Pavlova (2009:67), i.e., the role of importance, the essence of the proposed responses and the structure of the proposed responses to SD's demands. These three are the foundations for the development of the ESD strategies. In the current study, value position is explored further in TE as it has the potential to promote ESD. In conceptualising ESD, technological contexts in TE set up learning environment that makes it easier to achieve value change. UNESCO (2005) asserts that through learning and implementation, technology provides people with the means to improve their situation. This means that the conventional use of materials and the application of expertise as well as produced objects should also be commonly considered to include TE. Technology curriculum should then be incorporated consistently with sustainability objectives.

Hopkinson and James (2010:365) argue that STEM subjects are extremely important in SD teaching and learning. In contrast, Pavlova (2012:392), writing about the academics' perceptions of SD and ESD, argues that technology in

relation to SD may treat symptoms rather than the disease. However, value change is regarded as the primary approach to sustainability. As a result, Pavlova (2012) asserts that the fundamental transformations underlying values and attitudes characterise a radical shift in our thinking to achieve sustainability. In addition, Maley (1995:3) posits that societal values are attributed to TE. Furthermore, the societal values associated with TE are those contributions that increase and strengthen an individual's ability to act effectively as a citizen in a democratic technological society (Maley 1995). These values include gaining the skills needed for good technology selection and appraisal, developing informed citizens, and raising awareness of the social and environmental implications of technology. Gilberti (in Maley 1995:16) emphasises:

> In a democracy, citizens and consumers are continually being asked to make evaluations of the applications and limitations of technology to human wants, desires, and problems. By providing students with the skills to evaluate the appropriateness of various technological devices and fixes, the curriculum area of technology education helps to promote a more just and sustainable future.

Subsequently, learners in Technology are given the opportunity to learn to evaluate existing products and processes, as well as to evaluate their own products (DBE 2011:9). In this light, TE integrates the characteristics of ESD. However, despite the potential that the TE curriculum has with teaching that might incorporate ESD, most research studies undertaken are primarily on environmental education, and mostly at higher institutions, giving the TE curriculum limited attention on ESD with minimal link to IKS integration. For example, González-Gaudiano, Meira-Cartea and Martnez-Fernández (2015:73) provide some context for the need to emphasise the university's deep significance and role as a laboratory of current reality considering the region's concrete realities in the global context. As a result, environmental challenges have been incorporated into university functions, as well as the environmental factor has been internalised. Following that, the current study investigates ESD in TE curriculum from an indigenous perspective. According to Lenglet et al. (2010:95), ESD practice can be found in a variety of settings, including classrooms, seminar rooms, and laboratories, local communities and community

associations, museums, the media, nature reserves and national parks, corporate institutions, all spheres and sectors of production and consumption, and policy development. Based on Langlet et al.'s (2019) views, TE, ESD and IKS share similar fundamentals. Therefore, because TE materials are based on real-life scenarios, the incorporation of ESD content through IKS is possible.

In the South African context, Technology has been defined as the use of knowledge, skills, values, and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental issues into consideration (DBE 2011:8). This presents the opportunities for ESD as TE recognises knowledge, skills with an addition of values and resources. Values are the key indicators for environmental conscientisation (Gumbo 2019:4). TE also enables learners to be made aware of various co-existing knowledge structures (DBE 2011:10). Conversely, McGarr (2010:326) outlines that the absence of social, cultural, and economic effects of technology in technology related subjects highlight a significant failure to address ESD. TE has more opportunities in addressing the issues about ESD and through the recognition of social, cultural, and economic effects. Additionally, TE emphasises that learners should become aware of indigenous property rights and learn how indigenous cultures have used specific materials and processes to satisfy needs (DBE 2011:10). In view of the foregoing, there is an implied interrelationship between TE, IKS and ESD which needs to be explored.

Within the context of the study, the three concepts are interrelated because they all value social and environmental aspects, including the economic aspects, while embracing different knowledges that value the learners' values, skills, and attitudes in dealing with the SD issues. According to UNESCO (2014:21), quality education for SD is about how learners develop skills and attitudes to respond to challenges. In addition, the NCS Grades R – 12 for ESD in Technology teaching emphasises that learners should demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation. Furthermore, learners must be able to use science and technology effectively and critically, demonstrating the responsibility for the environment and others' health. However, according to UNESCO (2014:29), ESD is a lifelong

learning process that begins in early childhood and progresses through primary and secondary education, technical and vocational skill development, higher education, ongoing workplace training and professional development, and public awareness. Following that, the three concepts interlink because the ESD teaching begins in early childhood, implying that the child is born with an understanding of ESD, and that technical and vocational skills have a place for ESD incorporation. This also implies that the concept is included in TE curricula. While this is the case, many studies have found a weak link between the three concepts. As a result, this exploratory study incorporates ESD in TE within an indigenous context.

3.5.2 Indigenous Knowledge Systems

IKS is viewed as a knowledge form with considerable potential for addressing sustainability. In the same sense, Iyoro and Ogungbo (2013:87), IK is distinct from other categories of knowledge. Its one-of-a-kindness makes it a crucial tool for guaranteeing the long-term viability of local community societal development. Commonly, Adeyeye (2019), in the study, African IK and practices and 2030 SDGs, various academics have stated that IK might be a critical indicator in the realisation of SDGs. On the other hand, Dipholo and Biao (2013:50) posits that education is the primary tool for SD in Africa. They also confirm that the goal of education is developmental and that the process of growth is to be driven by the people. Therefore, the process, and methods of education, as well as the substance of education, must be carried out in a way that is understandable and adaptable by the people (Dipholo & Biao 2013). It can be concluded that developing such an environment requires the incorporation of IK. According to Gorjestani (2000), the realisation of IK helps to strengthen the sustainability of development efforts since the process of IK integration allows for reciprocal learning and adaptation, which contributes to the empowerment of local populations. For example, Dipholo and Biao (2013) argue that local people, particularly those in rural areas, are aware of how to make a living and solve difficulties in their lives through indigenous processes. As a result, it appears that IK could be useful in tackling SD difficulties.

Carm (2014:60) draws that knowledge that people in a certain community have developed over time and that continues to improve. For this reason, IK could be very useful in resolving current SD problems, giving the sense that IK is still relevant. Nonetheless, despite IK's good impact on SD, Cocks, Alexander, and Dold (2012:243) stated that the application and practice of bio-cultural diversity partnership with local indigenous populations has been slow to emerge. In a similar spirit, Breidlid (2009) notes that SD achievement is still evaluated solely via Western paradigms, and IKS remains absent from the global arena regarding SD. In the same way, Mochizuki and Fadeeva (2010:395) highlight that European theorisation of competence influences ESD discourses and practice globally. In addition, Tilbury and Mulà (2009), says despite the wealth of literature on ESD and culture, there are few documents that attempt to connect the two and find similar themes. Also, Tilbury and Mulà's (2009) review emphasise the apparent lack of culture in ESD. In the South African context, a study by Cocks et al. (2012) revealed that the national schooling curriculum places little emphasis on IKS. Conversely, the present policy statement acknowledges the inclusion of IKS in its content. Therefore, this may not be the case. However, this may still be an issue because the policy document, notably the Technology CAPS document, makes only a passing reference to how and when this type of knowledge should be provided. The DBE (2011:10) Technology document specifically articulates as follows:

> Whenever applicable learners should be made aware of different coexisting knowledge systems. Basically, learners must learn how indigenous cultures have used specific materials and processes to satisfy needs and become aware of indigenous intellectual property rights. although it is not clear how, but I hold a view that with these little knowledge teachers are given a directive to recognise IKS in the TE curriculum. therefore, through IKS the Technology contents have a stance to the implementation of ESD.

Smith and Sharp (2012) discovered in their study that the integration of traditional ecological knowledge (TEK), also known as IKS, has been unequal. In addition, the process of reorientating education policies, curricula and plans towards SD is well underway, although many studies show that the progress is uneven (Wals 2012:28). However, the findings focused mostly on climate science and politics,

which could also apply to other sectors which may be a case in TE curriculum. In this regard, Smith and Sharp's (2012) findings were based especially on TEK frameworks, such as the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4), and the Arctic Climate Impact Assessment (ACIA). Drawing from the preceding frameworks, the UNFCCC and Kyoto Protocol do not take indigenous peoples or indigenous peoples' knowledge into account. The AR4 does, however, have some references, but with little attention. So, the ACIA fully considers the inclusion of IKS, which serves as a starting point (Smith & Sharp 2012). Similarly, Mavuru and Ramnarain (2017:1) argue that incorporating socio-cultural background creates the learning opportunities. In support of the foregoing, Ngcoza (2019:1) contends that mother tongue re-appreciation can serve as a starting point for decolonising scientific knowledge in the curriculum, thereby empowering social-cultural innovations toward ESD. As a result, I believe that the TE curriculum has the potential for teaching ESD because it accounts for the inclusion of IKS in the subject. Therefore, recognising IKS provides a starting point for teaching ESD.

3.5.3 The relationship between ESD and TE within indigenous perspective

This sub-section discusses the relationship between ESD and TE within the indigenous perspective. According to De Pauw, Gericke, Olsson, and Berglund (2015:15694), preserving the natural environment and our planet's resources while developing prosperity and well-being for a growing population are critical issues for survival in the current times. Hence, SD was established as a concept to address challenges of sustainability. However, through SD, ESD was established as one of the solutions to dealing with sustainability (De Pauw et al. 2015; Carm 2014; De Sousa 2021). As a result, according to De Pauw et al. (2015), ESD strives to enable learning in such a way that learners comprehend the world via their own observations and build abilities to take an action for sustainability. Despite the promotion of ESD in formal or informal schooling, the expansion of ESD was not accelerating; either no responsibility for ESD was assumed, or no one knew where or how to begin (McKeown et al. 2002).

Furthermore, Teise (2013:66) demonstrates that education in South Africa is geared toward SD and the accomplishment of social and sustainable development (SSD). This clearly demonstrates that ESD is recognised in South African education. However, research has indicated that South Africa has positioned Environmental Education (EE) as the vehicle for attaining SD (Teise 2013).

Kioupi and Voulvoulis (2019:2) underline in their study that most empirical studies demonstrated that the effectiveness of ESD has been restricted, recommendations for ESD implementations on educational practices and policy are thought to have less impact, learners are disengaged with ESD and with no link to IKS. Hence, I contend that this may be the case with the introduction of ESD in TE curriculum. As a result, a study on the incorporation of ESD in TE in an indigenous environment is necessary. However, De Pauw et al. (2015:15695) read ESD as follows:

> "Education for sustainable development means including key sustainable development issues into teaching and learning; for example, climate change, disaster, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motive and empower learners to change their behavior and take action for sustainable development. Education for sustainable development consequently promotes competencies like critical thinking imagining future scenarios and making decisions in a collaborative way".

This definition addresses two critical parts of the TE curriculum, namely content and method. The contents of ESD, such as climate change, disaster reduction, sustainable consumption, and so on, might be seen in the TE curricula, notably in the teaching of TSE contents. The CAPS Technology document stipulates the following:

> Learners should be able to consider the impact of technology, both positive and negative, on people's lives. Learners should be made aware of bias in technology and be able to express opinions that explain how certain groups within society might be favoured or disadvantaged by products of technology (DBE 2011:10).

Considering the foregoing views, TE curricula stand a good chance because its teaching recognises the impact that technology has on the environment, society, and economy. Hence, the subject may benefit from including ESD within those features. The second part, on the other hand, relates to the methodological approach to ESD. The technique lays a strong emphasis on skills and competencies. The TE curriculum considers these skills knowledge, skills, values, designing, communication, teamwork, decision-making, and so on (DBE 2011). As a result, TE curricula have a foundation for incorporating ESD into their teaching. McKeon et al (2002:17), for example, assert that the components of knowledge, skills, perspectives, values, and issues should be included when teaching ESD. Therefore, it is from this perspective that these components allow for the teaching of ESD through IKS. Carm (2014:63) underscores the importance of the environment, as mentioned in the ESD Declaration. According to Carm (2014), the environment aspect in SD provides a view that IK could be seen in this perspective. In this regard, Gope et al. (2017) state that IK can aid in the resolution of numerous types of concerns related to the environment, economy and society.

SD is an important concept that requires a proper implementation in education. Tilbury, Keogh, Leighton, and Kent (2005) (cited in Shephard 2008:88) buttress that there is a call for the curriculum to recognise SD. Moreover, Tilbury, et al. (2005:14) denote “Curriculum change offers the opportunity to embed the principles of learning for sustainability such that all learners can address sustainability”. In the light of the foregoing, technology and TE serve as a vehicle of SD recognition in its curriculum. Zoller (2013:212) asserts that the framework and sustainable education courses and curricula should become an integral part of formal science, technology and engineering education curricula that would encourage the realistic practice of ESD. Shephard (2008:89) emphasises that the recognition of ESD should seek outcomes that involve knowledge, skills, and values. These provide a solid foundation for TE in promotion of ESD as stipulated in the CAPS document: “As learners progress through a task, they must be taught the associated knowledge and the skills needed to design and create a solution” (DBE 2011:12).

Therefore, these outcomes in TE would be on knowledge that learners would use on issues about sustainability, having skills on how to respond sustainably and values – act responsibly on issues of sustainability. Gumbo (2019:3) posits that "technology involves humankind's purposeful mastering and creative use of knowledge and skills with regard to products, processes and approaches so as better to control his environment". TE also encourages learners to apply critical thinking skills when solving technological problems; hence, they can think more critically about issues of sustainability. Assaraf and Orion (2005), Zoller (2004a, b), Zoller and Levy Nahum (2012) emphasised that the development of evaluative, critical, system thinking, decision-making, problem solving and transfer in science, technology, and environmental education of which is called technology, society, and environment in TE, promote literacy for sustainability pedagogy.

Creativity is one of the targeted skills for learners' development in TE curriculum that can afford them the opportunities to solve the technological problems that will build their capacity to think more about ideas to promote ESD in TE. In the decision-making process, strategic thought, systematic and creative in problem solving, ESD also encourages long-term perspective. In addition, ESD encourages all people to learn the requisite knowledge, skills, attitudes, and values to ensure a sustainable future (Rathod 2013:30). So, the description of ESD encourages awareness of environmental issues on the community's knowledge. The above aspects of ESD are clearly stipulated in the CAPS Grades R – 12. A close study of the CAPS makes one notice that, practically, TE is well connected to the issues of ESD. This is articulated through the fundamental principles undergirding the CAPS, which include indigenous knowledge systems, social justice, human rights, inclusivity, among others (DBE 2011). Specifically, the CAPS includes the need to teach about the relationship between Technology, society, and environment – this encapsulates teaching about technological bias, technological impact, and indigenous technology (DBE 2011). All this provides a fertile ground to teach about SD in TE.

In the preceding discussion, it has been shown that ESD, TE and IKS are linked because IKS promotes the sustainable ways of life. For example, in farming, IKS

is valued because it promotes sustainability. As a result of the connections between these three, the scope of both concepts connects with the scope of the TE curriculum because the subject values interaction between people's values and attitudes, technology, society and the environment. As a result, it is possible to conclude that the three concepts share the same goal of valuing social, economic and environmental aspects.

3.6 TEACHING AND LEARNING OF ESD THROUGH TE: AN INDIGENOUS PERSPECTIVE

ESD is a process that involves individuals and social groups in learning how to live in a sustainable manner (Parliamentary Commissioner for the Environment 2004). As a result, it is considered that ESD is more than just an educational theory, but also a tool supported by a vast array of scientific, historical, economic, political, and integrated studies (Huckle 2013). According to UNESCO (2014 in Bentham, Sinnes & Gjøtterud 2015:158), education would serve as a means of empowering ESD. On the other hand, the United Nations Decade of Education for Sustainable Development (DESD), as a worldwide platform, provides the opportunity for policymakers and practitioners to integrate sustainable development ideas into all areas of learning. This creates the sense that the TE curriculum has the potential to incorporate the concept of ESD into its contents through IKS.

In this study, IKS is understood in terms of *Ubuntu*. Seleke (2021:5) asserts that *Ubuntu* is an indigenous African philosophy of life and education. Obanya (2018:87-90) connotes that indigenous African education is founded on social recognition and the application of socially accepted pedagogies such as oral communication, team/group teaching, collaborative, apprenticeships, and so on. As a result of the foregoing, teaching ESD in the context of *Ubuntu* would have the greatest impact on the public and encourage communal practices. Museka and Madondo (2012:259), for example, argue that grounding curricula on *Ubuntu* philosophy is critical because it can elicit environmental awareness that is written in people's hearts. So, the moral order espoused by the *Ubuntu* philosophy regulates people's behaviour while also allowing them to recognise and revere

the special relationship they have with the physical environment and other non-humane species.

According to Bentham et al. (2015), learners should be encouraged to develop the competencies that will prepare them to confront local injustices, allowing all citizens to thrive now and in the future. In line with the foregoing, de Sousa (2021:2) argues that ESD is action-based, with reflective and stimulating learning methods such as cooperative learning, collaborative, and dialogue, engaging the entire system, active and participatory learning, innovation, new teaching, and learning experiences. Similarly, Pálsdóttir and Jóhannsdóttir (2021:3) assert that ESD necessitates a shift toward learning that focuses on learning outcomes, which learners are expected to possess because of their learning. Subsequently, this suggests action-oriented, transformative teaching and learning that supports self-directed learning, participation, collaboration, problem-solving, and inter- and transdisciplinary learning. Such teaching approaches enable the development of the key competences required for SD.

Korkmaz and Yildiz (2017:2) posit that governments, researchers, societies, and even regions and nations all have distinct perspectives on ESD. Therefore, in this regard, the are many alternative methods to ESD exist, including holistic, experiential, critically reflective, collaborative, problem-based, systemic, and participatory approaches. In same view, Korkmaz and Yildiz 2017), says it is necessary to apply transformative tactics such as engagement, problem-solving, critical thinking, and decision-making. As a result, the above methodologies are linked to the social constructivist theory as discussed in detail in Chapter 2. The TE curriculum, on the other hand, intends to develop learners' inventive, creative, and critical thinking skills. Furthermore, the subject seeks to provide learners with opportunities for collaborative learning and to foster group or cooperation (DBE 2011:8). According to Gumbo (2016:17), some of the abilities that learners should gain in TE are designing, decision making, evaluation, communication, time management, teamwork, and problem-solving. So, it is believed that the above skills inform on social learning, allowing for the implementation of the notion ESD in TE curriculum. Also, it informs the teaching of ESD within the philosophy of *Ubuntu* as outlined above. In support of the above, Museka and Madondo

(2012:265) argue that the philosophy of *Unhu/Ubuntu* ought to be incorporated into the EE/ESD curricula as a strategy for conservation. It is in this view that *Ubuntuism* may offer a unique set of ethical values that guide human beings in their day-to-day interaction with the environment (Museka & Madondo 2012:265).

Teaching the subject Technology in the manner described earlier fosters collaborative learning and teamwork in its contents (DBE 2011). In this regard, the subject can integrate ESD because its emphasis is on social interaction among learners as they work together. The Technology CAPS document specifically indicates that the subject intends to provide learners with the opportunity to learn to work collaboratively with others (DBE 2011:9). Furthermore, in its teaching, the subject emphasises decision-making, critical, and creative thinking, cooperation, and problem-solving approaches (DBE 2011). As a result, the preceding approaches inform teaching for ESD in the TE curriculum, as ESD is emphasised through the dialectical pedagogy in social interaction, as discussed in Chapter 2. Following that, UNESCO (2014:20) emphasises that ESD necessitates participatory teaching and learning methods such as critical thinking, imagining, future scenarios, and making collaborative decisions to empower learners to take an action for SD. Furthermore, according to UNESCO (2014:30), ESD facilitates interactive learner-driven pedagogies, such as innovative approaches, participatory learning processes, critical thinking, and problem-based learning, and these methods are particularly conducive to ESD. Hay and Dzerefos (2022) posit that indigenous societies protect natural areas by connecting with their ancestors and developing IKS to effectively conserve areas. Within O'Donoghue's (2015) model of learning into a 'third space,' Ngcoza (2019:2) opines that working together brings about change for the common good. For example, Lotz-Sisitka (2017) argues that when working together, the use of heritage practices and modern culture would bring about change in addressing ESD issues, as illustrated in Figure 3.1.

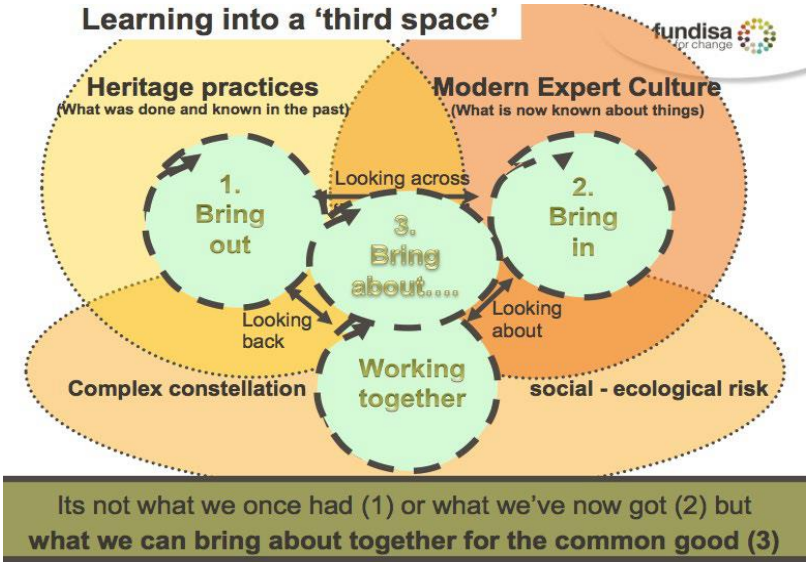


Figure 3.1: Adaptive transformation in indigenous knowledge practices (adopted from Ngcoza 2019; O'Donoghue 2015)

Furthermore, Ngcoza (2019:6) contends that co-engaged learning contributes to the emergence of changes in the lived environment, thereby addressing ESD issues. This is in relation to O'Donoghue's (2015) model of co-engagement and how it contributes to environmental changes, as shown in Figure 3.2. The diagram depicts how knowledge comes to us from others through cultural and biological history as we work in contexts of co-engaged meaning-making through open processes of dialogue (Talk), experiential encounters (Touch), and praxiological reflection (Think/Do).

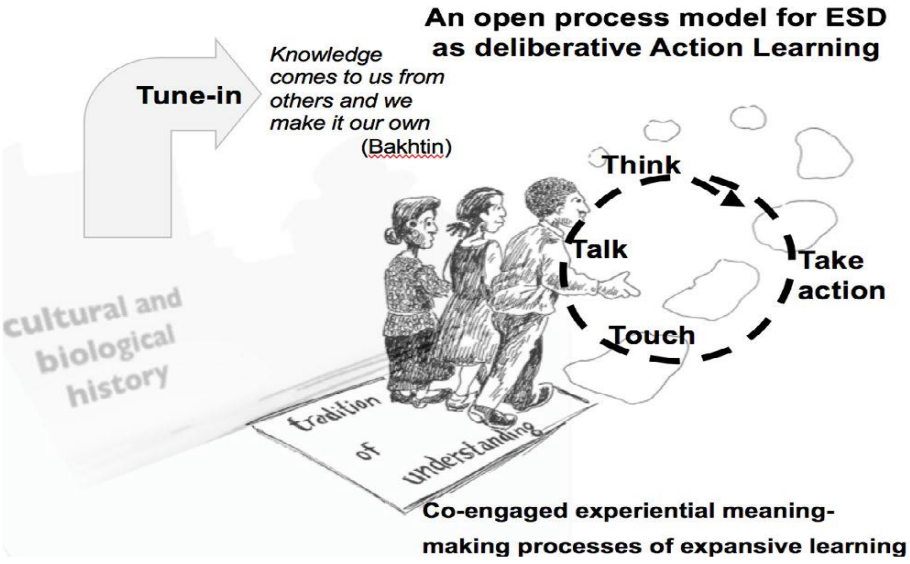


Figure 3.2. An open process model for ESD as deliberative Action Learning (adopted from Ngcoza 2019; O'Donoghue 2015)

According to Missimer and Connell (2012:174), sustainability pedagogical strategies such as lifelong learning, social learning, problem-based learning, dialogue education, and empowerment for ESD should be considered for the effectiveness of ESD teaching. According to Schnitzer (2019:242), increasing the transformative parts of ESD necessitates considering critical reflection, involvement, and social engagement, all of which are fundamental features of collaborative learning spaces. Furthermore, Wals (2010:388) claims that education for sustainability, above all, entails creating space for transformative social learning. As a result, creating a collaborative environment is critical in the teaching of ESD (Schnitzer 2019). However, according to Saitua-Iribar, Corral-Lage, and Pena-Miguel (2020:2), despite the potential of collaborative learning in teaching ESD, there are few studies that match these subjects, Sustainable Goals (SGs) and SDGs, in the collaborative learning approach. As a result, this could be the case with the TE curriculum, as relatively few research studies show ESD inclusion in Senior Phase Technology. However, I hold a view that the TE curriculum provides an opportunity for ESD incorporation because it emphasises collaborative learning and teamwork in its teaching. In support of the foregoing sentiments, Von Weizsacker and Wijkman (2018) concur that learning is most effective when it is collaborative. Furthermore, according to Schnitzler (2019), collaborative learning occurs in relationships. As a result, this considers teamwork, which would result in the learner's co-constructing knowledge as they interact to solve SD difficulties such as water conservation, climate change, biodiversity etc. Furthermore, the implementation of IKS would be viewed through the lens of collaborative learning, teamwork/group work, and knowledge co-construction in relation to O'Donoghue's (2015) models as illustrated above.

In addition, to the above, Lehmann, Christensen, Du and Thrane (2008:284), assert that social approach includes the concept of participant-directed learning, which emphasises a communal ownership of the learning process and, in particular, the identification of the problem. This thinking aligns with Lehmann et al. (2008), who aver that the social approach is team-based learning, which also

informs the collaborative learning process. Castillo, Herrera, Guffante, Paredes and Paredes (2021:2) explore the social skills which collaborative approach, a kind of group work, promotes, i.e., personal or behavioural skills, effective communication, technical knowledge, and so on among learners. The authors then clarify group work as a learning strategy in which learners work together in groups, relying on and supporting one another through cooperation and collaboration to reach a predetermined goal.

According to Castillo et al. (2021:1), with the rise of SD, there is a growing demand for social sustainability (SS) wherein social concerns are considered. Viewed by Castillo et al. (2021), the Architecture, Engineering, and Construction (AEC) industry evaluated group working as a strategy for implementing SD. This could be a case with TE curriculum because the subject supports teamwork. Hence, Castillo et al. (2021) assert that collaborative learning through group work generates spaces for social interaction and allows for direct relationships between peers, as well as creating an environment that enables participatory knowledge building, favours communication between learners, and increases shared responsibilities. In the same sense, Wachholz and Merrill (2012:77) posit that group work provides learners with direct experience with social action. This offers the impression that learners, through group activity, can connect with their surrounds, i.e., the environment. As a result, collaborative learning informs learning from a social constructivist perspective. In this view, sociocultural information is essential in the learning process. Hence, IKS can be viewed from this angle.

Lenglet et al. (2010:95) assert that learning about ESD is framed within social activity which means that it occurs both inside and outside of the classroom or seminar room. This therefore suggests that knowledge and understanding are not static entities but are always evolving. So, learning is about making meaning by identifying one's or the community's or the group's position in an unfolding reality and making sense of it through reactive action. Furthermore, according to Lenglet et al. (2010), learning and education contain knowledge and comprehension of scientific facts and processes, but they are also tied to past knowledge and understanding (e.g., cultural norms and indigenous or traditional

knowledge). Tilbury and Mulà (2009:29), on the other hand, argue that cultural variety and intercultural dialogue are internationally acknowledged and respected as tools for moving toward SD. In New Zealand, for example, education for sustainability is viewed to learn about cultural history. Furthermore, some scholarly literature indicates that acceptance of ESD must be culturally anchored and regionally relevant. It aims to define values, worldviews, and cultural expressions within the participatory and dialogic processes required for working together toward a common future.

Despite the preceding benefits of group work, Castillo et al. (2021) identified some of the challenges with collaboration through group work. Castillo et al. (2021) maintain that lack of responsibility and individual commitment in group work reduces effectiveness of collaborative work resulting in little coordination and poor organisation when creating activities for the development of a task, as well as a lack of coordination during the work. However, in relation to the current study, I believe that collaborative learning, group work and knowledge co-construction could help to establish the incorporation of ESD in an indigenous context because these approaches could promote the teaching of the concept consideration indigenisation of the ESD content, which would therefore embrace frameworks such as *Ubuntu*, LPP, and CoP. According to Lenglet et al. (2010:99), the distinguishing elements of ESD should pay particular attention to what happens in the "black box" of the learning environment; it should consider the interaction between the learners and their own home, community, local, and global context.

As demonstrated in the section, TE approaches inform social learning, which may serve as a starting point for incorporating ESD. According to Bourn, Hunt and Bamber (2017:2), ESD approaches tend to promote a social constructivist approach to teaching and learning. Drawing on the foregoing, TE and ESD approaches link cultural diversity, communal practices, *Ubuntu*, and social learning. As a result, collaborative learning and teamwork in the TE curriculum provides a solid foundation for ESD.

3.7 SUMMARY

The chapter explored SD within the context of ESD as a driving tool for sustainability. The term sustainability appeared differently throughout the literature, making it a multi-vocal concept with multiple meanings. Its effort, however, is to strive for a world in which the values inherent in sustainable development are integrated into all aspects of learning in order to encourage behavioural changes that allow for a more sustainable, economically viable, and just society for all, a world in which everyone has the opportunity to benefit from education and learn the values, behaviour and lifestyles required for a sustainable future and positive societal transformation. As a result, the study was framed within the various policy imperatives such as the UN (Agenda 2030), Agenda 2063, and South Africa's National Framework for SD. Hence, the chapter examined the prospects for ESD in TE through IKS, drawing from the different policies. Furthermore, the chapter discussed in detail the teaching and learning of ESD in a collaborative learning style, which could inform an indigenous perspective.

CHAPTER 4

METHODOLOGY FOR THE STUDY

4.1 INTRODUCTION

The aim of the study, as stated in Chapter 1 Section 4, is to explore ways that can make the teaching of Technology promote ESD. This chapter describes the research methodology chosen for the study to answer the research questions and achieve this aim ultimately. The chapter begins by providing a comprehensive overview of the research design. The chapter also discusses the philosophical assumptions in which the study is grounded. The qualitative research methodology is discussed. The research methodology used for this study is discussed, as well as the reasons why the specific research method was chosen with proper justification. Furthermore, the data collection procedures are discussed. Participant sampling methods and procedures are described and justified as well. Trustworthiness, credibility, confirmability, and dependability are discussed, and the data analysis method is then discussed. The chapter further discusses issues of ethics.

4.2 RESEARCH DESIGN

A case study was adopted to explore ways that can make the teaching of Technology promote ESD. Case studies are part of the methodologies commonly used in qualitative research (Yazan 2015:134). Researchers can use the qualitative case study methodology to study complex phenomena in their contexts (Baxter & Jack 2008:544). Case studies, according to Anderson and Arsenault (2005), are concerned with how and why things happen, allowing for the investigation of contextual realities and differences between what was planned and what occurred exactly. Rather than developing normative statements, they are concerned with describing real-life phenomena. These case study characteristics enable a researcher to concentrate on an individual's behaviours, attributes, actions, and interactions (Brewer & Hunter 1989). A qualitative case study is a research method that allows for the exploration of a phenomenon within its context using a variety of data sources. In my study, the

case study was chosen because I wanted to specifically study and develop a better understanding of the case in point, i.e., the incorporation of ESD in TE from an indigenous perspective.

According to Yin (2002), a case study investigates a contemporary phenomenon within its real-life context, particularly when the boundaries between phenomenon and context are unclear. This ensures that the issue is explored through a variety of lenses, allowing multiple facets of the phenomenon to be revealed and understood. In the case study, a researcher conducts an in-depth analysis of a case and may emphasise “episodes of nuance, the sequence of events in context, and the wholeness of the individual” (Stake 1995:xii). According to Noor (2008:1603), case studies are useful in capturing the emergent and immanent properties of life in organisations, as well as the ebb and flow of organisational activity, especially when it is changing rapidly. As a result, in the current study, case study assisted me in understanding teachers' incorporation of ESD in the current changing environments within the social context. The case study design was also used to gain an understanding of the existing literature on ESD integration in TE curriculum.

Case studies are classified as explanatory, exploratory, or descriptive by Yin (2003). A descriptive case study design was used in this study to describe the phenomenon and the context in which it occurred in real life (Yin 2003; Baxter & Jack 2008), and to describe this natural phenomenon as it occurred within the data under consideration (Zainal 2007). According to Yin (2012:144), descriptive case studies can serve a variety of purposes, including presenting a rarely encountered situation or one that is not normally accessible to researchers. According to Noor (2008), a descriptive case study attempts to describe, for example, what happens when a product is launched. These descriptions of the case study are in line with Atmowardoyo (2018:198), who claims that descriptive research method is used to accurately describe existing phenomena. Accordingly, the descriptive case study helped me to describe the phenomenon of teachers' incorporation of ESD in their teaching. As a result, my goal was to describe the data as they occurred and interpret them. The descriptive case study was appropriate for this study because ESD is a real-life phenomenon whose

goal is to promote teaching that respects indigenous and traditional knowledge (Rathod 2013). Correspondingly, this study described and interpreted the participants' views as they unfolded in their settings. In this case, the participants' local knowledge aided in the interpretation and analysis of the data.

Case studies can be single-case or multiple-case designs, with the latter requiring replication rather than sampling logic. When there are no other cases available for replication, the researcher is forced to rely on single-case designs (Tellis 1997; Kocdar, Okur & Bozkurt 2017). A single case study was used because the study explored the case at hand at Ehlanzeni District in Mpumalanga Province in two circuits (Mbombela and Mgwenya circuits) and Bohlabelo sub-district. Ehlanzeni is rich in indigenous cultures, especially the Swati culture. It is against this background that I investigated the case and analysed the data within the two circuits in Ehlanzeni. This enabled me to examine the subunits within a larger case, Ehlanzeni District (Yin 2003). Dyer and Wilkins (1991) argue that single case studies are superior to multiple case studies because they generate more and better theory. The study was founded on a single group of Senior Phase Grades 7–9 Technology teachers (Yin 2003). So, the two circuits and sub-district allowed me to analyse data using the cross-case analysis. This, therefore, enabled an in-depth analysis that added to the clarity of the case.

The single-case study was applied on the participants described in 4.5 section.

4.3 RESEARCH PARADIGM

Research studies are embedded in a paradigm. According to Villiers and Fouché (2015), a paradigm is a set framework that makes various assumptions about the social world, how science should be concluded, and what constitutes legitimate problems, solutions, and proof criteria. Guba and Lincoln (1994) assert in the same input that a paradigm is defined as a fundamental set of beliefs that guide action. As a result, the current study was founded on the constructivist paradigm in order to help understand and describe the views and practices of the participants in a school setting on the basis of the assumption that their multiple socially constructed realities exist (Chilisa & Kawulich 2012:55). This paradigm

is also known as the interpretivist paradigm because it arose from the interpretivist paradigm of philosophy. Honebein (1996) and Bada and Olusegun (2015) define constructivism as a philosophical paradigm in which people construct their own understanding and knowledge of the world by experiencing things and reflecting on those experiences. According to Bada and Olusegun (2015:67), this paradigm is concerned with how people construct their worlds. Adom, Yeboah and Ankrah (2016:1), on the other hand, the constructivist paradigm is a powerful tool that can be used to conduct research in a variety of fields of study, such as in the IK and SD field in this study, as they pertain to the teaching and learning activities that are practiced at the educational level.

In the constructivist viewpoint, learning occurs when learners actively construct the meaning of new knowledge considering their prior experience, knowledge, attitudes, and values (Mann & MacLeod 2015:53). As stated above, constructivism aided me in understanding how participants engage in their educational activities to make meaning in their experiences, and their attempts to promote the ESD in the TE classrooms. Furthermore, constructivism helped me to understand the constructions or meanings of broad concepts such as cultural values, context, custom, and history, which could aid in the promotion of ESD in the teaching of Technology in Senior Phase classrooms (Williamson 2006).

Kalender (2007) asserts that constructivist learning occurs only when the learner discovers knowledge through experimentation and doing. This suggests that the learner is better placed to discover and construct knowledge when they are active. Hence, learning does not occur solely through the traditional method of teachers standing in front of the class and lecturing (Adom et al. 2016:2). This happens a lot in TE owing to the subject being more practical in nature, thus encouraging the integration of SD. Constructivists argue that truth is relative and depends on one's point of view (Baxter & Jack 2008:545) – learners should be allowed opportunities to experience truth that would help them construct knowledge from their varied contexts.

Therefore, constructivism may aid in understanding the practices of a group or society, as in the case of the participants of this study, in relation to environmental issues in their immediate surroundings. Constructivism would inform social learning in the context of the study, which may delve into the opportunities for incorporating ESD in TE. The participants' subjective experiences should be used to construct and elaborate multiple realities. One can still argue that how these realities manifest themselves in indigenous contexts should inform the content and teaching of Technology in a typical multicultural South African classroom to promote SD.

The sub-sections that follow zoom into the tenets of constructivism which include ontology, epistemology, methodology, and axiology reflecting the stated multiple realities as they pertain to this study. These tenets reflect my fundamental philosophical assumptions in the study. Understanding research philosophy is critical because it serves as the foundation for how the researcher should approach their research (Wilson 2014:8). The understanding of the above tenets of a paradigm result in the selection of a philosophical paradigm (Denzin & Lincoln 1998). According to Crotty (1998), researchers can begin at any stage, whether ontological, epistemological, methods/methodology or axiology. Some authors emphasise that the best way to conduct research is to first identify the ontological assumptions, e.g., understanding the meaning of the word or realities (Grix 2004; Mack 2010; Hussein, Hirst, Salyers & Osuji 2014). Then, researcher's ontological assumptions inform epistemological assumptions, which in turn inform the methodology, and all of this gives rise to the data collection methods used. This is the route that I have taken this far in the study.

4.3.1 Ontology

Ontology entails the philosophy of reality/theory of origin (Krauss 2005:758), which informs one's perspective on reality and being (Mack 2010; Scotland 2012). Similarly, Mack (2010) asserts that the interpretivism's ontological assumptions are that social reality seen by multiple people, and these multiple people interpret events differently, resulting in multiple perspectives of an incident. Ontologically, there are multiple realities or truths that depend on how

one constructs reality (Goundar 2012:21). As a result, multiple realities are based on subjective experiences, which include the experiences of the participants (Senior Phase Technology teachers) in this study as they relate to SD. I hold that learners who reflect the multicultural society of South Africa harbour these multiple realities which could enrich their learning activities such that they are not divorced from SD, more so that the majority of these learners belong to indigenous communities.

Consequently, Creswell (2014) asserts that constructivism deals with the development of subjective meanings and understandings of one's personal experiences concerning specific topics based on their social and historical background. Hence, understandings about the world are constructed and interpreted by people (Crotty 1998; Kamal 2019). This, therefore, resonates well with the reasoning that reality in the context of the study is embedded within an indigenous context and/or *Ubuntu*. The constructivists point out that various interpretations are possible because we have these multiple realities (Žukauskas, Vveinhardt & Andriukaitienė 2018:128). Correspondingly, realities in the constructivist paradigm are multiple in their nature (Guba & Lincoln 1989; Kamal 2019). This implies that multiple realities may be possible in any situation such as in the teaching and learning situation. The ultimate truth is therefore regarded as not existing, and reality is subjective and changing (Bunnis & Kelly 2010).

Ontology, according to Denzin and Lincoln (1998), addresses questions about the nature of reality and the nature of the human being in the world. In respect of the present study, multiple realities of the world include my realities as a researcher, teachers, and curriculum advisors. In addition, Hughes (2010) perceives reality as unchanging and depending on universal laws. I, however, opine that reality is perceived by people and hence it produces multiple truths which can be shared to better understand the world and people's practices. Hence, in the present study, multiple realities were understood in the light of the eight cases of teachers so to realise the opportunities of ESD in their classrooms. Hence, the presentation of their realities was based on their own views/voices

and data were based on the emerging themes. In view of the foregoing, ontology shaped my theory of knowledge, that is, epistemology.

4.3.2 Epistemology

Epistemology and ontology are closely related because they address how people come to know reality (Krauss 2005:758). Mack (2010) defines epistemology as the study of how knowledge is acquired. According to Cohen, Manion and Morrison (2007:7), epistemology is concerned with the nature and forms of knowledge. The researcher's epistemological view is typically classified as either objective if he/she believes that knowledge is governed by natural laws or is subjective if he/she believes that knowledge is something that individuals interpret (Rashid, Rashid, Warraich, Sabir & Waseem 2019:3). Within the context of this study, I see knowledge as something that the participants interpret within a social context, informing communal practices in indigenous contexts. On an epistemological level, there is no access to reality independent of people's minds, and there is no external referent by which to compare claims of truth (Smith 1983 in Goundar 2012:21).

According to Guba and Lincoln (1984), the investigator and the object of study interact so that the findings are mutually created within the context of the situation that shapes the inquiry. To the contrary, Kaphagawani and Malherbe (1998:205) assert that general trends emphasise the existence of African philosophy. As a result, because African philosophy encompasses all forms and types of philosophising, it makes sense to speak of an African epistemology. According to Hamminga (2005:57), the African epistemological view is immediately social. This is suited to the fact that learning is social, something that should be promoted in the classrooms that are characterised by diverse cultures. Ajei (2007) contends that acquiring knowledge on one's own is insufficient in the absence of a social context. In this regard, the foregoing discussion lays the groundwork for the IK-based SD integration to facilitate communal ventures to learning that promotes ESD in TE classrooms.

Ozumba (2004:40), for example, observes that each society has its own set of epistemological thoughts, methods, and world views. According to Kanu (2017:15), each African has his or her own method or means of acquiring knowledge, although, I maintain, incidences of commonalities that are inspired by *Ubuntu* can be observed in African communities. Drawing from this claim, African epistemology entails societal influence in one's knowledge and interpretations of things, such as the promotion of ESD through togetherness.

Reality is something that is relative as described in 4.2.1. Subsequently, Gray (2014:20) posits that varied interpretations of the world are “constructed and not discovered” that is between both parties, researchers, and participants. Therefore, epistemology within the context of African philosophy enabled me to realise the participants’ realities towards the incorporation of ESD in their classrooms from indigenous contexts. Observations and interviews enabled me to the realise that realities are socially contrasted. Therefore, to the constructivists, reality is a product of the human mind, which develops socially, and this changes the reality (Onwuegbuzie 2000).

Ultimately, epistemology makes us ask critical questions: Whose knowledge counts? How is knowledge constructed and applied? What knowledge do teachers give to learners? Do they poise themselves to learn along with learners instead of being knowledge dispensers? Are learners offered the space to construct their own knowledge as informed by their contexts and cultures?

4.3.3 Methodology

Crotty (1998:3) defines methodology as "the strategy or plan of action that lies behind the selection and use of specific methods." Interaction with Senior Phase Technology teachers via interviews and observations yielded what (knowledge) they make of their reality (ontology) from an SD perspective. The qualitative methodologies (interviews, observations, and document analysis) were used in the study to collect the perspectives of Senior Phase Technology teachers on their experiences with the SD.

The constructivist paradigm believes that the methodology utilised in research should explore “the minds and meaning-making, sense-making activities” (Lincoln & Guba 2013:40). Therefore, the methodologies used in this study have allowed participants to express their views on reality and explain how they represent that reality, particularly through the concepts that they employ. That was through the employment of the case study approach using the above-mentioned methods to collect data guided by the CoP, LPP and social constructivism. This attests to the fact that the methodological aspect of a research should agree with the ontological and epistemological stances of the research (Kamal 2019). In relation to the constructivist paradigm, it is known that there is no single reality, and the construction of multiple realities are made through interactions (Kamal 2019) that the teacher should allow among the learners.

The methods used helped to clarify the participants' beliefs and *Ubuntu*, which serves as the foundation of African philosophy or worldview. Methodology, within the constructivist paradigm, was therefore built on an understanding of SD from an African perspective. Therefore, social, cultural, and historical perspectives play an important role in shaping people’s sense about the world (Crotty 1998; Kamal 2019).

4.3.4 Axiology

Axiology is concerned with what "ought to be". It is concerned with the nature of values and is related to moral value teaching and character development (Tomar 2014:51). Chilisa (2012:20) contends that ethics and value beliefs that define a researcher's and participant's relationships and responsibilities should be addressed before ontological and epistemological questions, and that the research process should begin with the formulation of the research findings. In the study, I made certain that the social/socio-cultural aspects to understanding the world and/or the nature of information were valued and that bias in the field was avoided. This entailed the respect due to the participants, which I had to show, as well as opened myself to the beliefs that informed their knowledge.

As a result, the foregoing relates with constructivist paradigm of people's knowledge construction in various ways. It is in this instance that knowledge creation and sustenance are dependent on cultural, context, custom, and history attributes that resonate well with IK and SD (Ezeanya-Esiobu 2019:108). Furthermore, IK should be used as the foundation for building on new concepts, a process known as constructivist learning (Ezeanya-Esiobu 2019:108). It is from these perspectives that the above assumptions shaped the study towards the qualitative approach as discussed in detail in the next section.

4.4 RESEARCH APPROACH

This study adopted a qualitative approach. Creswell (2014:32) defines qualitative research as a method for investigating and comprehending the meaning that individuals or groups ascribe to a social or human problem. Moreover, qualitative research looks at the big picture to gain a better understanding of the phenomenon and build a compelling argument capable of producing cross-contextual generalisations (Ary, Jacobs, Sorenson, Irvine & Walker 2018; Mason 2002). Moreover, qualitative research is an iterative process in which improved scientific understanding is achieved by making new significant distinctions because of getting closer to the phenomenon studied (Aspers & Corte 2019:139). It is in this view that qualitative research enabled me to gain insight on incorporation of SD in TE. On the contrary, qualitative research seeks to illuminate and comprehend complex psychosocial issues (Marshall 1996:522).

According to Baker and Edwards (2012:8), qualitative researchers generally study fewer people but delve deeper into those individuals, settings, subcultures, and scenes to generate a subjective understanding of how and why people perceive, reflect, role-play, interpret, and interact. The qualitative research in this present study opened opportunities to delve deep into individuals, settings, cultures relating to their standard of living so to understand the stand for ESD. Merriam and Tisdell (2016:6) maintain that qualitative approaches are concerned with identifying how people describe their own experiences, “how they construct their worlds, and what meaning they attribute to their experiences”. Therefore,

the qualitative approach in this study revealed the meaning of reality occurrence for the participants involved.

The qualitative research method is concerned with the subjective evaluation of attitudes, opinions, and behaviour (Kothari 2004:5). In this case, research is a function of the researcher's insights and impressions. It is from this view that qualitative research method assisted me to better understand people as well as the socio-cultural contexts in which they live (Palmer & Bolderston 2006:16). Through the subjective experiences of the participants, qualitative research enabled me to gain insight into the specific meanings and behaviours experienced in relation to the phenomenon thus incorporation of ESD in this case (Palmer & Bolderston 2006). Furthermore, qualitative research assisted me to capture the details, practice, and experience of the subjects (i.e., ESD implementation) as they occur. The methodology of qualitative research describes data in words rather than numbers. As a result, qualitative research in this study provided me with a clear understanding of teachers' views toward the inclusion of ESD in the Senior Phase Technology curricula.

4.5 POPULATION AND SAMPLING

4.5.1 Population

The first step in the sampling process is to define the target population precisely (Taherdoost 2016). According to Taherdoost (2016:18), the term population refers to the entire set of cases from which the researcher sample is drawn. Similarly, according to Oswala (2001:55), population refers to the number of people or objects covered by the study or with which the study is concerned. In this regard, the study's target population was Senior Phase Grade 7-9 Technology teachers and a CSA for General Education and Training (GET) in the Senior Phase in Mpumalanga's Ehlanzeni District. Bohlabelo is the sub-district of Ehlanzeni. As a result, the CSA from Bohlabelo was chosen to provide an official’s perspective on the incorporation of ESD in Technology Education. Subsequently, the main reason for selecting Senior Phase Technology teachers and CSA was that Grades 7–9 are part of the school system's Senior Phase. It is the ideal Phase for learners to be prepared before moving into the

specialisation streams of TE in the Further Education and Training (FET) phase. The Intermediate Phase was not chosen because it combines Technology and Natural Science (called NS & Tech) – the goal is to help learners understand the relationship between technology and science in this phase. Selecting Senior Phase Technology teachers would allow for early intervention of ESD incorporation in TE curricula. Ehlanzeni District was also chosen because it is one of the contexts in South Africa with the rich African cultural heritage and diversity. For instance, there are many cultural and heritage sites that carry the history about how indigenous people lived sustainable.

4.5.2 Sampling

I managed to collect data from all cases represented in the study that helped to answer the research questions. As a result, a sample was considered. More importantly, the sampling frame was a representative of the population. Sampling is the process of selecting a subset from a chosen sampling frame or the entire population. Sampling was used to draw conclusions about a population or to make generalisations based on the existing theory (Bhardwaj 2019; Taherdoost 2016). Accurate results from the sample were obtained. The study used a non-probability participant selection method. According to Cohen et al. (2007:113), a non-probability selection is derived from the researcher targeting a specific group, as opposed to purposive selection, which simply represents itself. Nonprobability sampling is frequently associated with the case study research design and qualitative research (Taherdoost 2016:22). Qualitative case studies were the focus on the sampling size in this study and were intended to investigate a real-life phenomenon on incorporation of ESD in TE within an indigenous context rather than making statistical inferences about the larger population (Yin 2003).

A sample of participants or cases does not have to be representative or random, but there must be a clear reason for including some cases or individuals over others. Purposive or judgmental sampling is a strategy in which specific settings, people or events are deliberately chosen to provide important information that cannot be obtained through other options (Maxwell 1996). When the population

size is large, sampling is an important tool in research. Based on this, sampling is classified it into two types based on this, i.e., probability and non-probability. Quota sampling, snowball sampling, purposive/judgmental sampling, and convenience sampling are examples of non-probability sampling techniques. Accordingly, purposive sampling was used to select the teachers who participated in this study. Eight Technology teachers were purposively chosen from six schools, five teachers from four schools in Mbombela and three teachers from two schools in Mgwenya circuits as well as the GET Technology CSA at Ehlanzeni District, Mpumalanga Province. The rationale for purposive sampling of the teacher participants was that they were engaged in their teaching contexts so that the case in question could be understood from the multiple perspectives from which ESD can be taught.

Purposive is a “feature of qualitative research in which researchers handpick the cases to be included in the sample based on their judgment characteristics being sought” (Cohen et al. 2007:115). Members for a sample are chosen for this type of sampling based on the purpose of the study. It is also known as deliberate sampling or judgmental sampling.

4.6 DATA COLLECTION METHODS

The interview, focus group, observation, and/or chart review are common data collection methodologies in qualitative research. In this regard, interviews, observations, and document analysis were used in this study. The three data collection methods would aid in triangulating data to better understand how Senior Phase TE teachers promote EDS in their classrooms.

4.6.1 Interviews

An interview allows for greater insight into the interviewee's world as well as a deeper understanding of the nature or meaning of the interviewee's everyday experiences. Interviews are especially useful for learning more about a participants’ experiences. Cohen et al. (2007:349) describe the interview as a versatile method of data collection that allows the use of multiple sensory channels, including verbal, nonverbal, spoken, and heard channels. Similarly,

Alshenqeeti (2014:40) emphasises that interviews are interactive, and interviewers can press for complete, clear answers and probe into any emerging topics. Interviews conducted within the context of the study provided an excellent opportunity to learn in-depth information from Technology teachers in response to ESD integration in their classrooms. According to Driscoll (2011:165), when interviewing, the researcher has the option of conducting a traditional, face-to-face interview or conducting an interview using technology via the Internet. Face-to-face interviews have the advantage of allowing researcher to ask follow-up questions and make use of nonverbal communication (Driscoll 2011). Individuals can say much more in a face-to-face interview than they can in an email; so, a face-to-face interview provides researcher with more information. Therefore, the study employed face-to-face interviews to interact with participants as they responded to interview questions.

According to Palmer and Bolderston (2006), there are three approaches to conducting interviews: structured, semi-structured, and unstructured interviews. Semi-structured interviews were used in the study to achieve depth by providing opportunities to probe and expand the participants' responses (Rubin & Rubin 2005:88). A semi-structured interview is a hybrid – the questions are formatted, but the interviewer may deviate from the scheduled questions if an unexpected topic of discussion proves fruitful (Palmer & Bolderston 2006). Unstructured and semi-structured interviews can generate richer data and provide a more in-depth understanding of a subject than a questionnaire. Semi-structured interviews were used in this study to learn how Senior Phase Technology teachers teach TE in a way that promotes ESD. The semi-structured sessions would encourage the participants to open and share their perspectives on local knowledge and cultures, as well as how these can be incorporated into their teaching of Technology. Furthermore, the semi-structured interviews brought the interviewer and interviewee closer together. The semi-structured interviews allowed me to collect the same basic information from all interviewees.

According to Drever (1995), semi-structured interviews are a very flexible technique for small-scale research. Because they allow the interviewer to delve deeper into the participants' perceptions rather than pre-empting the issues, the

semi-structured interviews allowed me to freely explore the issues of ESD within the context of indigenous perspectives. As a result, Arksey and Knight (1999:5) assert that semi-structured interviews begin with broad and general questions or topics. As a result, I had more freedom to explore issues as they arose rather than pre-empting them. Moreover, the semi-structured interviews make the research benefit from a more open framework (Pathak & Intratat 2012:4). The semi-structured interviews also yielded more useful information from participants in relation to the incorporation of ESD in teaching of TE.

4.6.2 Observations

The main benefit of using observation studies is that the researcher can see first-hand what people say and do in "real life," rather than relying on the individual's interpretation of the situation (Palmer & Bolderston 2006). According to Gorman and Clayton (2005:40), observation studies "involve the systematic recording of observable phenomena or behaviour in a natural setting." Furthermore, observation can be useful in the early stages of analysis because it allows the observer to form an opinion about how signs are read and therefore locate the data in the context in which it was collected (Scott & Usher 2011:109-110). Observations in the study aided in the discovery of a comprehensive understanding of the ESD integration. Through observation, one can gain insight into human history, which can then be used to inform indigenous ways of incorporating the concept of ESD. During the observations I made handwritten field notes and transcribing the notes to an electronic format. Each of the eight Technology teachers were observed for one hour within two periods.

According to Palmer and Bolderston (2006), there are two types of observation studies, i.e., participant observation and non-participant observation. Participant observation is a type of observation in which a researcher interacts with participants and becomes a member of their community. Conversely, non-participant observation means that the observer is "looking on" and not actively participating in teaching, for example (Urquhart 2015:30). According to Driscoll (2011:160), non-participant or unobstructive observation involves not interacting with participants but simply recording their behaviour. Non-participant

observation was used in the study to collect detailed information as the classes progressed and with less disruption. Therefore, non-participant observation was appropriate for the study because it gave me the opportunity to observe and record events as they occurred without interfering with them so that proper description would be achieved. Non-participant observation was therefore deemed important to comprehend the experience of implementing ESD in TE curricula.

Using this method, I gathered a wealth of data for testing and refining the study. The method did not interfere with the participants' work, but it was a time-consuming and an ethically sensitive activity for me. Negotiating access to the classroom, explaining the research to the potential participants, and assessing the acceptability of those affected by the observation activity throughout the day were all factors to consider. Before conducting observation, I carefully planned access to the research site, setting, and research. While observing, I made detailed field notes of the environment and the actions of the participants. The researcher can gradually develop his/her own insights and hunches by adding memos and analytical notes to field notes. Logs and field notes are the most common types of data collection (Polit & Hungler 1987:271). The former is used to document daily conversations or events, whereas field notes are "much broader, more analytic, and more interpretive" (Polit & Hungler 1987). The observational notes described what I saw in the field.

4.6.3 Document analysis

Document analysis is a systematic procedure for reviewing or evaluating documents, both printed and electronic (computer-based and Internet-transmitted) material. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted to elicit meaning, gain understanding and develop empirical knowledge (Corbin & Strauss 2008; Rapley 2007). Documents contain text (words) and images that have been recorded without a researcher’s intervention. Document analysis includes different forms: advertisements; agendas, attendance registers, and minutes of meetings; manuals; background papers; books and brochures; diaries

and journals; event programmes (i.e., printed outlines). The study focused on learners' textbooks and teacher's journals containing the lesson plans, annual teaching plans (ATP) and policies (CAPS).

Furthermore, Merriam (1988:118) avers that documents of all types can help the researcher uncover meaning, develop understanding and discover insights relevant to the research problem. Therefore, this study analysed the teachers' lesson plans, ATPs, policy documents and learners' textbooks to identify the opportunities that can include ESD in the teaching of Technology and to describe the attempts that are made to do that. Other mute or trace evidence, such as cultural artifacts, is not included in this discussion. Documents, according to Atkinson and Coffey (1997:47), are social facts that are produced, shared, and used in socially organised ways. However, teachers' lesson plans, learners' textbooks, ATPs, and CAPS document were considered as the main source of information for document analysis. Documents provide additional research data, are valuable additions to a knowledge base, and provide data on the context in which research participants operate.

Table 4.1 summarises the data collection methods describing the type of information that the interview guide, observation tool and document analysis tool targeted.

Table 4.1: Framework of data collection methods

Research question (s)	**Concepts from theory of the study**	**Research method(s)**	**Items for data collection**
What understanding do Technology teachers have about ESD?	LPP Social constructivism/dialectical CoP culture	Interviews (individual), observations	Understanding of ESD. Understanding of sustainable ways within communities. Understanding of social practice collaboration approach, CoP, and LPP towards ESD.

Research question (s)	Concepts from theory of the study	Research method(s)	Items for data collection
			Understanding of ESD through TE perspectives. Awareness of the concept of ESD. Understanding or knowledge of SDGs goals.
What opportunities does the TE curriculum present to teachers to teach for ESD?	Social constructivism LPP culture	Interviews (individual), observation and documents analysis	Understanding of Technology teaching activities Understanding the nature of the subject so to integrate ESD. Learners' activities which reflect ESD within the perspective of IKS. Kinds of activities given to learners/ during their teaching relating to IKS.
How can Technology teachers use IKS to incorporate ESD in their teaching?	CoP LPP Social constructivism	Interviews (individual) and observations	Strategies used to integrate IKS during teaching and learning of ESD. Activities used to promote awareness of the concept ESD. Strategies teachers use to teach Technology from IKS perspectives.
How can the TE curriculum be re-conceptualised so that it includes ESD?	LPP CoP Social constructivism culture	Interviews Document analysis	Information on the curriculum materials that teachers are exposed to during training/workshops in order to facilitate the incorporation of sustainability issues into IKS.

Research question (s)	Concepts from theory of the study	Research method(s)	Items for data collection
			Strategies to assist teachers in incorporating IKS into their lessons. Understanding of ESD integration of IKS.

4.7 Data analysis

The study employed thematic analysis. Fereday and Muir-Cochrane (2006:82) posit that thematic analysis is a form of pattern recognition within the data with emerging themes becoming the categories for analysis. The process involves a careful, more focused re-reading and review of the data. The reviewer scrutinises the selected data and performs coding and category construction based on the data's characteristics to uncover the themes pertinent to a phenomenon (Fereday & Muir-Cochrane 2006:83). In addition, thematic analysis is a general approach to analyse data that involve themes. The data were coded and segmented into the developing patterns, then these patterns were categorised into themes ultimately. The data were transcribed after the interview to prepare them for analysis. Transcribing refers to the process of creating a written record of what was said by participants. To avoid bias in my research, I recorded the interviews rather than relying on my memory. Recording interviews allowed me to directly quote the participants and re-read the interview while writing. I had two recording devices for the interview in case one of them failed. The interview data were aligned to the data from the observation sheets and document analysis and categorised to establish themes. The analysis was conducted in such a way that it responded to the research questions. I also studied each participant in the case to deepen the understanding of this case study (Yin 2009). The codes and the themes generated served to integrate data gathered through interviews, observation, and document analysis methods across the two circuits at Ehlanzeni district.

Alhojailan (2012) asserts that thematic analysis approaches are appropriate when samples are determined and defined prior to the beginning of the study. Furthermore, thematic analysis provides the flexibility to begin data analysis at any time during the project, even if there is no relationship between the data gathered and the outcome of the process itself. A researcher can use thematic analysis to identify numerous cross-references between the evolving themes and the entire data set (Hayes 1997). As a result, the data in this study were analysed using the model in Figure 4.1, which linked the various concepts and opinions of participants and compared them to data gathered in different situations and at different times from the participants. The data were coded using interview recordings, then they were cross-checked with observational notes and reports from document analysis.

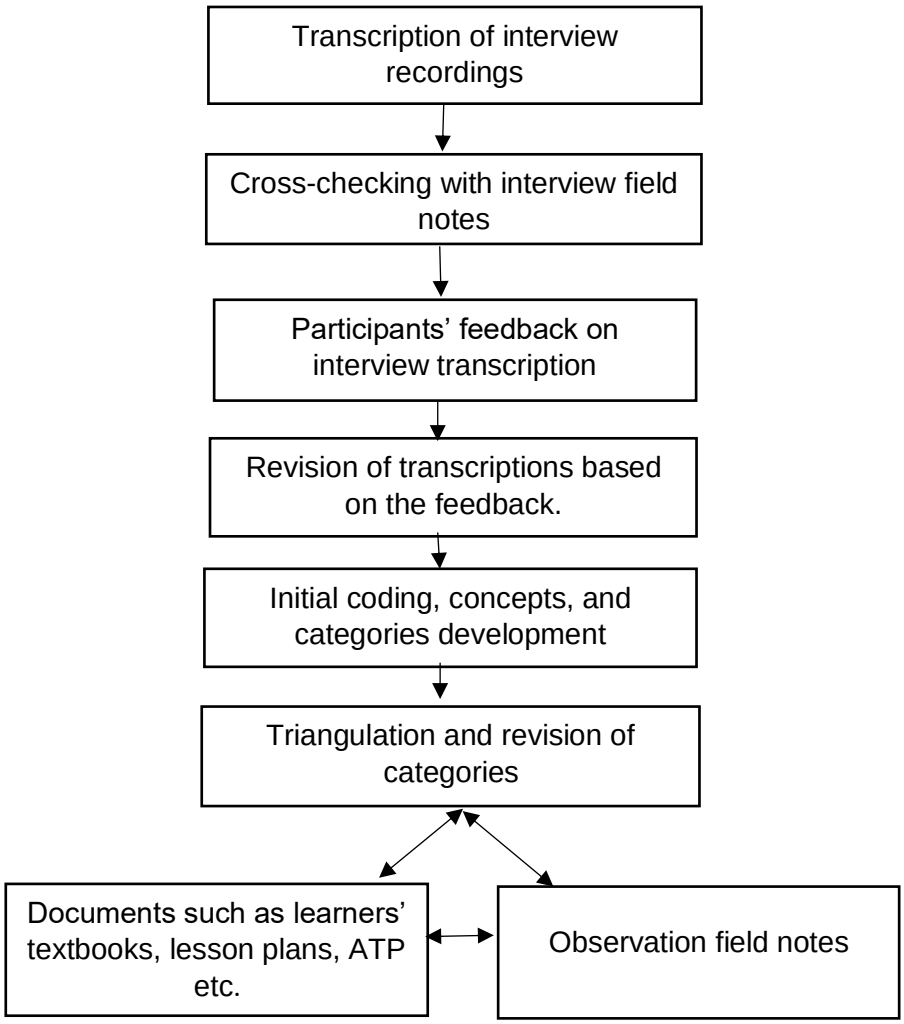


Figure 4.1: Empirical material interpretation process (adpoted from Rashid et al. 2019)

4.8 TRUSTWORTHINESS OF THE STUDY

Trustworthiness in qualitative research is used to measure the quality of research. Trustworthiness is described as a methodological (research design, data gathering, data analysis) accuracy (soundness) and adequacy of the research inquiry (Holloway & Wheeler 2002; Lincoln & Guba 1985). Lincoln and Guba (1985:301) further point out that trustworthiness is applied to qualitative research according to the four strategies which include credibility, transferability, confirmability, and dependability.

4.8.1 Credibility

I ensured that the process of the study and data collection and analysis are credible and trustworthy by piloting the instruments on the participants who are not part of the sample. By triangulating the data, the researcher attempts to provide a confluence of evidence that breeds credibility (Eisner 1991:110). By examining information collected through different methods, I corroborated the findings across data sets and therefore reduced the impact of potential biases that might exist in the study. According to Patton (1990), triangulation helps the researcher guard against the accusation that a study's findings are simply an artifact of a single method, a single source, or a single investigator bias. Hence, the study used multiple data collection methods (interviews, document analysis and observations). Document analysis is often used in combination with other qualitative research methods as a means of triangulation – the combination of methodologies in the study of the same phenomenon (Denzin 1970:291). The qualitative researcher is expected to draw upon multiple (at least two) sources of evidence; to seek convergence and corroboration using different data sources and methods. Apart from documents, such sources include interviews, participant or non-participant observation, and physical artifacts (Yin 1994).

4.8.2 Transferability

According to Bitsch (2005), transferability refers to the degree to which the findings of qualitative research can be applied in different contexts or settings with different respondents; it is the interpretive equivalent of generalisability.

Since this is a qualitative study, and more so a case study, generalisability to other contexts is not applicable. However, the study's findings contain the views and experiences that other teachers from different contexts may have. Furthermore, Bitsch (2005:85) asserts that the "researcher facilitates a potential user's transferability judgment through 'thick description' and purposeful sampling." Thick description involves the researcher in elucidating all research processes from data collection to the study context to final report production (Anney 2014:12). In this study, I made certain that a comprehensive set of details about methodology and context were included in the research report.

4.8.3 Dependability

The raw data from the interviews transcripts and field notes were discussed with the participants to check whether they were the true representation of what they know, and they were required to even sign as part of authenticating the data (Ndlovu 2012:38). The same data collection instruments protocols were applied to all participants to avoid bias towards the data interpretation (Korstjens & Moser 2018:121).

4.8.4 Conformability

This study provided a detailed descriptions of the context in which it was conducted to enable readers to make judgements of the similarities and differences to be obtained from the different context of the cases under study (Korstjens & Moser 2018:121). Comprehensive descriptions were provided through the transcripts from audio tapes during interviews, document analysis and observations.

As stated above, participants were consulted (member-checking) again to confirm the findings of the study. Participants were given a chance to verify the accuracy of the verbatim transcripts to be extracted from interviews and comment on the field notes to be taken during the observations (Ndlovu 2012:38). The research findings were presented to the participants to ensure the trustworthiness of the study in a form of a meeting. Data were triangulated across data sources to add to the understanding of the same and as a measure of trust.

Adler and Adler (1994:381) suggest that researchers should conduct their observations “systematically and repeatedly over varying conditions,” that is, varying the time and the place to “ensure the widest range of observational consistency”. Hence, the eight Technology teachers were observed in this study to ensure triangulation of data.

In summary, trustworthiness is further linked to credibility as an alternative to validity (Guba & Lincoln 1985; Tobin & Begley 2002). Therefore, the four specific strategies ensure the trustworthiness of this study which include data triangulation across the three methods of data collection (interviews, observations, and document analysis), member-checking to test the findings and interpretations with participants, persistent observation through extended interaction with the context and the participants so to gain an understanding of the essential aspects of the setting and peer debriefing with the participants. The validity of qualitative methods can be improved by using a combination of data collection methods (a process known as triangulation) and by analysis of the data by more than one person (Palmer & Bolderston 2006). I, therefore, demonstrated objectivity (seeking to represent the research material fairly) and sensitivity (responding to even subtle cues to meaning) in the selection and analysis of data from documents.

4.9 RESEARCH ETHICS

Ethical issues arise in all types of research (Orb, Eisenhauer & Wynaden 2000:93). As a result, ethical considerations are critical in all research. According to Orb et al. (2000), the research process creates tension between the goals of research to make generalisations for the benefit of others and the rights of participants to privacy. Maintaining ethical principles as a matter of human rights protection is therefore critical. It is in this light that Stuckey (2014:6) argues that before conducting interviews, the first step should be to obtain research ethics approval. The human protections review was created to protect participants' privacy and provide consent to conduct research in accordance with the protocol's established steps. A human rights review is required if the researcher conducts interviews or collects data from patients, students, or any living

individual (Stuckey 2014). It is critical that proper steps are taken to ensure that participants are fully aware of their participation and role (Rashid et al. 2019:7). More importantly, ethics specifies the ethical behaviour that were followed during the interviews, observations, and document analysis. This was approached in an *Ubuntu*-inspired manner – respect for participants, cooperation with participants, and so on.

According to Aina (1995), the code of ethics is intended to protect the rights of individuals used as research subjects. In this study, three fundamental factors were considered: confidentiality and anonymity, voluntariness, and biasness. Participants may reveal potentially embarrassing or damaging information, such as racist remarks or unusual behaviour. Their identities were kept anonymous by creating a "pseudonym" (or false name) for them. I respected their privacy by not leaving their information lying around. Furthermore, the Belmont Report (1997) suggests that, in most cases, the researcher must obtain permission from people before involving them in any primary research. As a result, participation was voluntary. Participants were asked to freely consent to participate in the study. As a result, there was no pressure on them to participate. This means that the participants were well informed about the study and the requirements for participation. Participants had the option to leave the study at any time. Bias may be present in the way the researcher asks questions, take notes, or draw conclusions from the data you collect as a researcher. As a result, the study's conclusions never took sides. Lastly, I applied for ethical clearance to the University of South Africa and sought permission from the DBE Mpumalanga and the school principals. I also asked the Senior Phase Technology teachers and the CSA to consent to participate in the study.

4.10 SUMMARY

The chapter discussed the research methodology that shaped the study, as well as the research design, population and sampling, data collection methods, and analysis using thematic analysis. Therefore, the philosophical assumptions ontology, epistemology, axiology, methodology, and/or methods were detailed. The chapter was written using a qualitative approach. The descriptive case study

was used as a research design. The chapter went on to explain how the single case study with embedded units aided in achieving the study's objectives. Furthermore, the rationale for the research design choices, as well as the samples and data collection methods, were outlined. I addressed the issues of credibility and trustworthiness using rigorous standards such as credibility, transferability, dependability, and confirmability. The study also ensured that human rights are important; so, ethical concerns were considered.

CHAPTER 5

PRESENTATION OF FINDINGS FOR THE STUDY

5.1 INTRODUCTION

To meet the study's objectives of incorporating education for sustainable development in Technology Education within an indigenous context, three data collection instruments were used, i.e., semi-structured interviews, classroom observations and document analysis. The findings presented in this chapter are based on all of the procedures and processes discussed in Chapter 4. The study's findings are based on current living examples in relation to the participants' views and literature. Therefore, the study's findings highlight the need to implement ESD in the Technology curriculum. The chapter begins by presenting the participants' biographical information, then the findings are presented in accordance with the three data collection methods, which are themes emerging from the semi-structured interviews, classroom observation, and document analysis.

5.2 BIOGRAPHICAL INFORMATION OF THE PARTICIPANTS

The teachers' teaching experience ranges from one to 11 years, but most of them have limited experience in teaching Technology as they were only allocated the subject owing to the less workload that they had. As a result, they have only recently begun to teach the subject. To support this, only three teachers had a B.Ed degree in Technology Education Senior Phase. However, one of these three teachers held an Advanced Certificate in Education (ACE) which he obtained at the time Technology was introduced as a subject. The other five teachers held degrees in analytical chemistry, BTech in Quality Management, B.Ed in technical subjects (FET), Agricultural Sciences, Siswati, Natural Sciences, and Mathematics. The study included four female teachers and four male teachers from the Mbombela and Mgwenya circuits. Mbombela Circuit had four female teachers and one male teacher, while Mgwenya circuit had only three male teachers. From the eight teachers, two females work in a multiracial school in the heart of Mbombela. Three other teachers (one male and two females) work

in township schools that are part of the Mbombela Circuit. One teacher works in a semi-rural school that falls under Mgwenya Circuit, while the other two work in a township school. Most schools lack Technology labs. These teachers fall under the following cultures: Swati, Zulu, Tsonga, and Indian (refer to Table 5.1). Pseudonyms were used for the teachers thus: T for Technology, t for teacher, m for male, and f for female. Table 5.1 provides a summary of the biographical information for the teachers.

Table 5.1: Teachers' biographical summary

Pseudonyms	**Circuit**	**Teaching experience (years)**	**Culture**	**Developmental context in which the school falls**
Tt1m	Mgwenya	7	Swati	Semi-rural
Tt2f	Mbombela	2	Tsonga	Urban
Tt3f	Mbombela	6	Swati	Urban
Tt4f	Mbombela	11	Swati	Township
Tt5f	Mbombela	5	Indian	Township
Tt6m	Mgwenya	1	Swati	Township
Tt7m	Mbombela	1	Zulu	Township
Tt8m	Mgwenya	4	Swati	Township

The participation of the chosen teachers in the interview was not easy. Initially, ten Technology teachers were planned for the interviews. However, this target was not met because many teachers stated that Technology was not their area of expertise and claimed that their knowledge of the subject was limited. However, saturation was reached by the time the seventh teacher was interviewed. I then decided to do the eighth teacher as well. This helped to counterbalance the original target number. The CSA for Technology in the Bohlabela sub-district's General Education and Training (GET) was also interviewed. Despite some teachers' reluctance to participate in the study, access to the schools and participants was achieved as the school principals gave me a warm welcome and the needed support. Five teachers from Mbombela circuits and three from Mgwenya circuits showed willingness to participate in the study.

5.3 FINDINGS FROM SEMI-STRUCTURED INTERVIEWS

In this section, the findings from the semi-structured interviews are presented. The presentation of the findings was guided by the emerging themes from the information that the participants gave in response to the questions posed to them. Moreover, the participants' own voices feature prominently in the presentation of these findings. Thematic analysis was used, and it allowed for the initial coding of concepts and phrases, followed by the identification of categories. Five broader themes emerged from long hours of the task of analysis of the data, from which sub-themes were identified as well. The information provided by these teachers and the CSA for the GET Band at Bohlabela District assisted in identifying the generated themes. The broader themes were identified in accordance with the research questions, and further sub-themes were identified (see Table 5.2). The table also gives examples of the verbatims under the sub-themes.

Table 5.2: Summary of main themes and sub-themes

Main theme	Sub-theme
The context of indigenous technology in TE curriculum	**Teachers' understanding of indigenous technology** • *It's one of the Africanism methods that were used by our forefathers.* • *Indigenous technology is technology used by the indigenous people of a country.* • *Indigenous technology is a technology that was done, that was used by our forefathers in solving problems.* **Realisation of indigenous technology/knowledge** • *If you can go and check in Grade nine, the topic where they talk about preserving food is an old methodology or method that is used in terms of preserving food.* • *Because we have topics such as processing, in processing we look at different methods that you can use in order to process materials and preserve them.* • *And even those methods or ways of let's make an example of preserving food and*

Main theme	Sub-theme
Teachers' understanding of sustainable development in the context of the African people	*so on is based on the indigenous knowledge.* **Subtheme: Sustainable development** • *And then we need to we need to have more knowledge about how to utilise these things, so that they can be sustained.* • *Standard that human society has to meet in a particular environment.* • *To improve life, but at the same time conserving the resources that we use that as we improve our lives.* **Subtheme: Sustainable development in an African context** • *If we look at indigenous people, they can sustain the information and then tell the generation about the information.* • *Indigenous people, when it came to sustainable development, they basically did very less to harm the environment.* • *African indigenous people, they use resources sparingly, they use them in a way that sustains them in a way that they can last for longer.*

5.3.1 The context of indigenous technology in Technology Education curriculum

5.3.1.1 Teachers' understanding of indigenous technology.

An understanding of the term indigenous technology is critical in relation to the teachers' understanding of ESD. The teachers demonstrated their understanding of the term indigenous technology by responding to the semi-structured interview questions. The teachers expressed their understanding by stating that indigenous technology is essentially about the knowledge that their ancestors used to solve day-to-day problems in the past. Tt8m described indigenous technology in the following way: "*indigenous technology is a technology that was done, that was used by our forefathers in solving problems before the new technology came into existence".* Similarly, Tt3f defined indigenous technology as technology that brings together people from various backgrounds to solve contextual problems using technology. Tt3f asserts: "*indigenous technology is about technology that involves different backgrounds of people, and it also*

involves how people believe or used to live in the early days, and how they used technology in their own way during that time".

It is clear from their views that they are aware of the term indigenous technology and believe that indigenous technology and modern technology are inextricably linked, as they believe that modern technology came into existence because of indigenous knowledge.

The CSA agreed that indigenous technology is the technology that the ancestors used before modern technology to solve problems. The CSA's explanation focuses on how things were done previously and how they have improved. She used the example of a pulley system that was used to draw water from a well. She went on to say that indigenous technology refers to knowledge that is used by a specific group of people of some kind. Furthermore, she understands that indigenous technology is an old way of solving problems, and that was technology in its most basic form.

Aside from the teachers' understanding of the term indigenous technology, Tt1m shared critical views about CAPS only giving some highlights and not much information; so; it is not widely recognised in their day-to-day teaching, particularly in the subject Technology. This teacher claimed:

> "*When it comes to indigenous technology, I think this is about the old knowledge or skills that were used before in order to do things around the communities, even though the CAPS document does not elaborate everything."*

Similarly, teachers provided their own interpretations of the term without providing any context how it relates to the teaching of the subject Technology. Tt2f openly described the term based on her knowledge to demonstrate its ambiguous relationship to the subject Technology with the believe that modern technology is about computerisation. She said:

> *"In my understanding, indigenous technology is the technology that was used before your electronics starts, before the invasion of computerisation, the things that we* [have] *done long time ago."*

The findings show that teachers have a common view about the term indigenous technology, despite the limited knowledge they have in understanding the concept. However, there were mixed views as to whether they consider themselves as indigenous people. This is because some believe their standard of living meets the demands of the 21st century. Tt3f maintains:

> *"From home chores, to traveling to everyday lives. I depend on modern technology, a lot more than indigenous technology. So, I wouldn't consider myself an indigenous person".*

Tt3m seemed to contradict the common view that there is a link between indigenous technology and modern technology, and that the former gave rise to the latter. This teacher would not relate the modern forms of technology to indigenous technology. To the contrary, Tt4f thought she wore dual identity:

> *"I can in some instances, especially when it comes to processing because there are some things like grinding mealies, grinding peanuts that I still do using the old ways of using a stone. And, I can say in that way I am indigenous but, in some cases, modern technology becomes easier to use in everyday life than the indigenous way."*

Even though Tt1m, Tt3f, Tt5f and Tt6f claimed that they are not indigenous, Tt2f, Tt4f, Tt7m and Tt8m still maintained and believed in their cultures; they still considered themselves to be indigenous people. This could be because their cultural identities are muddled by the two worlds that they live in, i.e., contexts of their cultural attachment, and the modern environments that they work in as professionals. However, Tt5f alluded that she respects indigenous people and that if it is necessary for her to teach in such a way that she recognises the works of indigenous people, she will do so despite her not being indigenous. In fact, the CAPS allows her to do exactly that in the sense that it is framed in the

transformation principles one of which is indigenous knowledge systems; and specifically, Technology as a subject includes indigenous technology – only that teachers seem not to take full advantage of this. Tt7m indicated that one's way of life is influenced by one's cultural background:

> "*Yes, I'm indigenous because most of the cases I believe in our cultures and ways of living or cultural standard of living. The way of doing things like looking at where we from and where we are going basically our backgrounds."*

The findings in this sub-section reveal the passion of teachers about indigenous technology even though they seem to have a shallow view of it. It is also noticed that they view indigenous technology in its past existence, which makes some not to realise the link between it and modern technology which is predominantly Western.

5.3.1.2 Realisation of indigenous technology/knowledge

The teachers felt that the TE curriculum content does incorporate the integration of knowledge, albeit with limited space. Tt1m, Tt4f and Tt8m argue that the TE content such as food preservation which is taught in Grade 9 allows for the incorporation of indigenous technology because the methods used were applicable even in the past and posed no risks to human health. Tt1m asserted that:

> *"Yes, I think it does incorporate indigenous knowledge or indigenous technology, because if you can go and check in Grade 9, the topic where they talk about preserving food is an old methodology or method that is used in terms of preserving food because these days, we use chemicals to preserve food, but back then they used to store food underground, just to prevent it from even contact of these microorganisms".*

Tt4f backed up this claim by saying:

“I can say yes, because we have topics such as processing, in processing we look at different methods that you can use in order to process materials and preserve them and also, when using such things such as the olden ways of processing materials or preserving them, we are able to apply them in modern times that we're living in now”.

In support of that, Tt5f mentioned the Grade 7 content that talks about recycling, with the belief that delivering such content would allow one to relate it to an indigenous context. Tt5f asserted:

“It does, like we say recycling. Plus, also in term four (4), they talk about indigenous dwellings, such as the San huts, the traditional Zulu huts, and those type of technologies that they use in the past and we compared to today”.

Notably, Tt2f and Tt3f believe that there is still much work to be done because the curriculum does not provide more information in relation to the integration of indigenous technology/knowledge in the TE content, so they do not have points of reference. According to Tt2f,

“There are still gaps because when I look at the syllabus that we have or the curriculum that we have [it] *is not focusing on older generation* [it] *is focusing on the generation of today, so I don't know, maybe their understanding is to say these children of now won't understand these principles”.*

Tt3f also stated,

“So, it does. But I think that even though it does, we, there's more that we can put in the curriculum about indigenous technology, maybe a whole entire topic, about indigenous technology”.

Tt7m, on the other hand, disagrees with the above comments in the sense that the content of the subject Technology does not provide the opportunity to

integrate indigenous knowledge in their teaching, with the belief that a lack of resources has a significant impact on the teaching of the subject. As a result, the integration of indigenous knowledge will fail.

> *"Not, it doesn't incorporate indigenous technology in the context of technology, because in the content of Technology designing and evaluating maybe structures we normally go to the class and only* [teach] *our general information about it but specifically we don't have the tools or programs that we are using to show learners if we draw a 3D what we must do which means there is still gap to cover these indigenous knowledge".*

This teacher's thinking was on resources that can only suit modern technology. Mpumalanga is rich in indigenous resources that can be used to teach Technology.

5.3.1.3 Opportunities available to teachers to incorporate indigenous technology into the Technology Education curricula

Teachers felt that the subject provides many opportunities to integrate indigenous technology as it allows them to teach in a way that references the positive and negative impact that technology has on the environment. As a result, Tt3f stated:

> *"Technology is concentrated on both modern and indigenous technology which means we can be able to teach our learners about technology in the indigenous way, and also teach them show them the negative impact that technology has as well as the positive impact that the indigenous technology has on the environment".*

Tt5f maintains that she sees an opportunity for indigenous technology integration in the teaching of recycling as an example because indigenous examples can be used to teach the topic.

Tt5f claims thus:

> *"Let's use recycling for example, right? Indigenous people made use of grass and sticks to create their temporary houses or huts. Also, pottery was created by the indigenous people, which is world famous today. So, we can teach the recycling which is there's a big need for it in today's society, and also pottery, and those types of stuff that came from indigenous people".*

Again, Tt7m emphasised that the content of teaching biodegradable and non-biodegradable provides an opportunity for indigenous technology integration. That is to say:

> "*In technology content we talked that some of the resources are biodegradable, non-biodegradable, which means even the indigenous knowledge of farming or planting our crops we can use natural material to plant our crops and then when we have planted the crops it can also be free from any diseases and us consumers".*

Tt2f and Tt3f, however, believe that there is still a gap because the curriculum focuses more on modern technology. As a result, integrating indigenous technology into TE curricula is difficult,

> *"That part is still lacking because when I look at the curriculum that we have now [it] is only focusing on the things that are automated or things that computer things, the things that are electricity based are not natural based things so it's very difficult to integrate this technology with the indigenous knowledge"* (Tt2f).

Tt3f expressed a similar viewpoint, but with the belief that the integration of indigenous technology can be noticed or considered during the design process:

> *"I'm not seeing much, but what I can say is that since in technology learners are trained to go through a design process and also go through*

investigations before they can make or maybe be before they can design any products. So, it gives them the opportunity to investigate if whatever they are planning to do, does it affect the environment is it environmentally friendly, so, they get the opportunity to actually assess the amount of damage that the product can have on the environment".

While teachers show a shallow understanding of indigenous technology, surprisingly, in this sub-section, they managed to give good illustrations and instances in the content where they could teach indigenous technology.

5.3.2 Teachers' understanding of sustainable development in the context of the African people

5.3.2.1 Sustainable development

The teachers were more certain that sustainable development (SD) is about one's environmental responsibility. Tt6m backed up this claim by saying: *"Sustainable development is the standard that human society has to meet in a particular environment."* This is basically done by looking at where one comes from and comparing it to what one has, then determining what needs to be developed in a sustainable manner. Tt5f added that SD refers to the assistance given to the country through various factors to avoid harmful substances that may end up polluting the environment, such as air pollution. She defines SD as follows:

"When we try to strengthen or support our economy or our country, using various factors, right, and some of them is how we use the sun's energy to create solar power, or we use the wind energy to create electric turbines or even windmills, which is also is trying to save is cost effective for the economy, and also electric transports to try to avoid emitting dangerous and harmful fumes and causing air pollution."

Teachers, on the other hand, believed that preserving the environment is critical because the resources in the environment must be preserved in such a way that

future generations will have access to them. As a result, knowledge and skills should be passed down through generations. Tt7m attested to the following:

> "*If we look, sustainable development is something that we can use not that we can use over and over again, but we can develop it in a sustainable way like it simply means we can meet the requirements for today and then those requirements can be got by our children. So, we develop in such a way that if we use technology, technology can also be used in 20 years to come again. "We develop now and stay for a long period of time."*

On the other hand, Tt8m added that the methods used by the ancestors to solve problems for survival are still relevant today. Therefore, our future survival is influenced by our past experiences. According to the CSA, SD is about meeting human needs without compromising the natural system. She claimed:

> "*To me sustainable development, it means it is a principle for meeting human needs, as I've indicated that even the indigenous technology was [used] to meet human needs and to solve problems. So, it is a principle of meeting human needs, meeting human developmental needs and goals. But making sure that we are sustaining the natural resources, while we are still providing for the human needs without undermining the natural system, the way the natural system works".*

5.3.2.2 Sustainable development in an African context

According to the preceding understanding, teachers believed that SD refers to how Africans used to live in the past in terms of how they were able to use their resources in a way that future generations will use. *"In relation to African people, I believe as Africans, we want to preserve things when we do something want to preserve it for future generations"* (Tt2f). According to the teachers' understanding, African people lived in a way that allowed them to keep their resources for a long time while never misusing them. Tt3f continues, saying: *"African indigenous people, they use resources sparingly, they use them in a way that sustains them in a way that they can last for longer".* Teachers observed that African people kept their knowledge by ensuring that knowledge is passed

down from one generation to the next to ensure that their traditions are not lost. This may be owing to how keeping the resources in good condition for a long period of time rather than using resources haphazardly, *"those indigenous people they do contribute positively on the environment because they minimize the effects that modern technology has on the environment"* (Tt4f).

Tt5f exemplifies African people as the first farmers who lived by growing crops and pastoralism as a sustainable way of life, highlighting that, like the San and Khoi, there was little damage done to the environment. Tt4f specifically mentioned:

> *"The first farmers made use of pastoralism right and growing of crops. So, they relied on sustainable development for survival. Right. And the San and the Khoikhoi also hunted and gathered, as well as the fished. So, they did very little to damage the environment. So, the indigenous people, when it came to sustainable development, they basically did very less to harm the environment*."

For example, the CSA believed that SD was relevant to African people because they had previously lived sustainably. She then claimed that SD in relation to African people is about how indigenous people lived in the past because their way of life had a lower environmental impact than modern living. She stated:

> *"Okay, when it refers to our African, our African indigenous people, if you can see that our indigenous ways, let me not say 100%, but it was rare that they will have a negative impact on the environment the way they did those indigenous ways".*

Apart from the preceding understanding provided by other teachers, teacher Tt7m indicated that the relationship that African indigenous people have in relation to SD is mainly their capability to keep information for future use for generations to generations. The understanding is that the information they tell remains the same and does not change, then that is how the information is sustainably kept. Tt7m emphasised:

"*If we look at indigenous people, they can sustain the information and then tell the generation about the information so that the generation can use it in the upcoming years, which means this knowledge they give cannot keep on changing which is sustainable of keeping things".*

Tt6m understands, however, that African indigenous people follow certain cultural norms that change with the current development, which simply means that the knowledge is sustainably developed with current living or environment.

"African indigenous people are these ones that still follow culturalism then the norms also change the values that were used in early 80s, they are not the same as they were so I can relate them that because things change".

Hence, Tt1m believes that there is a link between SD and African people, which is the understanding that in today's world, Western knowledge can be incorporated into one's culture for survival and environmental stewardship. Tt1m claimed:

"*That one, it's also based on knowledge and understanding in terms of how to integrate the western knowledge into your culture in terms of maintaining or developing your culture. It goes with the understanding and the ability to be able to link between the knowledge that we used to have or the indigenous resources that we used to have in relation to the new knowledge and technology that we have".*

Teachers understand indigenous technology/knowledge within the context of SD, as evidenced by their claims above. As a result, the relationship between the two concepts is conveyed, particularly within the Technology curriculum. Therefore, this comprehension may aid in the teaching to promote sustainability.

5.3.3 Teachers' awareness of the concept Education for Sustainable Development

5.3.3.1 Teachers' knowledge of the ESD concept

In responding to the question about the description of ESD, teachers appeared to be unaware of and/or have limited knowledge of what exactly ESD is in relation to Technology. In support, the CSA indicated that she has little understanding of the concept. The CSA went on to say that teachers are also less aware of it. The CSA backed this up: *"I don't think that our educators … even know that what we are doing is for sustainable development".* Although the teachers and CSA claimed to have little knowledge of ESD, their opinions gave me the impression that they did understand what it meant, as evidenced by the following discussions. Tt2f believes that ESD has to do with the education system, which teaches learners about real-life situations rather than just advancing to the next Grade. Tt2f clarified: *"Education is to learn in relation to real life situations, not to learn only to pass to the next Grade."* Furthermore, Tt1m says that ESD is about preserving knowledge and passing it on to the young for preservation. So, in essence, the understanding is on preserving knowledge for future generations. Tt1m stated further: *"So, it has to do with teaching that knowledge to the youth so that you can be able to sustain it."* Similarly, Tt6m, on the other hand, believes that we can survive because of our education.

> *"Education helps to follow what we have, if we can associate the sustainable development with education we cannot sustain without education, we sustain it because of education".*

He further asserts that ESD is concerned with informing or educating people about how to improve the current standard of living from the olden ways of living. As a result, he stated that: *"education for sustainable development* [is] *a way of showing us on how to improve, okay, from what was then to what is it is now".*

According to the teachers' views, ESD is about preservation of knowledge for future generations. This clearly shows that the teacher's basic knowledge is important in grasping the concept of ESD. Tt7m revealed:

"If we introduce our learners in education, it's a way in which we make our children aware that the education is dynamic, which means the information you receive today can keep on changing but let us develop some strategies of sustainability, so that it can be used by others like even the resources that will get under education keep on changing, but sometimes we have the same knowledge, or the knowledge is upgraded, but how can or how best we can sustain it is very important".

5.3.3.2 ESD in the TE classroom teaching

According to the CSA, education is concerned with teaching and learning. Thus, education for SD is simply the inclusion of key aspects or issues of SD. The CSA stated:

"In simple terms, education is about teaching and learning. So, we must incorporate these critical issues of sustainable development into our teaching and learning."

She further contended that education is important in promoting sustainability because knowledge is power, and if you want to make people aware, education is crucial. For example, in Technology, there are topics that teach learners about environmental issues and their consequences, such as climate change and electricity. Hence, in support of the foregoing, Tt5f have clearly stated that ESD is concerned with teaching learners about environmental issues and how to learn in such a way that those issues can be avoided in the future. According to Tt5f, "*education for Sustainable Development is teaching learners about many issues, such as poverty, pollution, the scarcity of water, and what we can do to avoid it for the future generations"*. Evidently, Tt4f supported the aspects of ESD that are about teaching people how to conserve the environment by reducing the negative impact of the technology used as it simplifies people's way of life, but people must be taught how to conserve the environment. She highlighted the following:

"Education for sustainable development should be education that involves telling people, how we can try to conserve the environment, while you are

having things that we can [improve life]*, but the things that can reduce the negative impact".*

Additionally, Tt3f states: *"ESD* [is] *about teaching learners to consider using resources in a way that they can be available in future, that we can still have them in the future for future generations. So, it's about teaching learners how to save the environment is used the resources".*

The TE curriculum topics allow for the recognition of environmental, social and economic aspects enshrined in ESD. As a result, teachers and the CSA were able to connect ESD to the Technology teaching.

5.3.4 Relationship between TE approaches and indigenous technology in ESD teaching

5.3.4.1 Collaborative and teamwork approaches for indigenous technology

Teachers were convinced that collaborative and teamwork would aid in the promotion of indigenous technology in their classrooms because learners would share knowledge from their diverse backgrounds. According to Tt1m,

> *"So, I think if they are working together, it brings different cultures together so that they can be able to share how food is being preserved in their culture. How do you cook in your culture, the thinking in that way? The group it does allow, also even the sustainability of indigenous knowledge, because it's where you bring different learners from different backgrounds together so that they can be able to produce maybe one project if it's a project".*

Tt2f went on to demonstrate how the two approaches, collaborative and teamwork as encouraged in Technology could assist learners in sharing their cultural knowledge towards the completion of practical task,

"I'll give example first, this school that I'm working in is a multiracial school. Kids from this school are coming from different backgrounds, we have Indians, we have Hindus we have Africans, we have combinations, and other kids coming from outside South Africa. So, as they work in groups, they tend to share the knowledge from different countries from different cultures. So, it does improve when it comes to indigenous knowledge because some kids know indigenous knowledge from their parents. There are other ways we teach them things of which, as Africans, we don't do it like that but in Indian, we do it like that. So, as they work together, they get more knowledge on how things are done so is easy for them to combine the knowledge of different countries and their knowledge of South Africa and make something that is tangible".

Tt5f concurred with Tt2f's views in that learners may design products in groups that reflect on various traditional effects. Tt5f attests to the following:

"In groups of three or four, they can all be given clay to create something that was made and used by the indigenous people, such as clay pots or jars, that can store water or grain. They can add some traditional designs to it, to also give it that whole traditional effect".

Therefore, the hope is that these approaches would aid in recognising the importance of ESD in the TE curriculum. Tt4f states:

"I think technology can help because if you can check, people are now dependent on a lot of things that make life easier. So, if we can transform technology into education for sustainable development or into something, or you can make and/or people aware that we can use technology to sustain our environment and develop it even further, then we can be able to reach a lot of people because people are interested in a lot of technologies that we use that make life easier".

Tt1m, Tt3f, and Tt5m also indicated that collaboration and teamwork would result in a shift in the teaching of Technology toward ESD. In this regard, Tt3f stated:

"Yeah, so when they work in a group, they, I think, there are opportunities to transform the technology into education about sustainable development. Because as they work as a group, they get to discuss about factors that could maybe lead to pollution, that they can do in order to make their product to be environmentally friendly. As a group, they can get to discuss such things".

Tt1m supported as follows:

"So, meaning as they are working in groups with different skills and knowledge. They can also, maybe come up with their own cultural context, when it comes to sustainability".

Meanwhile, Tt5f agreed and said:

"So, then here in groups, we can allow learners to collect material such as cardboard, plastic, paper, metal, and then they can collaborate in that groups and make something new out of that old scrap pieces that they brought, such as candle holders. They can make jewellery items with metal. They could make stationery holders which plays a major role in sustainable development".

Tt7m and Tt8m stated that when learners work together, they are also learning.

Tt8m indicated,

"Yeah, firstly I as an educator, I learn by their interaction while discussing and while learning, I also get to know being able to, I mean to create something of my own from that discussion that I will use, or I can use to solve problems".

Tt6m, on the other hand, believes that transforming Technology into ESD is about the development of the concept technology.

> "*This one needs ideas on how to help the level of technology that we are having so that it might be developed. I can cite an example of a cell phone. The cell phones that we are having now are not the cell phones that we used early 20s. They have improved at the same time, they are helping a lot in terms of education, because some of us will* [be] *learning using cell phones".*

5.3.4.2 Design and problem-solving activities geared toward ESD recognition

Teachers believed that the design and problem-solving activities would aid in the realisation of ESD in the subject. This is because teachers' views similarly showed that design and problem-solving engage learners in ways that allow them to relate to their cultural contexts to the co-create technological knowledge. Tt7m declares in this light:

> *"Yes, the activities make them to relate to their cultural context because if we design or evaluate those projects. The learners are coming with their material, they plan, talk as a group and also at the end make a project".*

Tt4f indicated that in the content of processing, learners can be taught in a way that allows them to relate to their cultural context because it allows for the incorporation of indigenous knowledge ways of living,

"I think in processing that is where we can relate to the cultural concepts, because most of the processing procedures indigenous ways of processing materials were practiced, and they're still being practiced in most homes and families".

This is one instance in which the teachers acknowledged that indigenous technology is still practiced to a larger extent.

Tt5f provided an example of how design and problem-solving activities allow learners to relate to their cultural context:

"So, we can say, we can ask learners to design a kraal in a rural settlement to house cattle. And by designing a kraal, they will be solving the problem of cattle getting loose and running away. The kraal must be made using sticks, it must be safe, user-friendly, spacious, yeah".

Tt3f stated in the same understanding that the development of design briefs helps learners relate to their cultural context. This teacher stated:

"Because during the design, the learners get to know when they have to write their design briefs; they have to go through every single detail of their design and also say why they are designing it in that way and consider environmental factors as well".

Tt2f also mentioned that the content of structures may allow learners to connect current content with indigenous knowledge:

"Yeah, there are some topics that relate to their culture, like we will talk about shelter, we are [ask them] to *give types of shelter that they know of. So, it brings about their knowledge of shelter. What is a shelter from back then until now, is the shelter that was used 20 years, still a shelter today".*

5.3.4.3 Design scenarios within cultural context

Notably, the teachers agreed that design and problem-solving activities allow learners to co-construct technological knowledge because the design scenarios relate to their cultural context. Tt3f, Tt4f, Tt5f and Tt7m agreed that the design task allows learners to co-create technological knowledge. Tt3f also concurs that the opportunity lies in the design process.

"Yes, definitely, there are opportunities for that are opportunities for that as I mentioned earlier there's a design step in the process; the learners they have to consider the different aspects of design including the drawing the angles Yeah, so, they do use their technological knowledge a lot".

Therefore, the scenarios relate to the learner's cultural context according to the teachers. More specifically, Tt4f said: *"I believe in most learners it does because most of the scenarios they are about the things that we have around us, the things that we have that they can be able to access".* Tt7m agrees that the scenarios support the learner's cultural context. He stated that: *"Yes, they do; Why, because before they do a project or a specific topic or content, we normal make them aware even through the image on what we expect when they are doing these projects".* However, in some instances teachers indicated that the scenarios are not designed in such a way that learners can relate to their cultural context. Specifically, Tt8m said some they do, others do not. Therefore, Tt8m: *"Yes, some of them they are but not all of them, some of them, yes".* This was the case with Tt1m, he also stated:

> *"It's not all the tasks that are relating to their context, because I'm teaching in most in sort of a rural area, but you will find the scenario talking about a municipality around town, some of the kids are not even aware of that place, some they don't even know the place".*

This leads him to believe that design and problem-solving activities are channelling learners to western education because the content does not reflect their cultural context. He stated:

> *"No, the projects that we normally give to kids they little bit channel these kids, because when you do for example, a mini practical task, you are given a certain context in terms of design and making. So, they design and make in a specific context. And if that context does not involve anything that has to do with their culture is quite difficult for them to bring what they know".*

On contrary, as part of specific aim three, the CSA stated that they encourage teachers during their workshops to incorporate aspects of indigenous technology in their teaching and activities. This extends to the practical assessment tasks assigned to learners, as they encourage teachers to ensure that the context of the design scenarios is relevant to their exposure to society. She contended that:

"We, we, we when they give the scenarios for the PAT. We tell them that you must give a relevant context for the learners and also, it must also the issue of culture is very, very important. For example, you cannot say to a child who is in the rural areas in Grade nine, we're dealing with electronic systems and then this is from an experience that I have one of the educators give a scenario about the irrigation system that it will be controlled by also checking about the humidity".

5.3.4.4 Community of Practice and *Ubuntu* philosophies in Indigenous Technology

Notably, teachers indicated that recognition of learners' cultural context in their activities informs centralised teaching within the community of practice (CoP) and *Ubuntu* principles. Significantly, the CSA believed that collaboration and teamwork can help to realise indigenous technology. As learners collaborate, respect one another, and interact with stakeholders, the approaches may aid in the realisation of the principles of *Ubuntu* and CoP. Tt3f revealed:

"And yes, definitely, it does give us an opportunity to consider Ubuntu, because in planning for our practical assessments, learners always have to look at the benefits for the community. There's always a case whereby the learners have to look at what benefits will the community have from whatever they are planning to do so that one is definitely covered? It does give us an opportunity to consider Ubuntu".

Tt8m believed that community of practice is important in their teaching.

"Yeah, because I have to promote it because they can know that they're not existing as an individual that there are other people who are also experiencing problems which may be of the same as they as but they have different way of approach on solving those problems and that they must know that they must take other people's view or contribution that yours is not the final one so, there may be other people you can learn from".

5.3.4.5 Technology curriculum for ESD teaching

The teachers believed that teaching in an indigenous context could enable the realisation of ESD for TE curriculum content. Tt2f believed that strategising her teaching would help to recognise indigenous technology to incorporate ESD.

> *"I think the best way would be as teachers to strategize, use the knowledge that we have from our grand grand-parents and give learners practical examples based on that knowledge and compare it with the technology that we have for example, when we talk about drying of food when we want to preserve food, food drying is done by machines and we must teach them that it can be done using the solar energy which is our sun".*

Tt5f specifically stated:

> *"Okay, let's use recycling as an example. Right? So, teaching of recycling is part of the curriculum for Grade seven (7) technology. It is also linked to indigenous technology. So, recycling as in turning old scrap into new reusable items helps to keep the environment clean. And that is how we slowly reach towards the goals of sustainable development".*

Similarly, Tt6m stated: *"maybe it can be teaching using the indigenous materials to design a project or products that can be a good to the environment".* Similarly, in relation to the subject Technology, the CSA stated that ESD is recognised in the subject, specifically in the Technology, Society, and the Environment (TSE), and that specific aim three informs the incorporation of ESD in the TE content. She stated:

> *"We have three specific aims. So, the third one is about it also includes the issue of the I will say it relates more to sustainable development, because it is about the impact of technology, the indigenous knowledge, and then also the biases. So, I can say that there is a relationship there. And then also the fact that even our question papers".*

She also mentioned some of the content that are appropriate for ESD inclusion. She stated that:

> "*For example, we have got plastics in Grade nine (9). And then also, we also have got the issue of the alternative energy sources that we are doing in Grade 8 when it comes to the efficiency and the efficient use of energy. So, I think we there".*

As a result, the CAPS emphasises the incorporation of ESD. She stated once more:

> *"And also even our assessment, it has been divided into three parts, one activity, for example, if it is a test 20% it should be about the impact of technology, the indigenous and also the biases in technology".*

As a result, she believed that indigenous technology provides opportunities for teachers to teach about ESD. However, the challenge is that teachers are unaware that the subject realises the teaching towards sustainable development because the understanding is that the focus should be on the curriculum's content.

She stated:

> *"Yeah, indigenous technology is present but I think with us, the challenge that we have. I don't think that our educators they even know that what we are doing is for sustainable development. Yeah, they just understand that is just part of the curriculum. Then this is what do we need to do".*

Furthermore, she stated that their teacher workshops do not include indigenous technology because the curriculum speaks only briefly about indigenous technology, resulting in its recognition being minimal. She asserted:

“Our workshops to be honest, we focus more on the content and then when it comes to the sustainable development, as I've indicated that the environmental part, the economic and also the social is just a small part in our curriculum”.

Although she states that the practical assessment tasks are related to the social context, the emphasis is rarely on the indigenous aspect. She stated:

“Although our practical assessment task, practical assessment task it is about solving a problem for a community. I can say that it relates to the social but as I've indicated that we do it as an as a yeah, partially, on top actually”. I don't even remember, when we're doing our PAT where we most of the time we incorporate indigenous technology, it’s rare”.

Notably, even during her class visits, she does not recall teachers incorporating indigenous technology into the classrooms.:

“To be honest, I've never done a class visit where there was that integration of indigenous technology. I would be lying if I said I have observed in my may be forgotten, because it's the COVID we no longer doing the class visits”.

As a result, the incorporation of ESD is not promoted; however, she stated that the content allows for the incorporation; the main challenge to teaching ESD aspects is the lack of awareness. She stated:

“*Yes, the focus is more on what is presented by the content. As I’m indicating that, for example, even some of these things, the practical’s, some of them are prescribed that we have to, for example, in Grade 7, but what we're doing is promoting that is just that we are not aware; you know when you are doing something meanwhile you are not aware”.*

5.3.5 The significance of indigenous knowledge holders and a framework for understanding Technology Education curricula

5.3.5.1 Roles of indigenous knowledge holders in Technology curriculum

The teachers recognised the importance of indigenous knowledge holders and have expressed an interest in inviting them to come and share their knowledge on some aspects of the subject Technology as part of their teaching. Tt3f declared:

> *"Um, yes, it does. But honestly, we, we never really used that opportunity. But there is an opportunity like that. Because during the practical assessment tasks, for learners, different phases are handed in at different times. In each course, learners are given the opportunity to consult external resources and teachers are also given the opportunity to invite people from outside as a resource for the learners"*.

However, this is not the case for some other teachers, who have never invited those people into their classrooms because they believe that the curriculum or resources do not allow them to do so. Tt1m asserted:

> *"We hardly do because the teaching resources that we have the, they're not in line with the indigenous technology, even though, when you're explaining you can also link this concept with what is happening in our daily life. But the resources that you have the likes of the textbook, the teaching aids that we have most of them; they don't have a relationship with indigenous knowledge".*

5.3.5.2 Indigenous technological framework for ESD

During the interview session, it was determined that a framework for incorporating indigenous technology into the subject would be extremely beneficial. They currently have no idea how to incorporate the concept. As a result, a framework would also shed light on the incorporation of ESD aspects

within an indigenous context. On the other hand, a framework, according to the CSA, would be extremely beneficial. She stated that the framework should go into greater detail about the concept of sustainable development itself. According to her, the aspects of sustainable development must be included. She is referring to the three pillars of sustainable development, which are the economic, environmental and social aspects. She believed that including them in the framework would provide a proper background and understanding of how to incorporate ESD in teaching and learning, particularly in the Technology curriculum, within an indigenous context. Tt7m indicated the following:

> *"There must be a guideline, why because if we know or see we are guided by a CAPS document, but in CAPS document, they only plan for the environment of a classroom for learners and that is why it normally accommodate some of the theory part and if we draft for technology in a form of presenting our subject in an practical manner or practical way, it would be very good so that we pick and take content to the context of indigenous because now we only took… even the structures in technology are from UK I have never seen or we few from South Africa; so, still there is a confusion because we are in south Africa because we are in Mpumalanga, I can't treat a learner from Mpumalanga as same as the one from Cape Town or whatever that will give us a challenge/problem".*

Additionally, Tt5f stated that:

> *"Okay, I said that indigenous technology is important, as it allows individuals to see how things were done in the past and how it was associated to sustainable development, as compared to technology today, learners will also see the advantages and disadvantages of modern technology as compared to indigenous technology".*

Drawing from the teachers' views on ESD in TE curricula within an indigenous context, they fully comprehended the concept and how it relates to the subject itself. According to their views, they have a strong cultural background, which may be relevant to their teaching of the Technology curriculum content because

they have rich indigenous knowledge that relates to the content, such as processing, structures, design, and so on. However, these teachers appeared to underutilise indigenous knowledge for this purpose because they believed that there is little correlation between modern standards and indigenous technology. Despite this, they were confident that African indigenous people live sustainably. As a result, indigenous technological knowledge could enable the ESD aspects in TE, particularly if CAPS document could provide extensive details about its incorporation into their teaching. However, as discussed in the following section, a further understanding of their ESD knowledge was gained through classroom observations.

5.4 CLASSROOM OBSERVATION FINDINGS

This section presents the findings obtained from observational data. In the Mbombela and Mgwenya circuits, eight Technology Senior Phase teachers were observed. Each teacher's observation lasted an hour, divided into two 30-minute periods. Learners were arranged in rows, as seen in all the classrooms. The learning environment was clearly defined, but there was limited space for movement among learners and the teacher because most classes had learners between 50 to 64 in total. It would therefore seem that teachers only talked theoretically about groupwork during the interviews, but they did not really group learners during the learning activities. The findings of the observation are reported under the headings below.

5.4.1 Resources and materials used during teaching and learning

According to my observation, teachers rely mainly on the textbook as their primary teaching aid, with no other materials or artifacts. Tt7m and Tt8m, however, brought other teaching resources besides the textbook for demonstration, which included a poster, ruler and a set of gears. The materials, however, did not encourage the incorporation of indigenous technology into their teaching even though teachers brought the above materials as other teaching aids. Hence, the content does not promote teaching towards the realisation of ESD. Subsequently, teachers concentrated on the given content with little regard

to other forms of knowledge, even though the opportunity exists, for example, teaching gears, recycling, and so on. Furthermore, the materials and/or resources are unrelated to the goals of sustainability and/or sustainable development goals (SDGs). Well, teachers might find it easy to integrate indigenous knowledge and ESD in certain topics, while not in others. In the interviews, they indicated examples of topics which do not relate to ESD i.e., Systems and Control, a topic that is more challenging to most teachers, let alone integrating indigenous knowledge into it.

5.4.2 Incorporation of indigenous technology

Teacher Tt3f, Tt5f, Tt7m and Tt8m attempted to connect the content to indigenous ways of living. Notably, examples were given to relate the content, such as the way olden people lifted loads, which was related to the designing and making of a crane, and the levers that indigenous people used when ploughing, which was related to the types of levers that are used today. This is one instance where some degree of Systems and Controls was implicated as a topic. Tt8m used an old watch with many gears to demonstrate the gear system to the learners. However, that was kept to a minimum because only those examples were provided, though not in a way that motivated learners to relate the content to their cultural background. The learning environment, on the other hand, did not promote teaching from an indigenous perspective because learners were not arranged in a way that allowed them to relate to their backgrounds. Furthermore, there were no artifacts in the learning environment that would encourage teaching toward the integration of indigenous technologies. Hence, teacher Tt1m, Tt2f, Tt4f and Tt6m found it difficult to integrate indigenous technology into their classroom instruction. The failure of teachers to incorporate indigenous technology into their teaching is because they believe that the technology, they are teaching is Westernised, and therefore, their teaching is Westernised. Hence, the teachers' subject knowledge during their interacting with learners in the teaching and learning process was informed by the Western forms of knowledge.

As previously stated, Tt3f, Tt7m and Tt8m were able to use notable examples beyond what was available in the classroom, such as stoves, bicycles, torches, switches, and so on. From this perspective, teachers at the very least attempted to engage learners in relation to their surroundings. Furthermore, the use of those examples allowed learners to try to connect their learning to what they are familiar with from their homes. However, teachers did not fully empower learners because there was no classification of all types of knowledge and skills to fully cater to indigenous technology. Furthermore, no encouragement was given by teachers to learners to the use of learners' culture in the articulation of knowledge and skills in relation to indigenous technology. This evidence that learners were only familiar with the examples provided by teachers because teachers did not prompt learners to provide their own examples related to the content.

5.4.3 Teachers' teaching strategies and approaches

During the teaching and learning process, the eight teachers i.e., Tt1m, Tt2f, Tt3f, for example, used demonstration and lecture methods. Teacher Tt3f, Tt4f, Tt7m used diagrams on the chalkboard to explain concepts to learners, while Tt1m, Tt6m relied more on the content presented in the textbook, making it difficult to give examples that are closely related to their learners' backgrounds to inform ESD teaching. For example, in the topic of Electrical Systems and Control, learners are exposed to many appliances at home and their impact on society; so, teachers had an opportunity to engage learners. However, the lecture and demonstration methods appeared to be the most used.

Except for two teachers who attempted to link their teaching strategies to indigenous technology, other teachers did not engage teaching and learning strategies that promoted indigenous technology. Hence, there is still a significant gap of how to integrate indigenous technology as this is still a problem for nearly all teachers. As a result, teachers do not allow learners to contribute their indigenous perspectives of technology because the learning environment has failed to promote socio-cultural interaction and knowledge sharing among learners, despite the diversity in the classrooms. Consequently, the teaching strategies did not provide information about collaborative and teamwork

approaches. Overcrowding in classes might have contributed to this scenario. Despite this, learners were able to complete their activities in the form of written and oral tasks, and it was notable that the lesson objectives were met, even though some were not clearly outlined. Although learners were able to produce proof of learning through their completion of the activities were not supported using indigenous technology, so responding to the activities was a bit difficult because they were using textbooks and notes as their reference point. As a result, teaching does not motivate learners' local knowledge to realise ESD issues in the TE curriculum.

5.4.4 Use of learner's contextual experiences in promoting Education for Sustainable Development

The teachers taught grade-appropriate content during the teaching and learning process. Despite being in line with the learners' grade, the content and methods were not adapted to the learners' socio-cultural contexts. Teachers' approaches to the subject did not assist learners in understanding various aspects of the subject content in relation to their socio-cultural contexts. As they taught, teacher Tt1m, Tt2f, Tt4f, Tt6m were more focused on Westernised paradigms. Hence, no other types of knowledge related to the learners' cultural context are encouraged. However, teacher Tt3f, Tt5, Tt7m and Tt8m attempted to illustrate the content with examples relating to learners' items used at home. In spite of this recognition, teachers appeared to be more at ease with Western paradigms. Subsequently, there is still a gap of indigenous technology integration in their teaching of TE content. Therefore, the incorporation and/or awareness of ESD in TE content is compromised. Moreover, incorporating indigenous technology appears to be a challenge for all teachers, despite efforts by others to provide examples outside the classroom that learners are familiar with. However, I noticed that learners' interest was stimulated as teachers provided notable examples outside of the classroom. Therefore, it is from this perspective that there were no learning barriers from the learners' perspective because they expressed an interest in the incorporation of indigenous technology as a reference point, except that teachers themselves were not confident enough to use indigenous context when explaining the content to learners. As a result, the

integration of indigenous technology is hampered. Hence, there were few instances where teachers were open to expanded opportunities in their teaching, therefore, resulting in little attention to learners' day-to-day experiences from other teachers. It is therefore from this understanding that a full recognition of expanded opportunities by all teachers would aid in the incorporation of ESD into the Technology curriculum.

5.4.5 Teacher-learner interaction

During the teaching and learning process, some learners actively participated, while others struggled to follow what teacher Tt6m were saying. This gave the impression that learners were struggling to adapt to the teachers' teaching strategies or approaches because they were limited to a certain level of interaction. This could be owing to a lack of other forms of knowledge or a failure to relate the content to the learners' surroundings. Even among learners, interaction was minimal because the learning environment did not encourage learners to work together as a team or in groups, so interaction was not at its best, except in classes where learners appeared to have a better understanding or were easy to adapt as teaching and learning occurred.

Based on classroom observational data, teachers did not own the opportunities that the subject Technology offers them to integrate indigenous technology. Consequently, learners' learning in an indigenous context was compromised. Additionally, despite claims made about the importance of the two approaches in promoting indigenous technology during interviews, teachers failed to use those approaches while teaching i.e., collaborative and teamwork. However, based on my observations, the demonstration and lecture methods had a strong foundation for the incorporation of indigenous technology to teach towards ESD.

5.5 DOCUMENT ANALYSIS

In total, 18 documents were chosen and analysed. The CAPS Technology document, ATPs, lesson plans, textbooks, and learners' activities were separated into five categories. Each document was examined to see how far the policy or content described addressed the incorporation of ESD within an indigenous

context in the Senior Phase TE curriculum. Despite the recognition of the concept indigenous technology in the policy document, the analysis of the documents revealed a lack of information on the incorporation of ESD within an indigenous context in the TE curriculum. The documents do, however, acknowledge the incorporation of IKS and indigenous technology into TE. This, in some ways, validates the need for ESD integration.

5.5.1 Incorporation of ESD within an indigenous context in CAPS for Technology

The recognition of indigenous technology in the subject is considered in the CAPS Technology document. The CAPS document emphasises the opportunity to teach learners to use authentic contexts rooted in real-world situations outside of the classroom. This is an opportunity for teachers to teach in a way that allows learners to reflect on their backgrounds. Furthermore, the distinct features and scope emphasise the opportunity to teach learners to use and engage with knowledge in a purposeful manner, meaning that the Technology curriculum opens for different forms of knowledge in its teaching. For instance, Technology, Society and the Environment (TSE) is one of the focus areas in the Technology curriculum that addresses the issue of indigenous technology, the impact of technology, and bias in technology. The document emphasises the significance of indigenous cultures even more. It states that: “learners should learn how indigenous cultures used specific materials and processes to meet their needs, as well as become aware of indigenous intellectual property rights” (DBE 2011:10). Furthermore, the document emphasises that teachers, “where applicable, should make learners aware of the various coexisting knowledge systems” (DBE 2011:10). So, in essence, the CAPS document allows for the incorporation of indigenous technology into its content.

Taking note of the foregoing, the CAPS documents do provide or recognise the incorporation of ESD in the Technology curriculum, but it does not clearly outline how teachers may teach towards the realisation of ESD in its content. Specifically, the definition of technology in the educational context emphasises the aspects of social and environmental factors in its teaching, particularly when

learners are solving problems. The CAPS document stipulates that when solving technological problems, learners should consider social and environmental factors. In support of the foregoing, the specific aim focuses on providing learners with the opportunity to appreciate the interaction between people's values and attitudes, technology, society, and the environment (DBE 2011). As a result, the CAPS document has provided numerous opportunities for the recognition of social and environmental factors within an indigenous context, demonstrating an understanding of the interaction between people's values and attitudes, technology, society, and the environment. However, the recognition is very limited because the issues of ESD in Technology curriculum remain unclear.

5.5.2 Annual Teaching Plan Grades 7-9

The Annual Teaching Plans (ATPs) for Grades 7-9 Senior Phase demonstrate that indigenous technology is integrated in the Technology curriculum as required by the CAPS. For example, in Grade 7 Term 1, the ATP emphasises that teachers must use two to three real-world examples of investigation, design, make, evaluate, and communicate (IDMEC) process while teaching. As a result, the subject technology relates the content to outside examples, which may include indigenous context. The same goes for explaining the concepts of fitness for purpose. Therefore, as shown in Table 5.3 below, the ATP suggests that teachers should explain the concepts to learners using examples that they will understand better, i.e. *Who is it for? What is it for? Is it safe? Is it easy to use (ergonomics)? Will it affect society? Will it affect the environment?* Furthermore, in Term 2, the emphasis is on the impact of technology, while in Term 3, the emphasis is on recycling and Term 4 emphasises on indigenous technology. Therefore, it is evident that the content of Technology Grade 7 has the potential to include various types of knowledge, such as local knowledge where the aspects of ESD can be realised.

Table 5.3: Grade 7 Annual Teaching Plan (adapted from DBE 2022:1)

Term 1 **47 days**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
CAPS Topic	**Design process skills**		**Communication skills**		**Mechanical systems & control**	
Core Concepts, Skills, and Values	**Introduction: what is technology?** • **Definition scope** – who does technology in the 'world of work'? • **How we will be working – the development of a technology task:** **IDMEC** **Investigate:** *find, use and acknowledge information.* **Design:** *design brief, specifications, constraints; initial idea sketches; choosing the best design; selecting materials.* **Make:** *draw plans; develop the manufacturing sequence; make the item/model.* **Evaluate:** *learners evaluate both their design stages and their final product.* **Communicate:** *learners present their solutions; learners compile all notes and drawings into a project report in their workbooks.* • **Use two to three real world examples of the IDMEC process.** • **How we will be working – the development of a technology task:** **Design considerations** • **Fitness-for-purpose:** *Who is it for? What is it for? Will it do the job? Is it cost effective? Is it safe? Is it easy to use (ergonomics)? Does it look good (aesthetics)? Will it affect society? Will it affect the environment?* • *[Explain the above by using examples for learners to understand the concepts better]*		**Introduction to graphical Communication** • **Purpose of graphics:** *develop ideas and communicate ideas.* • **Conventions:** *outlines (thin/dark); construction lines (thin/feint); hidden detail (dashed) scale; dimensioning.* • **Sketch:** *free-hand sketching.* • **Working drawings:** *two-dimensional drawing of one face of an object using conventions (dark lines; feint lines; dashed lines; dimensions; scale).* **Graphic techniques** • **3D oblique** – *front view with depth at 45˚(use squared 'quadrant' paper); oblique projection used to assist with interpretation, and with drawing single VP perspective.*		**Simple mechanisms** *levers – mechanical advantage: simple quantitative treatment – no calculations using moments.* *Examine the relationship between load, effort and their distances from the pivot.* • ***First-class levers:*** *characteristics (fulcrum/pivot placed between effort and load).* • *First-class levers may give a mechanical advantage or not – depending on pivot position.* • ***Case study:*** *first-class levers with mechanical advantage: ma > 1; ma = 1; ma < 1* **Second-class levers:** characteristics (load is placed between effort and fulcrum); give real examples. • Learners **demonstrate models of second-class levers**, which ***always*** give a mechanical advantage. • **Third-class levers:** characteristics (effort is placed between load and fulcrum): give real examples • Teacher to **demonstrate models of third-class levers,** which ***never*** give a mechanical advantage. **Practical Investigation:** *Levers and linkages* • ***Examine simple linked first-class levers*** *(e.g., pair of scissors; pair of pliers; hedge trimming shears).* • ***Examine simple linked second-class levers*** *(e.g., office punch, nut crackers).* • ***Examine simple linked third-class levers*** *(e.g., most office staplers, pair of tweezers).* • ***Examine more complex linkages*** *(e.g., linkages with more than one pivot)*	
Requisite Pre-Knowledge	Pre-knowledge of the Design Process in the Natural Sciences and Technology (NST) in the intermediate phase		Basic drawing skills		Pre-knowledge of machines/ mechanisms in Natural Sciences and Technology	
Resources (other than textbook) to enhance learning	Siyavula workbook/ Textbooks Applicable resources		Siyavula workbook/ Textbooks Applicable resources		Siyavula workbook/ Textbooks Applicable resources Examples of different classes of levers	
Informal Assessment	Informal Assessment		Informal Assessment		Informal Assessment	

On the other hand, the incorporation of ESD into the Grade 8 content could be realised as it presents the opportunity for the positive and negative impact of technology on society. Furthermore, the ATP emphasises the teaching of the

impact of technology, indigenous technology, and bias in technology. Similarly, as depicted in Table 5.4, investigation skills specifically provide various opportunities for learners to engage to realise indigenous technology and ESD. Hence, TE content allows learners to investigate the impact of technology in various forms as shown in Table 5.4. This is the impact of mining on the environment of acid mine drainage or on the environment of dust pollution from mine dumps on residential areas or iron age technology or iron age technology, indigenous mining of iron in South Africa prior to the modern era. In addition, the implementation of indigenous technology is acknowledged in the content of Grade 9, as highlighted in the ATP, primarily in Terms 1 and 4 for the Grade (see attached Appendix A).

Table 5.4: Grade 8 Annual Teaching Plan (adapted from DBE 2022:6)

Term 3 **48 days**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	
CAPS Topic	**Impact/ Indigenous and Bias in technology** **Investigation skills**		**Investigation and Design skills**		**Design & Communication skills**
Core Concepts, Skills, and Values	**INVESTIGATE** and report on one of the following: *Distribute the investigations so all are covered and reported in each class.* • **INVESTIGATE:** The impact on the environment as a result of mining of: Acid mine drainage **OR** • **INVESTIGATE:** The impact on the environment as a result of mining of: Dust pollution from mine dumps on residential areas. **OR** • **INVESTIGATE:** Iron age technology: Indigenous mining of iron in South Africa before the modern era **OR** • **INVESTIGATE:** Bias in technology: Gender bias in career choice / opportunities related to mining. Formal: • **INVESTIGATE:** Lifting mechanisms (wire rope-driven mine headgear) in use at South		**DRAWINGS for the shaft head-gear** – each learner draws a: • 3D isometric drawing of the selected design giving dimensions and drawn to scale. • 2D working drawing showing one or more views with dimensions and lines. • **Budget:** individual learners prepare a realistic budget detailing expected costs of constructing a real mine shaft headgear, detailing valid prices of materials and labour costs of the range of workers who would be involved in designing and building such a device.		**Revision:** • Mechanical advantage • Rotation direction of gears • Elements included in a design brief • Importance of budgeting

Term 3 48 days	Week 7	Week 8	Week 9	Week 10	
CAPS Topic	**Impact/ Indigenous and Bias in technology** **Investigation skills**		**Investigation and Design skills**		**Design & Communication skills**
	African mines for raising people and ore. • Sketch: initial idea sketches to meet the requirements given in the scenario. Design brief with specifications and constrains.				
Requisite Pre-Knowledge	Knowledge on how to gather information, report on the findings verbally and through sketches.		Knowledge on basic drawing skills.		
Resources (other than textbook) to enhance learning	Siyavula workbook/ Textbooks and or any other relevant resources.		Siyavula workbook/ Textbooks and or any other relevant resources.		Siyavula workbook/ Textbooks and or any other relevant resources.
Informal Assessment	Informal Assessment/Formal Assessment				

5.5.3 Lesson plans

There is no integration of indigenous technology in the lesson plans, which cover both teacher and learner activities (see Appendix B). Following that, Tt1m highlighted that they relied much on the lesson plans developed by the Mpumalanga Department of Basic Education (DBE). Hence, the presentation of their lessons was directed or guided by the content presented by the department. Therefore, in this view, it is argued that teachers' scope is limited because the lesson plans do not reflect the integration of indigenous knowledge or technology despite the opportunities presented by the CAPS document (see Appendix C). Therefore, there was no implementation of ESD in the Technology curriculum content during their teaching.

However, the ATP and CAPS documents have flexibility in the indigenous technology aspects, and some of the lesson plans' content is open for the integration of indigenous technology. For example, a Grade 7 lesson focused on the impact and bias of technology as shown in Table 5.5. Moreover, the lesson assesses learners' prior knowledge of recycling and material processing. The content also includes a case study on a scrap metal project, recycling scrap metals and classifying materials. So, in this view, Technology curriculum informs the integration of indigenous technology as learners learn to relate to their surroundings, which may allow the incorporation of ESD. However, the

presentation of the lesson enabled the incorporation of indigenous technology minimally because it was clearly outlined on the ATP how the concepts may be incorporated, specifically on the impact of and bias in technology.

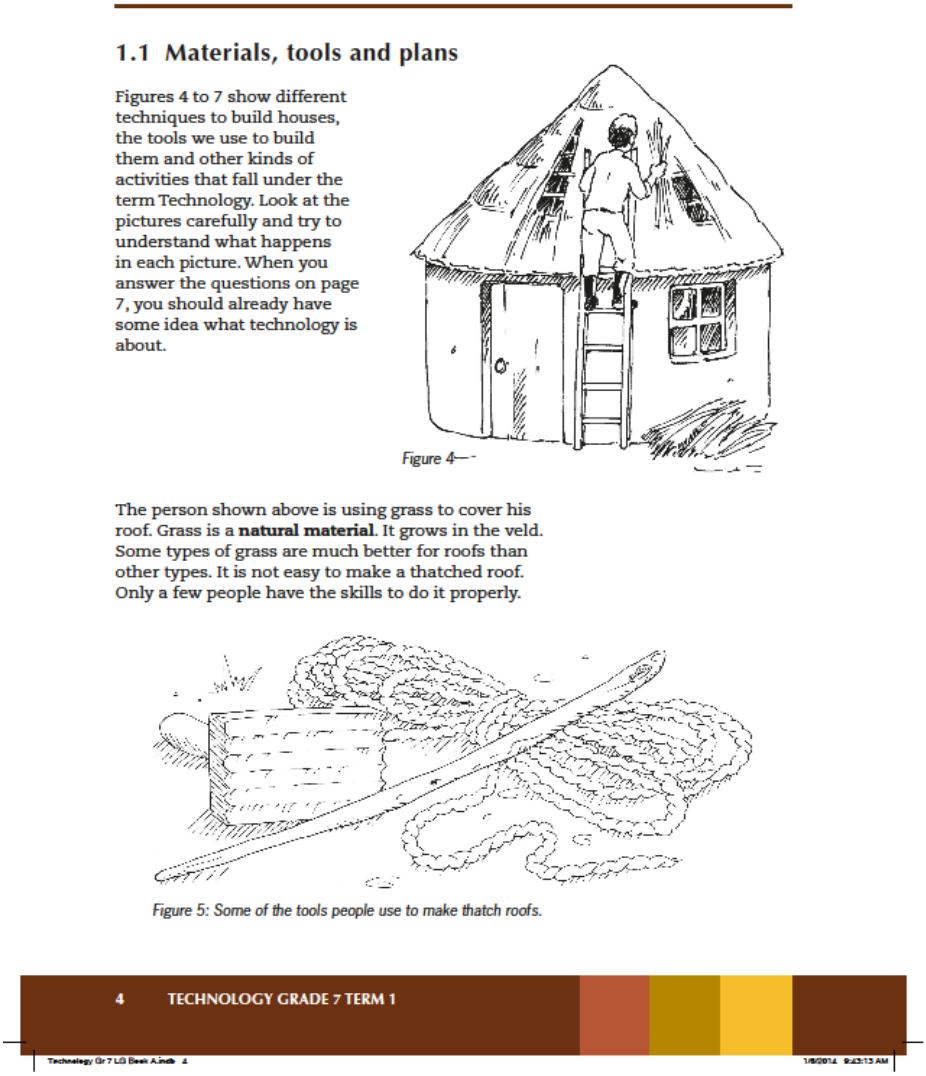
Table 5.5: Grade 7 Lesson Plan

<table>
<tr><td colspan="2">Teacher:</td><td colspan="2">School:</td></tr>
<tr><td>Term 3</td><td>Week 2</td><td>Date:</td><td>Duration: 2 hours</td></tr>
<tr><td colspan="4">Topic: impact of and bias in technology</td></tr>
<tr><td colspan="2">Prior knowledge:</td><td colspan="2">Link with next lesson:</td></tr>
<tr><td colspan="2">Content:
• Recycling scrap metals
• Case study: A scrap metal project
• Classifying materials</td><td colspan="2">Vocabulary/important words:
• Ferrous metal
• Corrode
• Non-ferrous metal
• Malleable</td></tr>
<tr><td colspan="4">Aims and objectives of the lesson:
• Learners will know the importance of recycling scrap metal.
• Learners will be able to classify metal into different categories.</td></tr>
<tr><td colspan="2">Teaching methods:
• Narratives
• Questions and answers</td><td colspan="2">Differentiation (Enrichment opportunities/Addressing barriers):
• Teach in simple English.
• Explain concepts more clearly.</td></tr>
<tr><td colspan="4">Assessment strategy: informal
Form of assessment: classwork
Assessment tool: memorandum</td></tr>
<tr><td colspan="4">Teacher:

Evidence of assessment:
• Enabling task marked and feedback given to the learners.</td></tr>
</table>

5.5.4 Learners' textbooks

The data examined came from a variety of textbooks, including Platinum, Top Class, and Study & Master Technology. However, it appeared that the Sasol Inzalo textbook was more prominently associated with the case at hand, that is, ESD incorporation in TE within an indigenous context. As a result, the focus of the analysis on Sasol Inzalo for the clear articulation for the study's context. For instance, the Grade 7 textbook, specifically the Sasol Inzalo, has made some references to indigenous ways of life in both books 1 and 2 as illustrated in Figure 5.1.



1.1 Materials, tools and plans

Figures 4 to 7 show different techniques to build houses, the tools we use to build them and other kinds of activities that fall under the term Technology. Look at the pictures carefully and try to understand what happens in each picture. When you answer the questions on page 7, you should already have some idea what technology is about.

Figure 4

The person shown above is using grass to cover his roof. Grass is a **natural material**. It grows in the veld. Some types of grass are much better for roofs than other types. It is not easy to make a thatched roof. Only a few people have the skills to do it properly.

Figure 5: Some of the tools people use to make thatch roofs.

4 TECHNOLOGY GRADE 7 TERM 1

Figure 5.1: Grade 7 Sasol Inzalo textbook (adopted from Sasol Inzalo Learners Book 2014:4)

Drawing from Figure 5.1, Technology curriculum recognises the importance of incorporating indigenous technology. Essentially, the understanding is the belief that technology began with our ancestors and continues to be relevant today. During the interviews, the teachers elucidate that technology is not a modern concept. The same is noticed in the Grade 8 content, specifically Term 2 in which the emphasis is on the recognition of items that learners may be familiar with from their homes (see Appendix D). The content is primarily based on the surroundings, including visuals and/or drawings that depict what learners encounter in their daily lives or in their ways of living at home. The Grade 9

content also incorporates elements of ESD and indigenous technology. For example, the content of Term 4 informs ESD aspects such as preserving metals, extending the shelf life of food, recycling, and manufacturing with recycled plastics, and reduce, reuse, and recycle.

However, it has been observed that some textbooks make it difficult for teachers to relate content to other forms of knowledge because the indigenous concept is not recognised. Subsequently, incorporating indigenous aspects into classroom instruction remains a challenge for teachers. Despite this, the content has a great opportunity to inform ESD implementation because it discusses issues affecting the environment and society, both positively and negatively, and what can be done to mitigate the impact.

Finally, except for Grade 7, learners were given a mini practical task that opened to other forms of knowledge to come up with a practical solution to the problem (see Appendix E). Nonetheless, except for the presentation of the final product, the activities assigned to them did not allow for the recognition of indigenous knowledge. This appeared to be a gap because it coincided with other Grade 8 and 9 activities. In these grades, the activities were largely informed by what was primarily discussed in the textbooks, and teachers did not attempt to structure the activities in such a way that learners could relate to their cultural backgrounds as they respond.

5.6 SUMMARY

The study's main aim was to explore ways that can make the teaching of Technology promote ESD. According to the participants, indigenous technology is related to sustainable development and should be included in technology curricula because it was a technology used by our ancestors to solve problems. It was also understood that indigenous technology had less of an impact on the environment than modern technology. Simply put, indigenous people had a lower environmental impact because their way of life was more environmentally sustainable, according to the participants' views. Despite the environmental benefits of indigenous technology, teachers believed that with modern

technology, the focus had shifted to modern technology, and the CAPS document is very shallow in its integration into the Technology curriculum. As a result, integration receives little or no attention. Furthermore, teachers demonstrated comprehension of the concepts of sustainable development and ESD. They also mentioned some TE curriculum content that allows for the incorporation of concepts within an indigenous context. However, they continue to believe that there is a significant gap for incorporation in the subject, and that a framework will greatly assist in the integration of indigenous technology to realise the ESD issues in TE curriculum.

CHAPTER 6

DISCUSSION OF FINDINGS

6.1 INTRODUCTION

The purpose of this chapter is to discuss the findings of the study which were presented in Chapter 5. Therefore, this chapter discusses the major findings on teachers' perspectives on ESD in the Technology Education (TE) curriculum to propose an enabling framework for realising the importance of ESD in the classroom, particularly with regard to local dynamics. The discussions are also checked against the literature review and the theory adopted in this study. The aim of juxtaposing the findings against the reviewed literature is to confirm or disconfirm their consistency with the trends in the literature and the theory. The discussion follows the logic of presenting the findings in the preceding chapter.

6.2 TECHNOLOGY TEACHERS' UNDERSTANDING OF ESD

The first objective of the study was to give a description of Technology teachers' understanding of ESD. The literature showed that education is key to advancing a society that can achieve SDGs (Hoque et al. 2022). The emphasis provided by the literature is that an awareness must be instilled among citizens at an early age (as early as secondary school) to motivate learners to pursue higher education and careers in renewable energy concepts and technologies (Hoque et al. 2022). Similarly, Anyolo et al. (2018) highlight that many theorists envisage that ESD enhances the active involvement of learners in and out of school learning initiatives to acquire knowledge about SD issues. This suggests that the scope of learning about SD extends beyond the school – learners should be empowered to care about and for the environment wherever they find themselves. They should be graduated to becoming patriotic citizens who will contribute actively toward environmental sustainability not only for their own benefit but for the benefit of the coming generations as well.

Studies conducted by Elshof (2005), Pitt and Luben (2009) and Pavlova (2009) draw similar conclusions that teachers' perceptions of what is important and

readiness to address issues related to SD, such as the sustainable use of natural resources, health (air and water pollution, exposure to toxic and hazardous materials, HIV/AIDs) and illiteracy reflected in classroom practices. On the contrary, studies show that the implementation of SD and ESD issues are still minimally addressed in schools and discrepancies are realised, including the areas of education, different types of documents, federal states, and the depth and quality of the contextualisation of ESD and related concepts (Urbańska et al. 2021; Agbedahin 2019; Holst et. al. 2020). Many studies showed that institutions have started with the implementation though the progress is very slow (Velazquez et al. 2006; Wals 2012; Anđić 2020). Similarly, in this study, the findings indicated that teachers are aware of ESD, however, the incorporation of the concept ESD in their teaching remains unclear. Nonetheless, Anyolo et al. (2018) show that teachers have a positive sentiment toward the inclusion of ESD into the senior secondary school curriculum. The TE curriculum can promote learning about the issues of ESD. The findings of the study established that TE curriculum topics allow for the recognition of environmental, social, and economic aspects enshrined in ESD as teachers and the CSA were able to connect ESD to Technology teaching. Such an understanding is consistent with Pavlova's (2011) conclusion that participants in her study were aware of the SD agenda.

The findings of this study revealed that teachers have a good understanding of the concept ESD, particularly in relation to the subject Technology. Literature on SD suggests that African Technology teachers understand the need to address SD through the subject, putting an emphasis on social development issues framed by environmental challenges (Pavlova 2011). The teacher participants and the CSA were able to articulate how ESD is related to the TE content. Climate change and electricity have been mentioned as topics related to sustainability in the subject. Although the findings of the study indicated that Technology teachers are aware of SD and ESD issues, taking advantage to teach Technology for SD to their learners is still a challenge. This could be due to their lack of expertise in the subject itself because of the qualifications they have for teaching the subject. Nonetheless, a study by Anyolo et al. (2020) on ESD has shown that senior secondary school teachers perceive ESD in terms of knowledge acquisition about the environment to use its resources sustainably for the benefit of future

generations. Furthermore, teacher participants and CSA regarded ESD as one of the critical concepts concerning the sustainable use of resources to avoid the negative impact that technology has on the environment. This resonates with the literature by Pavlova (2011), that the SD issues are viewed as important for teachers and their learners, as well as for the provinces where they live.

The findings of this study suggest that teachers have an opportunity to make learners aware of the concept during the teaching and learning of the subject Technology in the classroom. This supports the fact that teachers, as knowledgeable people, are the gatekeepers of the incorporation of ESD in TE curriculum. In support of this, Orsmond et al. (2022) indicate that knowledgeability, knowledge formed by a person in practice changes as learners change through relational ongoing practice with diverse others participating differently. Therefore, it is understood that through the LPP approach outlined in Chapter 2, learners may change and/or understand better issues of ESD wherein they may become different people towards them, which is how new identity construction occurs. Similarly, Timm and Barth (2020) conclude that teachers play an important role in the processes of change regarding the implementation of ESD in schools and therefore, it has long been recognised in studies. This conclusion is consistent with Urbańska et al.'s (2021) conclusion that teachers are important transmitters of knowledge also in the context of sustainability.

On the other hand, Gough (2005) concludes that a focus on sustainability is an appropriate strategy for revamping educational processes and achieving quality education and that the role of the school community (in general) and of teachers (in particular) should not be underestimated. The findings in this study suggest that LPP would have an impact on ESD teaching because teachers understand how ESD relates to the content of TE curricula. Hence, teachers are familiar with the concept and how it is inextricably linked to the TE content. This, therefore, is in line with the understanding of how an endogenous perspective may assist in the teaching of ESD in the TE curriculum as discussed in Chapter 2 Section 2.3.1.1. Velthuizen (2012) coined the term endogenous knowledge that supplanted indigenous knowledge. Similarly, Malik (2021) concludes that the indigenous perspective is relevant when exploring how learners develop from

novices to competent learners. Furthermore, Moshman (1982) (in Van Rooyen 2021) emphasises that the teacher's role (in a pedagogical context) should be to act as a facilitator in providing experiences that are likely to result in challenging learners' existing models. This means that Technology teachers may be the driving force towards ESD teaching as knowledgeable experts. Indigenous knowledge holders can also help to value indigenous practices for ESD. As the findings revealed, the participants showed an interest on how indigenous knowledge holders may assist towards the teaching of some of the Technology content that are related to ESD. It is in this view that I strongly contend that the inclusion of indigenous knowledge holders in the teaching of ESD in the TE curriculum would be extremely beneficial, especially to learners.

Despite the CSA's and teachers' understanding of ESD, the documents examined revealed a significant potential for incorporating ESD into the TE content. However, the analysis of the study revealed that teachers see a limited space for ESD's incorporation because the CAPS document, ATP and textbooks are not directly related to the concept. This finding is supported by de Andrade (2011), who indicates that some of the major ESD documents appear to carry a contradiction while acknowledging patterns of production and consumption as the core of unsustainability, they appear to point to the South, diverting attention away from the roots of problems and toward their symptoms. This claim was therefore observed during classroom observations, as teachers failed to relate the content to the aspects of ESD such as environmental aspects in relation to sustainability.

Consistently, Corney (2006) indicates that teachers have difficulties in terms of understanding the complexity of SD issues, the nature, and the interrelations of its sub-concepts. Moreover, it appears that teachers also have a little understanding of the term sustainability in terms of its content and principles. The findings of the study, therefore, established that teachers have a challenge in how to interpret the CAPS document in relation to issues of ESD. Urbańska et al.'s (2021) study shows that the inability of teachers to interpret the education programme policy is widely recognised in the literature and is influenced by their cognitive skills. More so, Green and Somerville (2015) found that teachers do not

understand the concept of sustainability and are unable to integrate it into an already overburdened curriculum.

Additionally, participants in this study believed that the CAPS document lacks information on ESD teaching. On the other hand, the findings revealed that the Technology CAPS document places a strong emphasis on ESD concepts, specifically environmental aspects. Such finding is consistent with Lotz-Sisitka (2011), that an analysis of the CAPS revealed that up to 50% of the content in some subjects is on environment or related to sustainability and that the environment and sustainability content pervades a wide range of subjects, in line with a curriculum principle that seeks to ensure an environmentally literate citizenry. However, the findings here suggest that teachers have a shallow understanding on the incorporation of the concept ESD in TE curricula in spite of the knowledge they have. The incorporation remains unclear in their practices. In the same way, Hoque et al. (2022) indicate that there is a significant lack of curricula on renewable energy concepts and ESD in secondary schools, reflecting the low knowledge, interest in, and awareness of renewable and its concepts among learners. It is against this background that Shallcross and Wals (2005) aver that while people have a high level of comprehension about environmental values, these views and values are generally not reflected in their behaviours.

Therefore, it appears that teachers' awareness of the concept of ESD has little impact because there is a gap in the concept's incorporation into TE curriculum. Teachers do not necessarily view themselves as future change agents, especially not at a school or a higher level (Van der Heijden et al. 2015). However, the findings from the study, as outlined earlier, suggest that teacher knowledge may aid in the incorporation of ESD because they are knowledgeable and have a thorough understanding of the concept and how it can be integrated into the TE curriculum. This understanding is consistent with Müller's (2022) conclusion that LPP focuses on apprentices learning from masters as community practitioners through a situated learning activity. Lave and Wenger (1991:29) use this concept to "draw attention to the point that learners inevitably participate in communities of practitioners and that mastery of knowledge and skill requires

newcomers to move toward full participation in a community's sociocultural practices."

6.3 OPPORTUNITIES THAT TE CURRICULUM PRESENTS FOR TEACHERS TO INCORPORATE ESD

The second objective of the study was to identify opportunities presented by TE curriculum that teachers can use to incorporate ESD in their teaching. A study by Glavič (2020) creates an understanding that ESD is recognised as a key element of quality education and a crucial enabler for SD. This supports the idea that ESD vision is a balance between society, economy and environment while preserving the natural resources of our planet for future generations (Glavič 2020). Similarly, Pavlova (2011) suggests that TE has opportunity to incorporate the ESD through the development of sensitivity towards nature and an understanding that technological growth should be balanced through applying the design principles, technological knowledge, and critical and creative thinking skills to bring a human aspect. Correspondingly, Leal Filho et al. (2009) indicate that TE may be used as a tool in meeting the challenges of SD. On the other hand, a study by Egarievwe (2015) suggests that STEM education has a fundamental role in advancing technology, medicine, sustainability, agriculture, national security, economy, and society. Correspondingly, the findings of the study revealed that the subject Technology has numerous opportunities for integrating ESD within an indigenous context. Participants believed that the subject itself relates to the content of indigenous ways of living, for example, food preservation and the impact of technology on the environment and society. This study is consistent with the literature, which postulates that technology is about what humans want to achieve in the future, and it aims to produce useful products, i.e., it may be geared toward sustainability (Gumbo 2019).

To the contrary, a study by Leal Filho et al. (2018) indicates that the concept of ESD has not been sufficiently integrated into the concept of transformation in the learning institutions. The same, as confirmed in McNaughton (2012), has been noticed at the schools that participated in this study. This, therefore, implies that there is a paucity of studies that examine the contribution that TE can make to

ESD. Hence, the usefulness of TE to the sustainability debate as a whole and to ESD, particularly, has largely been overlooked (Leal Filho et al. 2009). Literature on the implementation of ESD in the curriculum indicates that different types of knowledge are required for different strategies of implementing ESD in teaching (Timm & Barth 2020). If teachers are to incorporate ESD into their subjects, they must have extensive content knowledge in each subject to identify potential links with and entry points for ESD. According to the findings of this study, ESD may be well incorporated into the Technology curriculum from an indigenous perspective. Hence, I believe that the subject of Technology may incorporate ESD into its teaching to raise awareness in the Technology curriculum.

One of the noticeable differences in the findings of this study compared to the previous studies is that the third specific aim as specified in CAPS allows for the incorporation of IKS, and it is in this understanding that ESD issues may be considered in TE curricula. According to Korkmaz and Yildiz (2017), ESD promotes an educational viewpoint that balances the economic well-being with environmental and cultural values. However, as teacher participants stated during the interviews, this did not appear during their teaching because there was no means to acknowledge the aspects of ESD such as environmental, social, and economic. Although opportunities to teach about and for ESD are provided by the subject, Technology teachers limit their focus to the TE content without making effort to integrate ESD. To support this, the CSA stated that, despite opportunities, teachers' focus was on what the content presents, and therefore, their teaching does not reflect ESD aspects. It is clear from the findings that the subject of Technology has numerous opportunities to incorporate ESD during teaching. This is, as indicated because the subject emphasises the recognition of IKS in its topics, particularly the third specific aim of CAPS (DBE 2011). However, teaching the subject of Technology using Western approaches hampers the integration of ESD in the teaching of the subject.

Correspondingly, Glavič (2020) argues that owing to the rapid development of humanity in all the SD pillars (economic, social, and environmental), climate crises, and emerging new technologies and knowledge, education leaders and teachers are lacking modern and effective content for ESD. This raises concerns

that the dominant knowledge work while integrating a variety of forms of knowledge (as is expected of the teacher education under the new policy – Teacher Education and Development Policy Environment) tend to be limited by the content that teachers are familiar with and that on problems and issues for raising awareness, and fails to develop a deeper conceptual depth and understanding of environment and sustainability, as issues-based knowledge dominates (Lotz-Sisitka 2011). Ryan and Ferreira (2019) note that the South African national curriculum takes a predominantly Western scientific approach to the presentation of ESD, and teachers have reservations about IKS. Hay and Dzerefos (2022), therefore, suggest the essence of infusing IKS practices related to the sacredness of nature into school subjects in both South Africa and Japan owing to an escalation of environmental degradation and excessive consumerism. Moreover, Breidlid (2009) highlights the lack of respect for local or indigenous knowledge and the assumption by many Western scientists about the superiority of Western epistemology and scientific discourse [which] is a serious obstacle to SD in the light of their apparent failure to meet human development needs and, at the same time, to protect nature and the ecosystem.

The education system in South Africa has neglected IKS against the case for a holistic inclusion of indigenous knowledge (Odora Hoppers 2002), while Lebeloane (2017) and Masemula (2013) in their studies showed that cultural and religious practices are worldviews considered along with the Western metaphysical, ecological, economic, and scientific fields. Similarly, data from this study revealed that teachers do not fully own the incorporation of IKS in their teaching, which tempts them to maintain Western paradigms. Furthermore, the study's findings revealed that a certain number of teachers do not regard themselves as indigenous people as their way of life is influenced by the Western customs. This could imply that teachers place little value on their own traditions, resulting in non-indigenous teaching which therefore impede the ESD success.
Currently, countries of the world including South Africa are occupied by issues of environmental degradation especially those that are related to technology. As a result, summits on environmental sustainability are being held to seek solutions to the problem. In South Africa alone, rivers are clogged by litter and sewage spillage, which is hazardous to human and wildlife. IKS provides one of the

important solutions owing to its less or harmlessness on the environment. There is, therefore, an urgent need to train teachers to teach subjects such as Technology from an ESD integrated perspective, as well as train them for a change of attitude toward the environment. Then, they will be well poised to do the same when they teach learners.

Despite teachers' failure to recognise IKS in their teaching, the findings suggest that IKS within the context of *Ubuntu,* as discussed in Chapter 3, might be an enabler for integration of ESD in TE curriculum. The findings of the study are consistent with Museka and Madondo (2012), suggesting that grounding curricula on the *Ubuntu* philosophy is critical as it has the power to elicit environmental awareness based on indigenous ways. This, therefore, correlates with exogenous constructivism, discussed in Section 2.3.1.2 of Chapter 2. Furthermore, Moshman (1982) posits that exogenous knowledge is derived from one's surroundings and is a reconstruction of structures like observed behaviour, patterns etc. This then suggests that *Ubuntu,* as an indigenous African philosophy, may encourage social behaviours which may inform teaching towards sustainability in the TE curriculum. This is consistent with Carroll et al.'s (2019) conclusion that for a learner to learn successfully, he/she must interact with the outside world to build on new information – hence, as stated in the previous section, learners should be equipped for even the world outside the school and for the future. As a result, teachers can use the cultural context of their learners to promote ESD in the TE curriculum. According to Piagetian terminology, learning is primarily an adjustment of the organism's former structures to those imposed by its current environment. As a result of the findings of this study, the subject Technology has a solid foundation for incorporating ESD through IKS which is already paraded in CAPS – it should not be treated as a white elephant; teacher training and the ultimate implementation of the subject (Technology) should not miss out on it. This might suggest that Technology teachers recognised the significance of indigenous dynamics in the subject but did not take full advantage thereof at the teaching level.

6.4 WAYS TECHNOLOGY TEACHERS CAN USE IKS TO TEACH FOR ESD

The third objective of the study was to determine ways Technology teachers can use IKS to teach for ESD. This is a critical finding since teachers battle more with how to integrate IKS in their teaching (and now ESD as well). SD emphasises social sustainability. Therefore, social sustainability "builds on and extends the notion of stakeholder engagement and argues for a better alignment between the physical infrastructure and local conditions and needs" (Keast et al. 2012:9). As it can be noticed this far, the findings of the study support the claims purported by the literature. Therefore, social engagement might be a drive toward the establishment of ESD in the TE curriculum from an indigenous perspective. A study by Hay and Dzerefos (2022) suggests that IKS encapsulate place-based truths and cultural wisdom that apply to ESD. Hay and Dzerefos' (2022) study goes on to discuss indigenous practices that may be integrated into school subjects, for instance in natural sciences and technology topics such as food chains and life cycles, nutrients in food, nutrition and ecosystems and food webs. On the other hand, Odora Hoppers (2002) suggests a holistic inclusion of IK where cultural and religious practices such as the Vhavenda sacred places and rituals have the potential to infuse the IKS of sacredness into school subjects. The same conclusion was drawn by Hay and Dzerefos (2022) that IKS can be effectively transferred in multifaceted ways into the school subjects thereby enriching the school curricula and perceptions of nature. In relation to the foregoing, the findings of the study revealed that IKS has great impact in the teaching of Technology. Hence, the study by Bloom (2020) highlights the need to promote the IKS theme of forest use, caring for the environment, the protection of ecosystems, and cultural interchange.

To the contrary, for centuries in South Africa, the richness of IKS has been transmitted only orally, resulting in a deficit of documentation thereon (Setumu 2015). In a different light, in South Africa, there are no IKS examples where the sacredness of nature or the knowledge of insect harvesters is incorporated into the teaching and learning practices (Hay & Dzerefos 2022). However, the findings of this study indicated that the Technology curriculum content links to the

indigenous people's living and such living is still relevant even today (Gadgil et. al. 2021). Hence, indigenous examples, specifically in the subject of Technology, are ESD enablers. Moreover, Tharakan (2015) posits that IKS address the critical quality-of-life and standard-of-living issues. According to Tharakan (2015), IKS focus on appropriate technologies; this, therefore, means that the critical vision of people is the empowerment to take control of their human, natural and technological resources, which is aimed at efficient utilisation to improve the quality of their lives.

Noticeably, all teacher participants in this study were enthusiastic about indigenous technology, even though some failed to recognise the concept in their teaching. The study also revealed that teacher participants and the CSA share an understanding that indigenous technology is the type of technology that their ancestors used to solve problems before modern technology.

However, indigenous technology is still prevalent even today as it has more influence on modern technology. Based on this claim, indigenous technology has an influence mostly on the content of TE. Hence, teachers' understanding may be useful in modern teaching so to realise ESD specifically in the TE curriculum. Furthermore, the findings revealed that modern technology has evolved from a specific group of people's old ways of doing things. The findings prove that indigenous technology is understood by teacher participants as the knowledge that people in a certain community have developed over time and that continues to improve and is influenced by their culture, customs, and way of life (Carm 2014; Okpara & Ikokoh 2021). In with the same vein, Birney and Reed (2009) concur that the role of teachers and the need to "start from where people are" is the key in the process of helping schools become sustainable.

The teacher participants viewed indigenous technology in its historical context, which causes some misunderstanding of the connection between indigenous technology and modern technology, which is predominantly Western. This finding confirms the argument by Kilada Thomsen, Cicek, Mante and Herrmann (2021), that Western knowledge systems dominated the basis of engineering in Canada,

excluding indigenous people's knowledge. The participants also expressed concern that CAPS Technology contains insufficient information about the incorporation of IKS in its teachings. Hence, the findings of this study give the impression that, despite teachers' knowledge of indigenous technology, the integration of IKS in the subject remains unclear, which heightens the demand that they are shown how to do it during their training. This further confirms the view of Cocks et al. (2012) and Smith and Sharp (2012), that the national school curriculum places little emphasis on IKS, resulting in its unequal integration. Similarly, Kanyimba (2002) found resistance to change and deficiency in environmental policies as barriers that negatively affect the effective implementation of ESD. The findings further revealed that the participants were failing to incorporate IKS into their teaching, as the indication was a gap in how IKS should be incorporated in the teaching of Technology curriculum. While this is the case, documents such as CAPS, ATPs and Technology textbooks demonstrate a strong foundation that teachers could use as a starting point for IKS integration. Supported by literature, there have been numerous examples of technology that have been used for hundreds of years and continue to work successfully and make people’s daily lives easier (Goosen et al. 2013).

Surprisingly, as some teacher participants demonstrated a shallow understanding of indigenous technology, the findings revealed that they demonstrated that TE curriculum content allows for the integration of IKS. They provided good illustrations and examples in the content where they could teach using indigenous technology. Furthermore, the findings showed that the content of the TE curriculum does incorporate knowledge integration, albeit with limited space. In support of this, teacher participants stated that the subject provides many opportunities to integrate indigenous technology because it allows them to teach about the positive and negative impact that technology has on the environment. In line with the foregoing, Iyoro and Ogungbo (2013) highlight that before technology, people relied on IK to regulate their activities. As a result, the TE curriculum allows for the incorporation of IKS because practical challenges are linked to societal issues that affect communities. Although the learners were given limited opportunities to apply their cultural knowledge, the findings showed that some teachers were able to use examples that learners were familiar with

from their cultural backgrounds, and it was clear that teachers used familiar situations to make learning easier for learners (Utami, Sayuti & Jailani 2021). Drawing from the findings of this study, indigenous technology is integrative into the TE curriculum, and teachers should fully utilise it.

Teacher participants in this study were convinced that SD is about environmental responsibility. They also demonstrated that sustainability entails protecting resources for future generations. Furthermore, teacher participants understood indigenous technology/knowledge within the context of SD. Previous research has shown that IK has a significant impact on natural resource management; therefore, the success and sustainability of any development activity are linked to IK practices (Breidlid 2009; Gope, Behera & Roy 2017; Glasson, Mhango, Phiri & Lanier 2010; Mawere 2014; Sithole 2007). As a result, development should begin with what African people and communities know (Dei 2014). There is therefore a need for the Africanisation of the curriculum as a priority for educational transformation.

The relationship between the two concepts (SD and IKS) is conveyed in the study, especially within the Technology curriculum. Hence, this understanding could help with the teaching of Technology to promote sustainability. Similarly, the literature clearly shows that combining indigenous and local knowledge systems with scientific knowledge allows for the possibility of sustainability at various scales and in the educational sector (Hill, Harkness, Raisbeck-Brown et al., 2021; Tengo, Hill, Malmer et al., 2017). Shizha (2011) and Snively and Corsiglia (2001) conclude that IKS, as an alternative to Western science, is all-encompassing because it includes local handicrafts, performing and visual arts, and so on. Furthermore, IKS supplements science by incorporating local knowledge into farming, fishing, hunting expeditions, forest resource use, atmospheric processes and phenomena, knowledge transmission systems, building and construction, medicine, pharmacology, commerce, and law, and spirituality. Realising the subject contents within an indigenous viewpoint may promote ESD, and it is in this light that the findings on local knowledge recognition matter. Finally, exogenous constructivism is based on the idea that knowledge is acquired through the reconstruction of existing structures such as information,

behaviours towards environmental awareness (Moshman, as cited in Malik 2021).

The study also found a link between African indigenous people and SD, and the literature shows that through indigenous processes, local people are aware of how to make a living and solve problems in their lives because IK serves as their foundation (Dipholo & Biao, 2013; Gorjestani, 2000; Mugambiwa, 2020). The findings also revealed that African indigenous people live sustainably, and their way of life had a lower environmental impact, therefore, motivating IKS and teaching for ESD as a solution to the endangering of the environment. As a result, SD has its way within IKS. There is a sense that IKS is still relevant in solving today's environmental issues as it was before modern ways of living. However, some teacher participants were more focused on Western paradigms, resulting in no SD realisation in their teaching. Similar research shows that SD achievement was still evaluated solely through Western paradigms or approaches, and IKS remains absent even on the global SD arena (Breidlid 2009; 2020). Despite the teachers' understanding of SD from an indigenous context, some indicated that Western customs influence their daily lives. Subsequently, I am convinced that teachers' appreciation and recognition of IK in their teaching will benefit learners' diverse knowledges, which may help address issues of sustainability.

Roya and Hanieh (2015) argue that constructivism is an educational philosophy that teachers may explore to determine what learners know so to allow their own knowledge. It is in this understanding that the recognition of IKS informs on the dialectical constructivism as a starting point wherein teachers may consider their learners' cultures towards the establishment of ESD. Learning to apply and combine knowledge is proposed as an essential component of high-quality, long-term education in the 21st century (Seehawer & Breidlid 2021). Fleming's (2011) study concluded that the constructivist approach views learning as constructing the new meaning based on existing information rather than accumulating knowledge. The conclusion of the study is that there is an opportunity to implement SD teaching in TE in an indigenous context. According to Gumbo (2020), Technology as a subject provides a foundation for successful learning,

which is especially important in indigenous communities – this strengthens the need to incorporate IK. The emphasis in this study on SD realisation within an indigenous context is consistent with the literature on SD and IKS, for instance, Barnhardt and Kawagley (2005) (in Naidoo 2010) assert that IK is still effective today in addressing SD issues such as underdevelopment, sickness, and starvation.

Most participants concurred that scenarios, design and problem-solving activities are related to the cultural context of the learner. Therefore, issues such as culture and communal practices toward the environment would be recognised to teach ESD in TE curriculum. In support of the findings, it, therefore, can be argued that endogenous has an impact on the teaching of ESD as Velthuizen (2012) claims that specific social systems such as IK, external knowledge, cultural meaning-making, learning tools, and technical tools influence endogenous knowledge. As a result, endogenous would emphasise the use of cultural tools within the context, which would have a significant impact on the teaching and learning of the ESD concept. Teaching toward ESD lays a foundation, hence, Velthuizen (2012), indicates that many African theorists and academics prefer the word endogenous since it allows for the spread of information between cultures without supposing knowledge to be static. Furthermore, the study findings revealed that indigenous knowledge holders may have a significant impact on the TE curriculum because some participants believe that technology existed before our ancestors and is still relevant today. The findings of this study are consistent with the literature on the significance of indigenous people to the environment. Cajete (2020) views indigenous people as having a strong connection to the land, and many still rely on it for a living to survive catastrophic crises. As a result of the findings, teachers agreed that IKS integration would enable ESD issues in their teachings.

Similarly, Zindy (2021) concludes that the effect of IK originates from oral transmission from the ancestors, and it has generated science-related knowledge or indigenous science. As a result, a framework based on indigenous practices may benefit ESD teaching in TE. Drawing on O'Donoghue's (2015) models, as discussed in Chapter 3, a starting point could be the knowledge that

elderly people have on societal, environmental, and economic issues, to relate the current content to those and bring a better understanding of ESD concepts within an indigenous context in the subject Technology. Correspondingly, Gadgil et al. (2021) contend that if we want to calm the angry earth, we should look to the ecosystem people's wisdom, knowledge, traditions, and practices. Nonetheless, the study showed that the CAPS document still provides few opportunities for ESD issues in the subject, whereas IKS is seen as successful establishment of ESD in the TE curricula. Therefore, I contend that the richness of ESD, particularly within the subject, lies in the teaching of the subject content in an indigenous context.

6.5 WAYS TO RECONCEPTUALISE TE CURRICULUM TO INCLUDE ESD

One of the principles of ESD by the Ministry of Education, Culture, Sports, Science and Technology (2016) highlights presentation of opportunities for learners to have meaningful experiences rather than merely being engaged in rote learning. Consequently, on the effective approaches for ESD learning, the literature emphasises collaborative learning, social learning, transformative learning, problem-based learning, and so on (Missimer & Connell 2012; Schnitzer 2019; Saitua-Iribar, Corral-Lage & Pena-Miguel 2020; Weizsacker & Wijkman 2018). In this study, participants concur that collaborative learning or teamwork has great opportunities towards teaching ESD as these teaching approaches allow for knowledge sharing that reflects learners' cultural backgrounds. This was evident in their reflections on design scenarios, design and problem-solving activities. Equally, the study emphasises how teachers ensure that the scenarios and activities allow learners to relate to their cultural backgrounds. As a result, teaching from this perspective would enable ESD recognition in the Technology curriculum. de Sousa (2021) concludes that ESD is action-based, with reflective and stimulating learning methods such as cooperative learning, collaborative, and dialogue, engaging the entire system, active and participatory learning, innovation, new teaching, and learning experiences.

The findings of the study indicate that while some teacher participants believed that the approaches allowed for IKS incorporation, others believed that the design scenarios were not designed in a way that allowed them to frame them within the learners' cultural background. Therefore, the findings concur with the literature in that incorporating ESD in an indigenous context remains a challenge, owing to the scarcity of evidence on the development, outcomes, and impact that courses and educational initiatives introducing learners to sustainability competencies have (Cebrián, Junyent & Mulà 2021). Timm and Barth (2020) indicate that integrating ESD into classroom teaching requires a certain amount of affinity for the topic and perseverance to overcome resistance from the teachers because ESD is not part of the basic curriculum. Indeed, when working toward integrating ESD into school curricula, indigenous characteristics must be emphasised even more.

Hay and Dzerefos (2022) suggest that indigenous societies protect natural areas by connecting with their ancestors and developing IKS to effectively conserve areas. Furthermore, these authors indicate that by recognising IKS that protect biodiversity, water, air, and soil from exploitation, today's youth can be co-engaged to continue this trajectory. This falls under the collaborative and teamwork/group work approaches. Constructivism, according to Malik (2021), is a situational action in which learners are active, in control, and at the centre of learning. One's understanding of an experience is determined by one's individual and social interpretations of it. Similarly, ESD teaching in the Technology curriculum may be taught from one of the three constructivist perspectives (i.e., endogenous, exogenous, and dialectical), allowing for significant variation in how knowledge is constructed (Doolittle 2014). Situated learning and culture are linked to social constructivism in this study and may play an important role in ESD teaching and learning. According to Lave and Wenger (1991 in Chiou 2020), practical knowledge is embedded in the interactions of practitioners, social organisations, and communities of practice (CoP). Therefore, learning should incorporate both knowledge and practice (Lave & Wenger 1991). Subsequently, the findings suggest that the three constructivist perspectives as outlined in Chapter 2 Sections 2.3.1.1 to 2.3.1.3 play an important role in the subject, particularly when teaching ESD.

The findings revealed that there is an interdependence between TE curriculum, IKS and ESD. Teacher participants and CSA believed that there is a great opportunity to integrate indigenous contexts in Technology, Society, and the Environment. Therefore, issues of ESD can be understood in this context. The TE curriculum considers knowledge, skills, values, design, communication, teamwork, decision-making, and other factors (DBE 2011). Hence, this curriculum strongly allows room for incorporating ESD into its teaching. For example, McKeon et al. (2002) state that when teaching ESD, the components of knowledge, skills, perspectives, values, and issues should be included. Similarly, Carm (2014), the environment aspect in SD, provides a viewpoint from which IK could be viewed. Urbańska et al. (2021) state that a lack of tools for the proper transfer of knowledge on ESD remains a challenge. Subsequently, the study showed that teachers' resources and materials have less account on indigenous aspects even though the CAPS document and the ATP's emphasis on environmental issues. Hence, the SD concept was not considered in their instruction. In a similar way, Glavič (2020) claims that a lack of resources is slowing down development i.e., maybe on issues of ESD.

Rannaikmae et al. (2020) posit that social constructivism encourages collaboration and problem-solving in the pursuit of meaningful knowledge construction. In this study, some participants viewed teamwork and/or collaborative learning as an approach that allows learners to share their IK to gain a better understanding of the content. Although some teacher participants failed to use these approaches to integrate IK, they still believed that IK has a significant influence on the teaching of the subject. Some participants also indicated that communal learning can be considered from this perspective. Furthermore, Savaş (2016) posits that constructivism emphasises social negation of understanding and meaning. Subsequently, sustainable earth and sustainability science must engage society and creatively employ all available sources of knowledge; this suggests the inclusion of IKS. Drawing from the findings, teaching from a dialectical i.e., social perspective is informed through endogenous and exogenous perspectives. These perspectives are about teachers' knowledge of ESD and the belief that the knowledge or practices that

indigenous people have on ESD, may be beneficial to ESD teaching in the TE curriculum.

The findings reveal that collaborative and teamwork approaches promote teaching in an indigenous context. This can be connected to *Ubuntu*, which is an indigenous African philosophy of life and education (Seleke 2021). Obanya (2018) further maintains that indigenous African education is founded on social recognition and the application of socially accepted pedagogies such as oral communication, team/group teaching, collaborative, apprenticeships, etc. As a result, the study's participants believed that the approaches, such as collaborative and teamwork in TE, inform the consideration of CoP and *Ubuntu* in the Technology classrooms. According to Museka and Madondo (2012), *Ubuntu* philosophy can elicit environmental awareness that is written in people's hearts. Hence, the holistic view and approach of indigenous people and the respect that they have toward the environment can help achieve this.

However, the results of the study revealed that the aforementioned principles were lacking in the teaching of the Technology subject because learners were arranged in a way that did not encourage groupwork and collaboration in order to trigger learners' cultural backgrounds. The study also revealed that social learning was hampered because learners were not encouraged to collaborate and share information about social practices. Furthermore, Lotz-Sisitka (2017) contends that when heritage practices and modern culture are used collaboratively, they can bring about change in addressing the ESD issues. However, the study indicates that *Ubuntu* and CoP may lay a proper foundation in the teaching of ESD. Dalgarno (2002) agrees that learning in groups allows for the development of conceptual understanding through a social learning process. As sustainability considers the realms of the environment, society and economics and the cultural dimension (UNESCO 2012), the aforementioned context suggests that the dialectical and/or social learning enriches learners' learning of the concept ESD while taking societal knowledge into account. Nonetheless, the findings indicate that the learners' cultural knowledge within collaborative and teamwork approaches may establish the aspects of ESD teachings in the subject, as the approaches are valued in the Technology curriculum. Hence, I am

confident that these approaches will help to inform the teaching of ESD. However, the findings revealed a gap in how learners' cultural knowledge was not considered in teaching and learning, resulting in the ESD aspects being viewed as less important in the subject.

The findings have yielded the fundamental aspects that can translate into a framework for teaching ESD through TE. Therefore, a framework (see figure 6.1) is suggested that can orientate the teaching of Technology toward the integration of ESD. The successes of the ESD implementation in TE can be found in the three constructivist perspectives depicted in Figure 6.1. According to Doolittle (2014), the formation of knowledge is interdependent. Simply put, knowledge acquisition is influenced by one's sociocultural background, prior experiences, or culture, whether through interactions with others or direct instruction; therefore, these perspectives are interconnected. The interrelationship can be better understood through Hardianti et al.'s (2021) definition of constructivism as it comprises the concepts discussed above, i.e., exogenous, endogenous, dialectical, as it correlates with the constructs of social learning/constructivism, culture, LPP, *Ubuntu*, CoP, etc. That is, constructivism is the result of 'mental construction' where learners build their understanding by reflecting on their personal experiences and connecting new knowledge with what they already know. Each learner makes his 'change' or mental model for understanding the world and accommodate new knowledge (learning) by adjusting it. One of the principles that support learning is to look for meaning; therefore, to be effective, a teacher should help learners find their meaning (Hardianti et al. 2021).

Figure 6.1 depicts a possible framework for teaching ESD in the Technology curriculum in an indigenous context. This framework aligns to a larger extent with the African Technology Education Decolonization Framework developed by Gumbo, Moalosi and Gaotlhobogwe (2020). Seven layers were found prominent for the teaching of ESD within the three constructivist perspectives, with collaborative and teamwork being the starting point as they inform principles such as LPP, *Ubuntu*, and CoP, and the principles being within the activities given to the learners, therefore, the design and problem-solving activities. More specifically, opportunities for ESD teaching are found in the social and

environmental aspects outlined in the definition of the TE curriculum in Chapter 3. As a result, the social, environmental and the principles and practices of social and environmental justice and human rights as outlined in the CAPS document hold a strong foundation for the transformational teaching of the TE curriculum to realise ESD within an indigenous context.

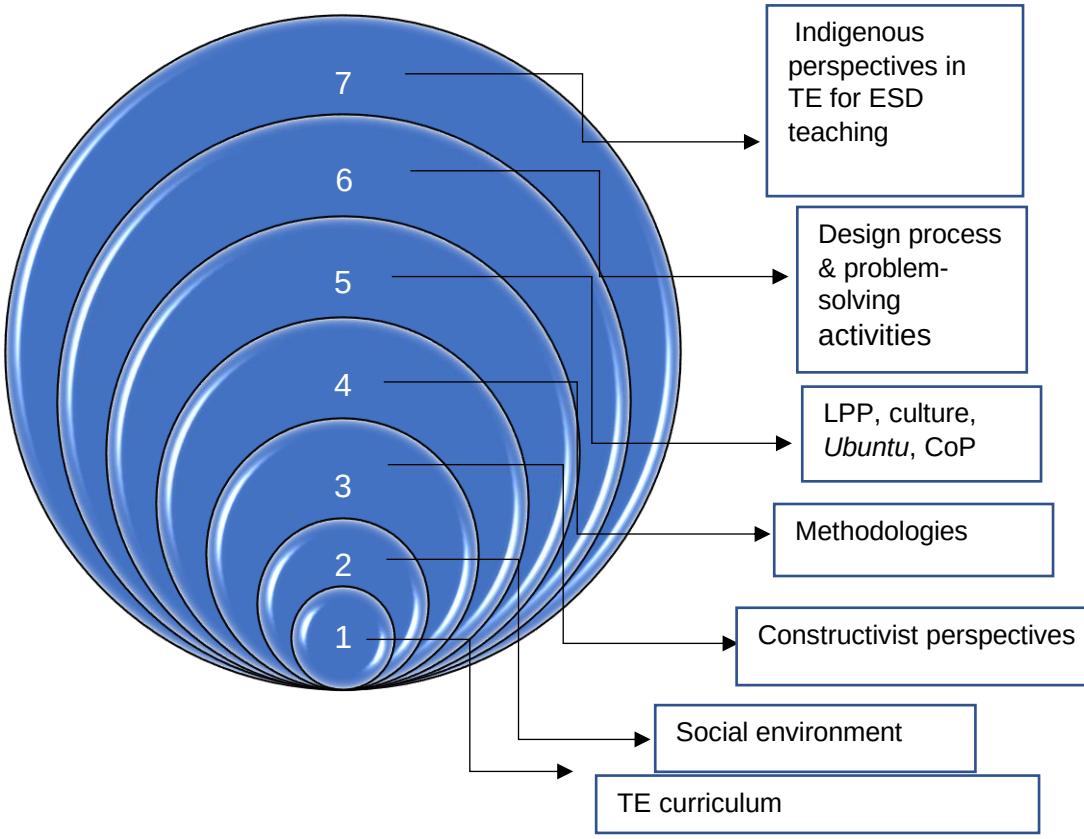


Figure 6.1: A Learning framework for ESD in the Technology curriculum

The framework consists of seven layers, being:

1. TE curriculum – TE curriculum consists of outcomes down to assessment as outlined in Chapter 3 Section 3.5. It is critical that the curriculum as a whole be understood and taught in the light of the curriculum principles, especially the principle of IKS; this would steer the curriculum toward teaching for ESD. The third teaching aim also provides a launching platform to teach for ESD since it includes the term, indigenous technology. The design process is the crux (backbone of TE as a method) of the curriculum delivery as it is used to structure teaching in the TE

curriculum; it includes investigation, design, make, evaluation, and communication (IDMEC). Besides the knowledge that it targets, design process targets multiple skills in learners, e.g., critical thinking, creative thinking, making, cutting, drawing, skills etc. The ability to design is the most important skill to teach in TE, with problem-solving being followed in the design process. Teacher training should empower Technology teachers to teach the subject from the IKS perspective. They should be trained as agents of change, not curriculum implementers only. This way, they will keep thinking critically about the curriculum and suggest changes where it falls short of relevance to ESD.

2. Social environment – The principles and practices of social and environmental justice and human rights, i.e., IKS, human rights, social justice, and environmental justice may inform transformational of TE curriculum teaching to allow constructivist perspectives in relation to ESD incorporation. It is intended that by using IDMEC in the classroom, teachers' social behaviours may be changed so that they inculcate learning that is aligned to the learners' cultural environments. Design activities and scenarios should therefore be extended to IKS-related issues so that even the learners' investigation activities help to link their learning to their cultural contexts instead of designing for urban environments only. For example, design scenarios may reflect on social behaviours such as indigenous practices to raise environmental awareness. In the context of this study, the human rights principle has a significant opportunity for transforming the TE curriculum toward sustainability. Human rights, for example, may encourage teaching that recognises *Ubuntu*. *Ubuntuism* may offer a unique set of ethical values that guide human beings in their day-to-day interaction with the environment (Museka & Madondo 2012). Teamwork, groupwork and/or collaboration, which are the most advised teaching approaches owing to the nature of the subject, should be fully explored to encourage teaching toward SD.
3. Constructivist perspectives – teaching ESD through TE may fall into one of three categories, i.e., endogenous, exogenous, or dialectical. Learner engagement and social interaction should be prioritised in TE design

activities. When learners solve technological problems while considering social and environmental principles and practices, especially in indigenous contexts, they will be actively engaged and interact socially during learning – this will promote teaching toward ESD. Teacher training can be used to understand social constructivism from an *Ubuntu* principle that encourages *letsema* (collaborative activities).

4. Methodologies – collaborative and teamwork in TE would provide a solid foundation for ESD teaching. Design activities taught in the TE curriculum could promote social engagement and teamwork in learners. As learners collaborate, they may generate ideas that promote environmental sustainability by drawing from indigenous people's practices. This would call for IKS not to be undermined and dismissed as outdated or primitive as colonialism has described it.
5. LPP, culture, *Ubuntu*, and CoP – These are critical in ESD practices, particularly in TE curriculum. As stated earlier, the subject promotes collaborative and teamwork. Simply put, design activities emphasise communal practices. As a result, collaborative and teamwork would guide the use of culture, *Ubuntu*, CoP, and LPP to realise ESD in the subject.
6. Design process and problem-solving – Activities emanating from these approaches would help realise ESD – One of the most important issues to address in the TE curriculum is the teaching of practical skills through the design process. Through design activities, social interaction would be promoted among learners, and ESD issues incorporated in the teaching of the TE curriculum ultimately. This, therefore, may open recognition of indigenous ways of living toward ESD. Creative thinking skills may provide learners with the opportunity to solve technological problems related to ESD issues – they will be prepared as engineers, artisans, architects, etc who may not solve problems in conventional environments, but in indigenous environments as well.
7. Indigenous perspectives for ESD teaching in TE – The use of LPP, culture, *Ubuntu*, and CoP in the solutions of practical problems in the TE curriculum would enable the realisation of indigenous ways of life in teaching toward ESD.

These seven layers are very interactive. They may not be seen or applied isolated from one another.

6.6 SUMMARY

The study's findings were discussed in this chapter in relation to the study's objectives, which were outlined in Chapter 1. The findings in this chapter indicated that the teacher participants and the CSA understand SD and ESD issues and how they relate to the subject Technology, particularly in an indigenous context. According to the chapter, indigenous people have long recognised the concept of sustainability. In this context, constructivist perspectives were deemed relevant to the establishment of ESD issues in the subject Technology. This assumes that Technology teachers are well aware of the concepts and their relationship to indigenous ways. However, the CAPS document has been viewed as an impediment to the success of ESD incorporation, particularly in an indigenous context, owing to the document's brief information or content, according to the study's findings. Nonetheless, despite its brief coverage of ESD and IKS, the Technology curriculum provides enormous opportunities. As a result, concepts such as LPP, *Ubuntu,* CoP, collaborative, teamwork approaches, design, and problem-solving activities were identified as important aspects that could help to establish a framework for successful ESD recognition in Technology curriculum.

CHAPTER 7

SUMMARY, LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

The previous chapter discussed the findings of the study, which focused on teachers' perspectives on ESD in the Technology Education (TE) curriculum. This chapter concludes the study by summarising the study and confirming the main research findings. Most importantly, the chapter confirms the answering of the research questions that the study set out to seek answers to. Lastly, the chapter presents the conclusion, recommendations, and the limitations of the study.

7.2 SUMMARY OF THE STUDY

The first chapter provided the context for the study and introduced the problem statement. The aim of this study was to explore ways that can make the teaching of Technology promote ESD. The study's objectives were to describe Technology teachers' understanding of ESD; to identify the opportunities presented by TE curriculum that teachers can use to incorporate ESD in their teaching; to determine ways Technology teachers can use IKS to teach for ESD; and to suggest ways that can enable the re-conceptualisation of the TE curriculum to incorporate ESD. The study was motivated by a desire to understand teachers' perspectives on the incorporation of ESD in TE curriculum, as my observation about teaching and learning in TE is that teachers do not teach the TSE aspect in relation to ESD despite the CAPS' emphasis on IKS. The chapter identifies education as a critical sector for ESD implementation, especially the Technology subject with its practical nature. It is for this reason that this study sought to address the gap about the incorporation of ESD in the TE curriculum. The TE curriculum has the potential for ESD incorporation, especially in the TSE content.

In Chapter 2, the constructivist theory guiding this study was described, justified, and shown how it framed the study. Its main constructs, i.e., endogenous, exogenous, and dialectical constructivism provided insights into how ESD teaching might be understood and practiced in TE curriculum. It, therefore, facilitated the understanding the incorporation of ESD in the TE curriculum within an indigenous context. Constructivism emphasises social interaction and the prior knowledge that learners bring to school, on which to build new learning. It contributes in ESD by considering learners' cultural aspects such as language, tools, and resources. IK and culture could therefore potentially benefit ESD teaching in TE. The social constructivist version of the theory was beefed up with LPP, culture, *Ubuntu*, collaborative learning approach, and CoP as critical aspects in the learning of ESD.

Chapter 2 was married to Chapter 3 as it played a directive role of guiding the literature review. Hence, relevant literature on ESD incorporation in the TE curriculum from an indigenous context was reviewed in the chapter. The literature review covered topics such as sustainable development for human capital development, policy imperatives, indigenous knowledge as seen through SD, educating for sustainable development, TE curriculum, IKS and ESD, and teaching and learning of ESD through TE from an indigenous perspective. The chapter touched on the cardinal policies driving ESD, both UN's and AU's, such as Agenda 21, Agenda 2030, Agenda 2063, and the South African National Framework. In the chapter, literature the relationship between the TE curriculum and IKS for teaching ESD in the TE curriculum was explored. The findings of the literature review show that the TE curriculum allows for teaching toward ESD through TSE. The CAPS presents the opportunity for Technology teachers to teach learners how to deal with inclusivity, human rights, social, and environmental issues in their tasks.

Chapter 4 presented the qualitative methodology of the study within a constructivist paradigm to gain a thorough understanding of teachers' perspectives on incorporating ESD into the TE curriculum. A case study design was chosen, motivated and followed. The targeted participants, who are Senior Phase Technology teachers and a CSA, were fully described. The methods of

research included semi-structured interviews, classroom observations, and document analysis. These were described and motivated, as well as their application in the study. Thematic analysis was chosen to analyse the data. The chapter accounted for the trustworthiness of the study.

The findings of the study were presented in Chapter 5, where five broad themes and sub-themes were identified. These themes include the context of indigenous technology in Technology Education curriculum; teachers' understanding of sustainable development in the context of the African people; teachers' awareness of ESD; the relationship between Technology Education approaches and indigenous technology in Education for Sustainable Development teaching; and the significance of indigenous knowledge holders and a framework for understanding Technology Education curricula.

The findings, which were discussed in Chapter 6, made the study to contribute an indigenous teaching framework for ESD.

7.3 SUMMARY OF THE KEY FINDINGS

The following sections are about the key findings that emanated from the study.

7.3.1 Technology teachers' understanding of ESD

Teachers demonstrated knowledge of SD and ESD concepts, particularly how they relate to the TE curriculum topics or contents. For example, one of the topics related to sustainability in the subject is the teaching of electricity and climate change. Though teachers reasonably understood SD and ESD, they still have challenges teaching them as part of Technology. They have not yet taken an advantage of the opportunity that Technology presents to teach toward ESD. This challenge is related to the difficulty to interpret CAPS. They alleged that the CAPS does not clearly demonstrate how they can teach for sustainability in the subject. To the contrary, however, Technology can accommodate the incorporation of ESD, especially through TSE.

7.3.2 Opportunities that TE curriculum presents for teachers to incorporate ESD

According to this key finding, Technology presents numerous opportunities through its inclusion of indigenous technology to incorporate teaching toward ESD. The subject raises issues that relate to the people's indigenous ways of life. Hence, learners could be taught about food preservation and the impact of technology on the environment and society from indigenous perspectives instead of confining their learning to the Western perspectives only. It is in this sense that the third specific aim of TE allows for the incorporation of IKS, and it is in this context that ESD issues may be addressed in TE curricula. Since the teaching of Technology should integrate the three specific aims (they must not be taught in isolation), learners can be taught to design (Specific Aim 1) for indigenous contexts or incorporate indigenous knowledge and skills in their designs for alternative contexts (they could be presented with scenarios or case studies that relate to indigenous contexts. Their learning tasks could be framed within the topics/content of TE (Specific Aim 2) and the relationship between technology, society, and environment (Specific Aim 3). Currently, the findings revealed that teachers confine themselves to teaching the subject in a Westernised way, denying themselves the chance to teach toward ESD.

7.3.3 Ways Technology teachers can use IKS to teach for ESD

As stated above, the findings of this study revealed that IKS has a significant opportunity in the teaching of Technology. As a result, indigenous examples, especially in the field of technology, are considered ESD enablers. However, the findings revealed that indigenous technology is viewed in its historical context only – treated as something that belongs to the past and not useful today, which causes some misunderstanding of the relationship between indigenous technology and modern technology, which is predominantly Westernised.

7.3.4 Ways to reconceptualise TE curriculum to include ESD

Collaborative learning or teamwork was spotlighted as one of the main ways that can serve as springboard to teach toward ESD because these teaching approaches allow for knowledge sharing that is culturally relevant to learners.

However, some of the design scenarios are not planned in a way that promotes or prompts learners' cultural backgrounds, indicating that there is little attention paid to the IKS incorporation in the subject. The findings also revealed a link between the TE curriculum, IKS and ESD. There is, therefore, an opportunity that this link presents to integrate IK and practices in TSE. As a result, ESD issues can be understood in this context. Hence, this aligns well with the *Ubuntu* and CoP principles which promote collaboration/teamwork – technology learners can be organised into teams or groups of that can collaborate with each other and even with the community members to attend to their learning activities. However, the findings revealed that the teaching of the TE contents did not encourage collaboration and teamwork, resulting in less recognition of *Ubuntu*, CoP and IKS. It is in this light that the findings created a need to suggest a Learning Framework for ESD in the Technology Curriculum (see Chapter 6 Section 6.5) that can guide the teaching of Technology in such a way that it incorporates ESD. The main constructs that were illuminated by the findings were used in the development of the framework. The framework serves as the main contribution of this study.

7.4 REALISATION OF THE RESEARCH OBJECTIVES OF THE STUDY

The study sought to explore ways that can make the teaching of Technology promote ESD. The following objectives were achieved:

- To describe Technology teachers' understanding of ESD
  The evidence derived from the participants in the study presented the findings that led to the conclusions that were drawn. The findings did provide the teachers' and CSA's understanding of SD and ESD in the Technology, and a clear picture about their shared interests in ESD and the Technology content. Hence, this objective was met, as evidenced by the relevant discussions in sections 5.6 and 6.2.1.1.

- To identify the opportunities presented by TE curriculum that teachers can use to incorporate ESD in their teaching.

The analysed data in the study enabled the emergence of the findings that led to the conclusions drawn. The views of participants about the opportunities provided by the subject to teach towards ESD aided in the achievement of this objective. Hence, this objective was accomplished and discussed further in sections 5.6 and 6.2.2.1

- To determine ways Technology teachers can use IKS to teach toward ESD.

  The participants' understanding of IKS and how it relates to ESD aided in determining how teachers can use IKS in the subject to teach toward ESD issues. Hence, the findings of the study enabled me to draw relevant conclusions, and this objective was met as discussed in sections 5.6 and 6.2.3.1

- To suggest ways the TE curriculum can be reconceptualised to include ESD.

  The analysis of the data enabled me to propose a framework, guided by the findings and how the entire study unfolded, to guide the promotion of ESD in the teaching of Technology, especially through CoP, LPP, culture, *Ubuntu*, and so on. Hence, this objective was met, and the findings and conclusions were discussed in great details in sections 5.6 and 6.2.4.1

7.5 LIMITATIONS OF THE STUDY

The qualitative research approach was the optimum choice for this study because research instruments like individual interviews, observation and document analysis allowed me to capture the teachers' views on the incorporation of ESD in TE in an indigenous context. In hindsight, I believe that a focus group would have aided in gaining a collective understanding of the teachers' views about the incorporation of ESD in the TE curriculum.

This study was limited to two circuits in the Ehlanzeni District, i.e., Mbombela and Mgwenya. Data were collected in one urban school, four township schools, and one semi-rural school. Data collected, especially from other schools in deep rural

areas, may have revealed more teachers' views about the incorporation of ESD within the TE curriculum. It would have added data from indigenous contexts. Rural areas are still dependent on indigenous ways of life, therefore, researching IKS in those areas can deepen an understanding of a researcher on the IKS issues.

The study provided an opportunity to interact with the four teachers' lesson plans (only four teachers provided me with their lesson plans), textbooks, CAPS document, and ATPs Grades 7-9, which represented the actual understanding of the implementation of ESD in the Technology curriculum. Though 18 documents were collected and analysed, and all eight sampled teachers were observed successfully, only four lesson plans were examined as part of document analysis because obtaining lesson plans from the teachers proved difficult. Curriculum materials, such as lesson plans, which were not produced by teachers themselves hampered determining how teachers create their own lesson plans that promote ESD. A participatory action research study might have “forced” them to design their own lessons.

The study was designed as a case study. The Mbombela and Mgwenya circuits case studies allowed me to investigate complex situations with multiple variables under consideration. Case studies mostly limit researchers to investigation of a small number of participants, though their thoroughness lies in the voluminous information that they collect to be able to deepen their understanding of the case in question. An alternative study, such as phenomenology, could have sourced information from a bigger number of participants.

The study was limited to eight teachers and a CSA in the Ehlanzeni District. A cross-district comparison would have deepened the understanding of teachers’ and CSA’s views of about the incorporation of ESD in the TE curriculum from an indigenous context. Incorporating learners would have also given me a better understanding of the significance of teaching ESD in an indigenous context in Technology subject since learners, especially indigenous learners are the ones affected by what is taught to them and how.

7.6 RECOMMENDATIONS

The study's recommendations are divided into three categories, i.e., policymakers and curriculum implementers, teachers, and further research.

7.6.1 Recommendations for policymakers (Mpumalanga Department of Basic Education) and curriculum implementers

- The Mpumalanga Department of Basic Education should establish ways for Technology teachers to have confidence in the integration of indigenous ways in their teaching toward ESD.
- The Department should ensure that the support that teachers receive does not only focus on Western notions of technology but indigenous notions as well – the third specific aim of TE (stated in the CAPS) should not be compromised. The curriculum principle, IKS (also stated in the CAPS), should be realised.
- Teacher training should include indigenous technology. IKS should not only beautify the CAPS; the incorporation of IKS and ESD ultimately will ensure the transformation of the TE curriculum.
- Teachers should be encouraged to develop lesson plans that incorporate IKS to help with ESD teaching. Specifically, the conceptualisation of ESD from an indigenous standpoint should be encouraged. Teacher training should show how teachers can do this. The framework that this study has contributed could be used to realise this.
- Curriculum implementers should consider workshops, as enrichment of teacher training, that provide a clear understanding of indigenous technology and how it can be incorporated into the TE curriculum content.
- Curriculum implementers should encourage and show Technology teachers how to plan activities that reflect IKS.

7.6.2 Recommendations for Technology teachers

- Teachers must thoroughly engage with the CAPS to understand its pronouncements about the integration of IKS in the subject. They should

extend their understanding of IKS by willingly embarking on research. They can also do this by enrolling for further studies with universities which offer programmes that integrate IKS.

- Teachers must develop lesson plans, design and problem-solving activities that centre learners' cultural knowledge.
- When teaching the subject, teachers must respect indigenous knowledge holders whom they can use as human resources to share their knowledge and demonstrate indigenous technology.
- Teachers should add to their collection of teaching resources materials that help learn about IKS. Textbooks are not the only resources available; indigenous environments are endowed with rich materials and practices that can be used.
- Teachers should critically think about their own cultures and confront prejudice so that they may accommodate their learners' cultures and knowledge. As lifelong scholars, they can learn along with their learners.

7.6.3 Recommendations for further research

Based on the study's findings, the following additional research could be considered:

- A broader study on the incorporation of ESD in TE using the methods and alternative studies such as those mentioned under limitations above.
- A similar study could be conducted on covering different districts in the province.
- A research project that explores the relationship between Western Knowledge Systems and IKS should be considered so to promote a dual understanding of ESD in TE curriculum. Such approach will also benefit both indigenous and non-indigenous learners.

7.7 SUMMARY

The findings of this study revealed that teachers are familiar with the concepts of ESD and indigenous technology and/or knowledge. Teachers believe that ESD has a place in the TE curriculum because of this, especially from an indigenous perspective. This is more reliable in TSE content teaching because the content

emphasises the impact of technology, indigenous technology, and technological bias. The study also revealed that sustainability is linked to African indigenous people, implying that teaching from this perspective would help to ensure the successful implementation of ESD from an indigenous perspective. However, participants expressed concern that the CAPS policy document is very shallow in terms of integrating IKS in their teaching of Technology curriculum content. Hence, their teaching is informed by Western paradigms, even though some still believe in their cultures for sustainability and living. Consequently, there is no discussion of ESD in the classroom. Clearly, assistance is required for teachers to understand how IKS can be incorporated into their teaching for ESD implementation.

The findings demonstrated that the TE curriculum can incorporate ESD content into the teaching of Technology because the subject is linked to or recognises IKS. This is evident in the way design scenarios and activities are related to the learners' cultural backgrounds in the CAPS. Consequently, there is a link between TE, IKS and ESD. The Specific Aim 3 emphasises the recognition of IKS and there lies the opportunity to teach toward ESD.

The theoretical framework for this study allowed me to frame my research methods in a manner that solicited the data that I needed to answer the research questions. The constructivist perspectives, namely endogenous, exogenous and dialectical, provided a framework within which data were collected, ordered and findings were established. The framework aided in focusing the study on accordance with the research questions, aims, and objectives – indeed, the research objectives were achieved. The framework contributed to the realisation of concepts such as *Ubuntu*, CoP, culture, LPP, and collaborative learning and their significant impact on the teaching of ESD from an indigenous perspective in TE. Subsequently, a framework was proposed because there is a need for teachers to teach with reference to the learners' cultural worldviews (in this case, the indigenous worldviews), as specified in the CAPS. The study has created an important awareness that ESD is one of the disciplines that have uses constructivism; conversely, dialectical constructivism has been used. In this study, the three perspectives correspond with social constructivism and fit well

with the incorporation of ESD in TE within an indigenous context, i.e., teaching within the contexts of collaboration and culture, which then informs social learning.

Finally, the knowledge gained in this study about the incorporation of ESD in the TE curriculum in an indigenous context may be viewed as a starting point for raising awareness of the concept in the subject and meeting the demands of the 21st century, specifically the SDGs.

REFLECTIONS ON MY PhD JOURNEY

The study explored ways that can make the teaching of Technology promote ESD in the Ehlanzeni District of Mpumalanga Province. The wish to conduct the study was motivated by the desire to discover Technology teachers' views and understanding of sustainability and its teaching in the content of the TE curriculum in the Senior Phase Grades 7-9, as there is a paradigm shift towards sustainability in various sectors, including the education sector globally. When I first conceptualised this study, my supervisor, Prof MT Gumbo, made me aware of the global importance of sustainable development and for indigenous people in particular. Our discussion sparked my interest in the concept from which I identified the issue of my investigation ultimately. The following question resulted: *How can ESD be incorporated in Technology Education in indigenous contexts?* Understanding that living sustainably is not a new concept, it was recognised by African indigenous people, and it continues to be relevant today. So, based on this understanding, I considered how indigenous ways of life could help with ESD teaching, particularly in the TE curriculum, where most of the topics and/or the design processes are related to indigenous technology. Hence, it was thought that indigenous ways of life could aid in the transformation of the CAPS toward the recognition of ESD and IKS in their most basic form.

It was difficult to begin with my PhD journey because I first registered in 2020, during the COVID-19 outbreak. Hence, proceeding with the study was the most difficult experience because, like many of my colleagues, I was still adjusting to the new normalcy. During that time, I never attended any doctoral workshops organised by the Unisa as it was previously done. It was extremely difficult, but I was able to adapt; thanks to the timely feedback received from my supervisor, Prof Mishack T Gumbo. Nonetheless, I collected data during the post-COVID-19 era, and it was not difficult because I adhered to the government's safety precautions and the ethics procedures provided in the Unisa’s policy. However, collecting data, analysing it, and putting the chapters together was difficult because I had to attend to some work-related matters. Even though a significant amount of time was required, everything eventually came together. I appreciate the encouragement, support and endless inputs provided by my supervisor, Prof

Gumbo which heightened my energy levels to complete the study. Prof Gumbo was the supervisor for my master's dissertation. Then I was a teacher. In 2020, I was appointed as a lecturer in the Department of Science and Technology Education at the University of South Africa. Prof Gumbo happens to be my colleague in this Department. This drew me closer to him as a supervisor – it has been convenient to work with him. I also happen to be part of a group of his mentees in research and whom he is preparing to apply for the National Research Foundation rating. Collecting data for my PhD study was a one-of-a-kind experience in which I felt connected from the first to the last day of data collection.

The Technology Senior Phase teachers and the CSA provided me with the most comprehensive data I could have imagined. I can still see their friendly faces as I approached them. Initially, I had some reservations about teachers' understanding of the concepts SD and ESD, particularly in relation to the subject Technology, but their cultural diversity reflected so many aspects of sustainability that may serve as a good weapon in enriching the goal of ESD in the subject Technology. I was able to analyse the data collected using three data collection instruments: individual interviews, classroom observations, and document analysis. Although gathering the data was difficult, I gained an experience that will help me as a developing scholar in my academic career. It was an exciting journey to investigate the incorporation of ESD into TE curricula, particularly in an indigenous context in Mpumalanga Province, South Africa. I feel I am well on my way to becoming a formidable specialist in the field. Issues of sustainability take a centre stage in global forums on sustainable development. From here, I will share the knowledge that I have gained through writing for the publication from my study, presenting papers at academic conferences, and presenting seminars. I will interact with renowned scholars many of whom I met through their works as I was reading for this study. I am a team member of Prof Gumbo's Engaged Scholarship project, A Strategic Intervention in Mathematics, Science and Technology Education, which is a partnership with the Mathematics, Science and Technology Agency which is commissioned by the Mpumalanga Department of Basic Education to improve learner performance in the province. The project

will keep my experiences of this PhD study alive since I will remain in touch with the context of my study. I will also contribute my expertise in the project.

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APPENDIX A: ANNUAL TEACHING PLAN

Private Bag X11341, Mbombela, 1200
Lilitha la Temfundvo. Umnyango wa Fundo Departement van Onderwys Ndzawulo ya Dyondzo

2022

2022 Annual Teaching Plan – Term 1: TECHNOLOGY: Grade 9

Week 7	Week 8	Week 9	Week 10
Investigation skills and Design skills		**Design skills**	**Costing and Making**
Investigate: provide the scenario so that learners can investigate the problem situation and various possible structures which could solve the problem(s) they identify. Analysis of existing products relevant to the identified problem in terms of fitness-for-purpose (including suitability of materials), safety for users, costs of materials and costs of construction. Realistic costs of real materials, labour, transport, etc. Textbook writers must supply useful resources for this. **Design:** • **Sketch initial ideas:** each learner generates two possible ideas. • **Evaluate and adapt**: learner evaluates the ideas and develops a final chosen idea. • **Design brief:** learners write a design brief with specifications for the final idea. • **Flow chart:** learner draws a flow chart.		• **Working drawings:** each learner draws the plan (or an aspect of the plan) using first angle orthographic projection with suitable scale, correct line types and dimensions.	• **Budget:** costing of the "real-life" solution, including correct materials and labour costs **Consolidation of work done in term 1:** • More examples of first angle orthographic drawings • Forces, strengthening of structures • Properties of construction materials • Design brief and budgeting
Investigation skills; Design Skills		Graphic Communication	
DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource YouTube videos, etc.		DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource YouTube videos, etc.	
Informal Assessment: Remediation	Formal	Formal	Informal
SBA (Formal)	**Formal Assessment**		

APPENDIX B: LESSON PLAN

DAILY LESSON PLAN

TECHNOLOGY GRADE: 09 **YEAR: 2022** **TEACHER:** _____

<table>
<tr><td colspan="4">TERM : 3 Week 3 Week ending: 05/08/2022 Topic: electric systems and control (resistor colour codes)

Date Completed: .....</td></tr>
<tr><td colspan="4">Key concepts: resistor, colour codes, tolerance, inversely

Prior-knowledge:</td></tr>
<tr><td colspan="2">LESSON 1: Resistor colour codes
DATE: 05 August 2022
Duration: 1 hour
Lesson objectives: Learn how to read the value of resistor.
Calculate resistance, current and voltage using ohm's law</td><td>LESSON 2:
DATE:</td><td>RESOURCES: Textbook (top class), Chalks, exercise books, calculators, pen, pencils, ruler and resistors.</td></tr>
<tr><td>Teacher's activity
• Distribute top class textbook?
• Instruct learners to open page 97
• Link previous lesson with the new lesson.
• Introduce new topic.
• Communicate lesson objectives
• Instruct learners to read paragraph on page 97
• Explain the: resistor, resistor colour code and resistor colour code table
• Demonstrate on the chalk board how to interpret and calculate colour codes
• Explain and give learners Activity 1 on page 98.
(10 min)

• Facilitate the learning process.
(10-35min)

Give learners feedback in a form of corrections
(20 min)</td><td>Learners' activities
• Open page 97
• Read paragraphs and ask questions
• Do activity 1 page 98
(25 min)</td><td>Teacher's activity</td><td>Learners' activities</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
</table>

APPENDIX C: EXTRACT FROM CAPS

- Through practical projects using a variety of technological skills (investigating, designing, making, evaluating and communicating) that suit different learning styles.

2.4 TOPICS AND CORE CONTENT AREAS IN TECHNOLOGY

- The table below indicates the main focus areas in the Technology curriculum:

1.	**THE DESIGN PROCESS SKILLS (non-linear):** • Investigation skills • Design skills • Making skills • Evaluation skills • Communication skills 
2.	**STRUCTURES**
3.	**PROCESSING OF MATERIALS**
4.	**MECHANICAL SYSTEMS AND CONTROL**
5.	**ELECTRICAL SYSTEMS AND CONTROL**
6.	**TECHNOLOGY, SOCIETY AND THE ENVIRONMENT** • Indigenous technology • Impact of technology • Bias in technology

There are four core content areas in Technology in grades 7 – 9. These are:

STRUCTURES	**PROCESSING**	**MECHANICAL SYSTEMS AND CONTROL**	**ELECTRICAL SYSTEMS AND CONTROL**

NB: All electric circuits must be battery powered in the GET Band – Max 9V dc.

These four content areas form the basis of the **four strands** which must be done each year in every grade. Where possible in the senior phase, the learner should engage in projects that **integrate** processing, structures and systems and control. The recommended approach will be to **introduce the required knowledge followed by practical work in which the knowledge is applied**. In all cases, the teaching will be structured using the ***Design Process*** as the backbone for the methodology. Some of these elements will be assessed formally each term.

As learning progresses, learners must be made aware of the interrelationship between technology, society and the environment. Wherever applicable, learners should be made aware of different coexisting knowledge systems. They should learn how **indigenous cultures** have used specific materials and processes to satisfy needs, and become aware of indigenous intellectual property rights. Learners should be able to consider the **impact of technology**, both positive and negative, on people's lives. Learners should be made aware of **bias in technology** and be able to express opinions that explain how certain groups within society might be favoured or disadvantaged by products of technology.

APPENDIX D: CONTENTS GRADE 8

Term 2

APPENDIX E: Mini-PAT GRADE 7

GRADE: 7 TECHNOLOGY FORMAL ASSESSMENT TASK: TERM 3
Mini-PAT

TOPIC: Electrical Systems and Control, Structures, Mechanisms

CONTEXT: Recycling and impact of technology

CONTENT: Structures and electricity, cranks and pulleys

Name: _____ Date: _____

Scenario:

A scrap metal dealer near your school needs to sort out magnetic (ferrous) from non-magnetic (non-ferrous) metals into separate piles for recycling.

He has asked you to build a crane with an electromagnet to sort these metals.

You must build a working model of a crane with a crank and pulley system and an electromagnet. The crane must be a frame structure that is strong and rigid. It must be reinforced using triangulation, and must be able to carry the weight of the electromagnet and the metals that will cling to it. The crane must pivot or be able to raise and lower its arm. Use any bought materials, paper dowels, "elephant grass" or cardboard to build the crane. The electromagnet must be strong enough to pick up several steel paper clips, coins or nails. It must have an on or off switch, with a light to show when it is on. You must use four 1,5 V D cells, a switch, a 6,5V MES lamp, connecters, electrical wire, insulation tape, and a 150mm nail and a long length of insulated copper wire to make the electromagnet. You also need staples of paperclips to demonstrate how the magnet works. You must construct the model using safe working methods. You will use your drawing skills and knowledge of structures, magnetism, electric circuits and electromagnets, cranks and pulleys.

Investigate

1. Identify features of a crane that you have observed. **(10)**

_____

_____

_____

APPENDIX F: ETHICAL CERTIFICATE

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2022/07/06

Ref: **2022/07/06/56712715/14/AM**
Name: Ms P Blose
Student No.:56712715

Dear Ms P Blose

Decision: Ethics Approval from 2022/07/06 to 2027/07/06

Researcher(s): Name: Ms P Blose
E-mail address: eblosep@unisa.ac.za
Telephone: 0823623826

Supervisor(s): Name: Prof MT Gumbo
E-mail address: gumbomt@unisa.ac.za
Telephone: 0124293339

Title of research:

Incorporation of education for sustainable development in Technology Education for indigenous context

Qualification: PhD Technology Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2022/07/06 to 2027/07/06.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2022/07/06 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
8. No field work activities may continue after the expiry date **2027/07/06**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2022/07/06/56712715/14/AM** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof Mpine Makoe
ACTING EXECUTIVE DEAN
qakisme@unisa.ac.za

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX G: REQUEST FOR PERMISSION TO MPUMALANGA DEPARTMENT OF BASIC EDUCATION TO CONDUCT RESEARCH AT EHLANZENI DISTRICT

Title of the research study: Incorporation of education for sustainable development in Technology Education for indigenous context
Date:

Dear Sir/Madam
I, ……, am doing research towards a PhD in Education under the supervision of……, a Research Professor, who is attached to the Department of Science and Technology Education at the University of South Africa.

The aim of the study is to explore ways that can make the teaching of Technology promote Education for Sustainable Development (ESD).

Ten (10) Senior Phase Technology teachers and one (1) curriculum specialist, all from Ehlanzeni districts, will be selected to participate in this study. The reason for selecting the teachers, and the curriculum specialist from the two circuits is because of the richness of African cultures and traditions in the area which will help me with a deeper understanding of attempts to integrate indigenous knowledge in the teaching and learning towards the promotion of ESD. The teachers have a variety of experiences that can contribute to the rich and valuable information that will provide a deeper insight into how they can incorporate ESD within an indigenous context. On the other hand, the curriculum specialist shall have worked with and supported teachers. The participants will be briefed about the research objectives and processes. The teachers and curriculum specialist will be asked to complete the biographical information sheet at the beginning of the research to obtain.

The study will benefit the schools and Mpumalanga Department of Basic Education in the sense that the findings of the study will help guide practice and alert the stakeholders to the need for relevant teaching and learning in relation to IK and ESD. The study will also help the Technology teachers integrate indigenous technology as per the CAPS requirements.

The potential risks are minimal in that confidentiality, privacy, and anonymity of the participants will be highly upheld. No photoshoot or video recording will be administered

during the study without the consent and assent of the participants. The participants will have the right to participate or not to participate in the study and will be allowed to terminate their participation at any stage of the study. This research will prioritise the observance to Covid-19 protocols and regulations, and this matter will be discussed in-depth with all prospective participants in this study. There will be no reimbursement or incentives for participating in the research.

The feedback procedure will entail participants being given the opportunity to comment on the interview transcripts before they are finalised for analysis. The final report on the findings will also be communicated to the Department of Basic Education, schools, and districts involved.

Yours sincerely

_____ (insert signature of researcher)

_____ (insert name of the above signatory)

_____ (insert above signatory's position)

APPENDIX H: REQUEST TO THE SCHOOL PRINCIPAL TO CONDUCT RESEARCH

School Name:

Title of the research study: Incorporation of education for sustainable development in Technology Education for indigenous context

Date:

The School Principal

Dear Sir/Madam

I, ……, am doing research towards a PhD in Education under the supervision of……., a Research Professor, who is attached to the Department of Science and Technology Education at the University of South Africa.

The aim of the study is to explore ways that can make the teaching of Technology promote Education for Sustainable Development (ESD).

Your school has been selected because of the teachers' exposure to African cultures and traditions that will assist in better understanding and coming into terms with the realities in the classroom. Also, the teachers' good track record and experience of teaching Technology can contribute towards the rich and valuable information that will provide a deep insight into the understanding of how teachers can integrate indigenous knowledge systems (IKS) towards realisation of ESD. The study will entail audio recorded interviews with the teacher and lesson observation and document analysis. The research process will not disrupt the normal running of the school. Class observations will be conducted during the allocated time or period for Technology.

The study will benefit the schools and Mpumalanga Department of Basic Education in the sense that the findings of the study will help guide practice and alert the stakeholders to the need for relevant teaching and learning in relation to IK and ESD. The study will also help the Technology teachers integrate indigenous technology as per the CAPS requirements.

The potential risks are minimal in that confidentiality, privacy, and anonymity of participants will be highly upheld. No photos or videos will be taken during the study without participants' consent. The participants have a right to participate or not to participate in the study, they can withdraw at any stage of the study. There will be no reimbursement or incentives for participating in the research.

The feedback procedure will entail participants being given an opportunity to comment on the interview transcripts before they are finalised for analysis. The final report on the findings will also be communicated to the parties involved.

Yours Sincerely

APPENDIX I: TECHNOLOGY TEACHERS' CONSENT LETTER

Date:

Title of the research study: Incorporation of education for sustainable development in Technology Education for indigenous context

DEAR PROSPECTIVE PARTICIPANT

I, ……, am doing research towards a PhD in Education under the supervision of……..., a Research Professor, who is attached to the Department of Science and Technology Education at the University of South Africa.

WHAT IS THE PURPOSE OF THE STUDY?

In this study, I will collect important information that could help to establish how can education for sustainable development (ESD) be incorporated in Technology Education (TE) in indigenous contexts in the classroom. The study was prompted by the Curriculum and Assessment Policy Statement (CAPS), which is informed by the human rights principles on one hand, and the dominant western knowledge systems that front the development of Technology and TE curriculum.

WHY AM I BEING INVITED TO PARTICIPATE?

We would like to invite you to participate in the study titled: Incorporation of education for sustainable development in Technology Education for indigenous context. Your invitation to participate in this study is because your exposure to African cultures and traditions will assist in better understanding and coming into terms with the realities in the classroom. Also, the teachers' good track record and experience in teaching Technology can contribute to the rich and valuable information that will provide a deep insight into how teachers can integrate indigenous knowledge systems (IKS) in the teaching of the Technology contents and/or design process activities when dealing with ESD.

I obtained your contact details from the district curriculum advisory section after discussing the research objectives and describing the caliber of participants we are looking for to participate in the research process. We took the POPI Act, no 4 of 2013 into consideration. You are one of the 10 teachers from Ehlanzeni district identified to participate in this study. Confidentiality, privacy, and anonymity of participants will be highly upheld. No photoshoot or video recording will be administered during the study without the consent and assent of participants. The participants have a right to

participate or not to participate in the study, they can withdraw at any stage of the study. This research will prioritise observance to Covid-19 protocols and regulations, and this matter will be discussed in-depth with all prospective participants in this study. There will be no reimbursement or incentives for participating in the research.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study will require you to participate in structured interviews, observation, and document analysis. Regarding the structured interviews, you will be interviewed about:

- your understanding of ESD.
- your understanding of the relationships between content and strategic knowledge that involve strategies to integrate IKS when teaching about ESD.
- the strategies you use to teach Technology from IKS perspectives.
- your knowledge of the subject from the IKS perspectives.
- the successes and failures of your strategies to plan and teach Technology; and
- your contribution towards the development of a framework to guide the effective integration of IKS in teaching the concept ESD.

You will be expected to dedicate 30-40 minutes of your time to face-to-face structured interviews.

The lesson observation will comprise the learning environment; subject content; teacher and learner participation; teaching strategies, interactions, and type of activities that includes the aspects of ESD from an indigenous perspective; and teacher and learner lesson reflections. Document analysis will be carried out on the learning and teaching support material (LTSM), i.e., textbooks, pacesetters, learners' workbooks; workshop/training materials and lesson plans.

You will also be requested to allow us to visit your classroom of Technology in the concerned Senior Phase class.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

You will gain an insight on how to integrate the IKS in realisation of ESD in the teaching of TE contents. Furthermore, the research findings will be communicated to the participants, schools, and the Department of Basic Education in the form of feedback or a digital copy of the report. The study recommendations will also be presented to help improve practice in different contexts than this. The benefits can only be realised through interacting and engaging in the research process with me as the researcher.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There will be no negative consequences as the interview and observation will be done based on the information to be gathered through interviews, non-participatory observation, and document analysis. The consent form should be submitted. This research will prioritise observance of Covid-19 protocols and regulations, and this matter will be discussed in-depth with all prospective participants in this study.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research **OR** Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

My supervisor and I will be the only ones to have access to the data and will maintain confidentiality as from the beginning. We will not disclose your name and that of the school, even on recording, there will not be any mention of your name or school. The reports will only show the name of the district, not the school. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

The outcome of this research may be presented to the research report, journal articles, and/or conference proceedings. In instances such as mentioned, you will not be identifiable as only codes will be used to report the findings.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Soft copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at Unisa, office duplicate in various storage facilities, the external hard drive that will be accessible by me and the supervisor for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. In the event where data should be discarded when it will have a sell-by date, the following methods will be used: in case there are hard copies will be shredded, and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Under normal circumstances, there will not be any reimbursement or incentive through participation in this research process or study. In the unforeseen circumstances that due to Covid-19, restrictions are enforced up to a point we cannot do face-to-face interviews, mobile data will be provided strictly to enable participation in a virtual platform.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the College of Education Research Ethics Committee at Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Ms. P Blose at 0124296174 or email eblosep@unisa.ac.za. The findings can be accessible after 6 months from the day the field research will be concluded.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Ms. P Blose at 0124296174 or use the email eblosep@unisa.ac.za.

Should you have concerns about the way in which the research has been conducted, you may contact the supervisor, Prof MT Gumbo, on the email gumbomt@unisa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study. Thank you.

_____

(insert signature)

_____

(type your name)

CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interviews and lesson observation

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

_____

_____ _____

Participant Signature Date

Researcher's Name & Surname (please print)

_____

_____

_____

Researcher's signature Date

APPENDIX J: CURRICULUM SUBJECT SPECIALIST'S CONSENT LETTER

Date:

Title of the research study: Incorporation of education for sustainable development in Technology Education for indigenous context

DEAR PROSPECTIVE PARTICIPANT

I, ……, am doing research towards a PhD in Education under the supervision of……..., a Research Professor, who is attached to the Department of Science and Technology Education at the University of South Africa.

WHAT IS THE PURPOSE OF THE STUDY?

In this study, I will collect important information that could help to establish how can education for sustainable development (ESD) be incorporated in Technology Education (TE) in indigenous contexts in the classroom. The purpose of the study was prompted by an investigation that surfaced from the Curriculum and Assessment Policy Statement (CAPS), which is informed by the human rights principles on one hand, and the dominant western knowledge systems that front the development of Technology and TE curriculum.

WHY AM I BEING INVITED TO PARTICIPATE?

We would like to invite you to participate in the study titled: Incorporation of education for sustainable development in Technology Education for indigenous context. Your invitation to participate in this study is because your exposure to African cultures and traditions will assist in better understanding and coming into terms with the realities in the classroom. Also, the teachers' good track record and experience of teaching Technology can contribute towards the rich and valuable information that will provide a deep insight into the understanding of how teachers can integrate indigenous knowledge systems (IKS) in the design process activities when dealing with ESD.

I obtained your contact details from the district curriculum advisory section after discussing the research objectives and describing the caliber of participants we are looking for to participate in the research process. We took the POPI Act, no 4 of 2013 into consideration. You are one of the 10 teachers from Ehlanzeni districts identified to participate in this study. Confidentiality, privacy, and anonymity of participants will be highly upheld. No photoshoot or video recording will be administered during the study

without the consent of participants. The participants have a right to participate or not to participate in the study, they can withdraw at any stage of the study. This research will prioritise observance to Covid-19 protocols and regulations, and this matter will be discussed in-depth with all prospective participants in this study. There will be no reimbursement or incentives for participating in the research.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study will require you to participate in structured interviews, observation, and document analysis. Regarding structured interviews, you will be interviewed about:

- your understanding of ESD.
- your understanding of the relationships between content and strategic knowledge that involve strategies to integrate IKS when teaching about ESD.
- the strategies you use to teach Technology from IKS perspectives.
- your knowledge of the subject from the IKS perspectives.
- the successes and failures of your strategies to plan and teach Technology; and
- your contribution towards the development of a framework to guide the effective integration of IKS in teaching the concept ESD.

You will be expected to dedicate 30-40 minutes of your time to face-to-face structured interviews.

The lesson observation will comprise the learning environment; subject content; teacher and learner participation; teaching strategies, interactions, and type of activities that includes the aspects of ESD from an indigenous perspective; and teacher and learner lesson reflections. Document analysis will be carried out on the learning and teaching support material (LTSM), i.e., textbooks, pacesetters, learners' workbooks; workshop/training materials and lesson plans.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

You will gain an insight on how to integrate the IKS in realisation of ESD in the teaching of TE contents. Furthermore, the research findings will be communicated to the participants, schools, and the Department of Basic Education in the form of feedback or a digital copy of the report. The study recommendations will also be presented to help improve practice in different contexts than this. The benefits can only be realised through interacting and engaging in the research process with me as the researcher.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There will be no negative consequences as the interview and observation will be done based on the information to be gathered through interviews, non-participatory observation, and document analysis. The consent form should be submitted. This research will prioritise observance of Covid-19 protocols and regulations, and this matter will be discussed in-depth with all prospective participants in this study.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research **OR** Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

My supervisor and I will be the only ones to have access to the data and will maintain confidentiality as from the beginning. We will not disclose your name, even on recording there will not be any mention of your name. The reports will only show the name of the district. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

The outcome of this research may be presented to the research report, journal articles, and/or conference proceedings. In instances such as mentioned, you will not be identifiable as only codes will be used to report the findings.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Soft copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at Unisa, office duplicate in various storage facilities, the external hard drive that will be accessible by me and the supervisor for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. In the event where data should be discarded when it will have a sell-by date the following methods will be used, in case there are hard copies will be shredded, and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Under normal circumstances, there will not be any reimbursement or incentive through participation in this research process or study. In the unforeseen circumstances that due to Covid-19, restrictions are enforced up to a point we cannot do face-to-face interviews, mobile data will be provided strictly to enable participation in a virtual platform.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the (*identify the relevant ERC),* Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Ms. P Blose at 0124296174 or email eblosep@unisa.ac.za. The findings can be accessible after 6 months from the day the field research will be concluded.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Ms. P Blose at 0124296174 or use the email eblosep@unisa.ac.za.

Should you have concerns about the way in which the research has been conducted, you may contact the supervisor, Prof MT Gumbo, on the email gumbomt@unisa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

_____

(insert signature)

_____

(type your name)

CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interviews and lesson observation

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

_____

_____ _____

Participant Signature Date

Researcher's Name & Surname (please print)

_____

_____

_____

Researcher's signature Date

APPENDIX K: TEACHERS' INTERVIEW TOOL

1. The CAPS Technology includes the term indigenous technology. What is your understanding of this?
2. Do you regard yourself as an indigenous person? Why?
3. Indigenous technology is related to the term, sustainable development. What does sustainable development mean?
4. What is sustainable development as it relates to African indigenous people?
5. What, then, is education for sustainable development?
6. What opportunities (if any) does Technology present for you to integrate indigenous technology/knowledge?
7. How could you use the incorporation of indigenous technology in Technology as a subject to teach towards Education for Sustainable Development?
8. Does the current content of the Technology subject incorporate indigenous technology?
   - 8.1 If yes, please provide examples.
   - 8.2 If no, what do you suggest could be done to ensure that it does incorporate indigenous technology?
9. The teaching of technology encourages learners to collaborate and work as a team in their learning activities. What opportunities do these teaching approaches present for you to:
   - 9.1 promote the incorporation of indigenous technology?
   - 9.2 transform Technology into education for sustainable development?
   - 9.3 consider Ubuntu in your teaching activities?
   - 9.4 promote the CoP in your practice?
   - 9.5 engage learners in design and problem-solving activities that relate to their cultural contexts?
   - 9.6 prepare the design activities for learners such that they can co-construct technological knowledge?
   - 9.7 relate design scenarios to the learners' cultural contexts?
   - 9.8 involve indigenous knowledge holders in the teaching of learners?
10. Do you think there should be a framework that can guide Technology teachers to integrate indigenous technology in their lessons? Why?
11. Is there anything else that you want to say which is not covered in this interview?

APPENDIX L: CURRICULUM SUBJECT SPECIALIST'S INTERVIEW TOOL

1. The CAPS Technology includes the term indigenous technology. What is your understanding of this?
2. The related term to indigenous technology is sustainable development. What does sustainable development mean?
3. What is education for sustainable development?
4. What is sustainable development as it relates to African indigenous people?
5. How would you relate Education for Sustainable Development to Technology as a subject?
6. Is Education for Sustainable Development included or implied in the CAPS Technology? Please, explain.
7. What opportunities does indigenous technology present for teachers to teach for education for sustainable development? Give examples.
8. Do Technology teachers' workshops incorporate indigenous technology?
   8.1 If yes, explain how.
   8.2 If not, explain why.
   8.3 How could the workshops be designed such that they promote teaching for sustainable development?
9. From your experience as you visit classrooms for support, how do learners receive the integration of indigenous technology?
10. What mechanism do you put in place to ensure that teachers are assisted to realise the importance of indigenous technology integration in their teaching activities?
11. How could you assist teachers to approach their design activities such that they:
    11.1 plan the design scenarios that relate to the learners' cultural contexts?
    11.2 promote interaction with indigenous communities?
    11.3 promote the incorporation of indigenous technology?
    11.4 Inculcate the principles of Ubuntu, especially considering collaborative and teamwork activities that the Technology subject relies on?
    11.5 promote the CoP in their practice?
12. Do you think there should be a framework to guide you in achieving the incorporation of education for sustainable development in your planning for teacher support?

12.1 If yes, what are the suggested elements that can be included in such framework?

12.2 If no, elaborate further.

13. Do you have anything more to say?

APPENDIX M: CLASSROOM OBSERVATION TOOL

Lesson Presentation Observation Tool			
Before:			**Comments (check incorporation of indigenous technology)**
Prior review Grade: Lesson topic: Lesson objectives/outcomes: Duration of the lesson:			
Access to the classroom Seating arrangements (e.g. rows, circles, groups, etc) Number of learners Space for easy movement			
Classroom setting	**Yes**	**No**	
Conducive for teaching and learning:			
Learning environment clearly defined:			
Teaching and learning resources Is/are there materials and or resources available that reflect ESD? (e.g. incorporate indigenous technology, indications of indigenous technology in the materials)			
Is there any teaching material besides textbooks used, e.g. artifacts which represent indigenous technology? Is/are the materials and or resources relevant to sustainability and or Sustainable Development Goals?			
During the lesson:			
What is being taught as it relates to indigenous technology?			
Is the lesson topic clear?			
What appears to be the main purpose of the lesson?	**Yes**	**No**	
Learning a procedure			
Application of a concept			
Learning new knowledge Revising/reviewing work already covered			
Learning environment:	**YES**	**No**	

Lesson Presentation Observation Tool			
Before:			**Comments (check incorporation of indigenous technology)**
Does the learning environment: promote socio-cultural interaction among learners and knowledge sharing?			
promote indigenous technology?			
promote collaborative learning and teamwork?			
encourage the use of culture towards the articulation of knowledge and skills in relation to indigenous technology?			
Teacher: Are the tasks appropriate to the Grade being taught?			
Does the teacher interpret and elaborate the information based on learners' contextual experiences (indigenous technology) in promoting ESD?			
Learner involvement: Learners participate actively during the lesson			
Subject content competence:			
Does the teacher demonstrate the depth of knowledge of the subject content?			
Are the content and methods adapted to the learners' Grade and socio-cultural context?			
Do the teacher's approaches to the subject matter help the learners to understand different aspects of the subject content in relation to their socio-cultural context?			
Does the teacher classify all types of knowledge and skills to cater to local knowledge (indigenous technology)? Does the teacher expand the opportunities for learners to relate the content to day-to-day experiences in their communities so as to accommodate ESD?			
Teaching strategies, interactions, and activities:			

Lesson Presentation Observation Tool			
Before:			**Comments (check incorporation of indigenous technology)**
Which teaching method(s) does the teacher?			
Does the teacher engage the teaching and learning strategies that promote indigenous technology?			
Does the teacher offer information and insights beyond what is available in the class? (notable examples).			
Does the teacher allow the learners' contributions or adapt methods to accommodate indigenous technology?			
Do the developed activities help to promote a community of practice (CoP) and integration of indigenous technology in the classroom?			
Does the teacher motivate learners to use their local knowledge in the learning of ESD?			
Are the learning barriers towards integrating indigenous technology identified and addressed?			
After the lesson:			
Are lesson objectives met?			
Are the learners' abilities to complete the activities in line with indigenous technology supported?			
How do the learners deliver proof of learning? (i.e., written or oral task).			
Does the general lesson presentation suggest improvements in the next lesson?			

APPENDIX N: DOCUMENT ANALYSIS TOOL

Document description: _____Grade: _____

Item	Yes	No	Comment(s)
1. The document emphasises combining concepts and the general principles that resonate with the socio-cultural context of learners.			
2. The document fully addresses aspects of ESD related to indigenous ways of living			
3. The document suggests a central role of a teacher to diversify knowledge and skills to cater for indigenous technology.			
4. The document largely draws awareness to the need to teach the subject content knowledge in relation to ESD			
5. The document clearly emphasises the context that shows the influence of the local knowledge (indigenous technology) on the development of the concept ESD			
6. The document offers teaching alternatives and effectively gives room for the teacher to develop his/her own material that promotes the integration of indigenous technology to cater for ESD			
7. The document takes into consideration the incorporation of ESD.			
8. The document promotes interest into local knowledge (indigenous technology) and socio-cultural context in the teaching and learning of ESD			
9. The document offers ample opportunities for the integration of ESD			
10. The document promotes a substantiated involvement of the ESD concept towards its incorporation			

APPENDIX O: SAMPLES OF TEACHERS' INTERVIEW TRANSCRIPTS

Teacher 3

Researcher

Once more, thank you very much for allowing me to interview you. So, it's much appreciated. As I indicated last time this study, it's on the incorporation of education for sustainability in technology within an indigenous context. So, I'm going to start with my first question, which is basically on your understanding what is indigenous technology? Since in the CAPS document, it includes the term indigenous technology. So, what is your understanding?

Teacher

Oh, my understanding is that in indigenous technology is about technology that involves different backgrounds of people. And it also involves how people believe or used to live in the early days, and how they used technology in their own way during that time. That's my understanding about indigenous technology.

Researcher

Okay, all right. Thank you for that. Since you have explained the term, do you regard yourself as an indigenous person? And if so, why?

Teacher

I do not, honestly, I don't. Because I think modern technology has taken over our lives. Our lives revolve around more than technological devices. From Home chores, to traveling to everyday lives. I depend on modern technology, a lot more than indigenous technology. So, I wouldn't consider myself an indigenous person. Okay, yeah, my life depends mostly on the modern technology.

Researcher

Okay, before I move to the next one, since you say, your life depends on the modern one, don't you think that the indigenous way can assist in the modern technology, like solving problems, because we know that back then, our parents, they were solving problems and using technology? Yeah. So, with that knowledge, don't you think it can assist even in the current living,

Teacher

I think it can assist a lot, especially in terms of the amount of pollution that our modern technology is contributing into the atmosphere and the land, the water, so if we, if we can consider introducing indigenous technology in our lives, some of those resources can be reserved, or they can be conserved. We can use them sparingly if you can introduce indigenous technology, I think it can, it can really help. It's just that we, we, we I think we allowed modern technology to take over. But indigenous technology can I believe it can make it can help us. Because sometimes, some of the things, we choose to use modern technology because it's faster. But if you if you think about it, sometimes time is not even a problem. You don't really need to save time, but you may just use modern technology.

Researcher

Right. All right. Then, again, as indigenous technology is it's a term that is related to a sustainable development. I heard you talked about pollution and all that. So really, it confirms that the term is related to sustainable development. So, what does sustainable development mean?

Teacher

Okay, according to my understanding sustainable development, it means to, to improve life, but at the same time conserving the resources that we use that as we improve our lives. That is sustainable development.

Researcher

Okay, so, what is sustainable development as it relates to African indigenous people?

Teacher

African indigenous people, they use resources sparingly, they use them in a way that sustains them in a way that they can last for longer. So, these two terms are related highly related. Because in every way, African indigenous people, they do not misuse resources. They do not misuse resources.

Researcher

Right, then what is education for sustainable development?

Teacher
It's, it's about teaching learners to consider using resources in a way that they can be available in the next the future, that we can still have them in the future for future generations. So, it's about teaching learners how to save the environment is used the resources.

Researcher
okay, just the awareness,

Teacher
actually awareness.

Researcher
Okay, all right, then what opportunities if any, does technology present for you to integrate indigenous knowledge or knowledge?

Teacher
By technology referring to the subject

Researcher
Yes, the subject. opportunities that are there to integrate

Teacher
The indigenous technology/knowledge. I'm not seeing much, but what I can say is that since in technology learners are trained to go through a design process and also go through investigations before they can make or maybe be before they can design any products. So, it gives them the opportunity to investigate if whatever they are planning to do, does it affect the environment, is it environmentally friendly, so, they get the opportunity to actually assess the amount of damage that the product can have on the environment? So, it's some for some extent, it does give the… give us that opportunity to present that to integrate the indigenous technology because when we assess the impact that the product could have on the environment, its whereby we then divert from modern and rather choose indigenous options, so in absolute to an extent it does.

Researcher

Right, right, then how could you use the incorporation of indigenous technology in technology subject to teach towards education for sustainable development?

Teacher
Okay, repeat the question again, for me,

Researcher
Since you said they are opportunities for indigenous technology. So, as a teacher, how can you incorporate indigenous technology towards the teaching of Education for Sustainable Development like making learners aware of Education for Sustainable Development, looking or through the indigenous knowledge, how can you incorporate that.

Teacher
okay. Firstly, when I do… when I design a practical assessment task for learners, I will ensure that there is always a section where the learners are supposed to investigate about the environmental impact of whatever they are planning to do. And then I will also allow learners to investigate about other options which are more indigenous than Morden, which they can go for so in their assessments, I will put a section in that focuses on indigenous part of technology.

Researcher
Okay. All right, then. does the current content of technology subjects incorporate indigenous technology. Then if yes, you can provide examples, if no, what do you suggest could be done to ensure that it does incorporate indigenous technology?

Teacher
Okay. I think it does. It does incorporate indigenous technology, for example, learners learn about the pulley systems, which require more chemical energy, or maybe electrical energy learners do learn about mechanical systems, which also most of the time they don't use any chemicals. They do not emit any poisonous gases. So, it does. But I think that even though it does we, there's more that we can put in the, in the curriculum about indigenous technology, maybe a whole entire topic, about indigenous technology.

Researcher

the teaching of technology encourages learners to cooperate and work as a team in their learning activities. So, what opportunities does this teaching approaches present for you to number one, promote the incorporation of indigenous technology?

Teacher
It gives you an opportunity to present indigenous technology in a way what can I say? Like when the learners work in a team, they get to hear each other's ideas. And in cases whereby one of the learners have an idea about indigenous technology, then in a way the entire group can now be aware in they can now think along those lines. Because most mostly people nowadays their minds have been channelled towards modern technology. So, if the groups the chances of them getting awareness about are higher, because if one knows then, automatically, everyone will know.

Researcher
Okay, then opportunities that presents for you to transform technology into education for sustainable development, opportunities, as learners work in a group.

Teacher
Yeah, so when they work in a group, they I think they are opportunities to transform the technology into education, about sustainable development. Because as they work as a group, they get to discuss about factors that could maybe lead to pollution factors that could maybe things that they can do in order to make their product to be environmentally friendly, as a group, they can get to discuss such things. So, I think it does give us the opportunity to transform this technology into sustainable development, education.

Researcher
Okay, then, the next one, do you consider *Ubuntu* in your teaching activities.

Teacher
And yes, definitely, it does give us an opportunity to consider *Ubuntu,* because in in planning for our practical assessments, learners always have to look at the benefits for the community. There's always a case whereby the learners have to look at what benefits will the community have from whatever they are planning to do so that one is definitely covered? It does give us an opportunity to consider *Ubuntu.*

Researcher

The approaches present for you to promote community of practice in a practice like communal work working together the togetherness as they are solving the problems, learning activities?

Teacher

Yes, definitely because if the learners are working groups, everyone gets to have a part that they are responsible for. So, the, they develop the ability to depend on one another and the ability to ensure that people who are depending on you to get what they need from you. So, they do get to community of practice.

Researcher

Okay, engage learners in a design and problem-solving activities that relate to the cultural context the activities, design and problem solving,

Teacher

okay. So, the opportunities that we have to engage learners in designing problem-solving, problem-solving activities we do have opportunities to engage learners within their cultural context. Because when they…. during the…. design during the design, the learners get to know when they have to write their design briefs, they have to go through every single detail of their design and also to say why they are designing it in that way and consider environmental factors as well. So, yeah, I think it does relate to the cultural context in a way

Researcher

okay. All right, do you prepare the design activities for learners such that they co construct technological knowledge like a as you are designing your activities are their opportunities for you to ensure that learners, they will co construct technological knowledge.

Teacher

Yes, definitely, there are opportunities for that…. are opportunities for that as I mentioned earlier there's a design step in the process, the learners they have to consider the different aspects of design including the drawing the angles Yeah, so, they do use their technological knowledge a lot.

Researcher

So, the scenario since we are talking about the design activities, do the scenarios relate to the cultural context?

Teacher
Yes, definitely because there are scenarios the scenarios are always taken from cases that relates to their lives the only taken from their everyday lives, they are things that they are familiar with things that are part of their lives.

Researcher
So, do you involve the indigenous knowledge holders in the teaching of learners or does it give that opportunity maybe for you to invite in indigenous expect, such as maybe for an example, Dr Esther Mahlangu. she's good in drawings like the graphical drawings. So, is there any opportunity that your teaching allows the engagement of those people?

Teacher
Um, yes, it does. But honestly, we, we never really use that opportunity. But there is an opportunity like that. Because during the practical assessment tasks, for learners, different phases are handed in at different times. In during each course, learners are given the opportunity to consult external resources and teachers are also given the opportunity to invite people from outside as a resource for the learners. So, it does provide opportunity.

Researcher
Okay, so do you think there should be a framework that can guide technology teachers to integrate indigenous knowledge in their lessons and why?

Teacher
yes, I think there should be a framework that will guide us because according to what we have, what we have kind of gives you an idea about indigenous technology, but it doesn't go deep. It doesn't give it a physical framework, which can show us even how far we can go in integrating indigenous technology in our lessons, what examples can we use? Yeah.

Researcher
Then we have come to the end of our interview session. So, is there anything that you feel like it was left in the questioning that you may want to add?

Teacher

No, I'm okay with the questions.

Researcher

No, thank you so much for your time.

Signature  Date: 12.08.2022

APPENDIX P: TEACHER 5

Teacher

See I hope that I'm able to answer the questions and I won't answer something totally different from what you are expecting.

Researcher

Okay. All right. Okay, will see that. Yeah, just be free is just an interview just to understand what is it that you know, and how we can improve the curriculum in order to fit the aspects of ESD, which is education for sustainable development in technology. So, starting with the first question. When we look at the CAPS document, it talks about the term indigenous technology. So, what is your understanding about indigenous technology?

Teacher

Okay, indigenous technology is technology used by the indigenous people of a country. When I say indigenous, I meant, like people from the original people of the country, like the San and the Khoi, the first African farmers, and it's, it was fairly useful and cost effective. And as compared to modern technology today.

Researcher

Okay, all right. That's good. So, as you indicated, what is the indigenous technology? Do you yourself perhaps as an indigenous person? why?

Teacher

okay? No, I'm not. Okay. I'm South African. I was born in South Africa. But I believe that the indigenous people of South Africa were not Indians. They were like I mentioned, the first African farmers, the San and Khoikhoi. So basically, I don't see myself as being an indigenous person. But I do respect it. And if I need to teach learners based on the indigenous culture, then there's no problem there.

Researcher

Okay. All right. Then, the indigenous technology its related to sustainable development. So, what does sustainable development mean?

Teacher
Sustainable development is when we try to strengthen or support our economy or our country, using various factors, right, and some of them is how we use the sun's energy to create solar power, or we use the wind energy to create electric turbines or even windmills, which is also is trying to save is cost effective for the economy, and also electric transports to try to avoid emitting dangerous and harmful fumes and causing air pollution. That's another thing to sustain development in our country.

Researcher
Okay, thanks. So, what is sustainable development as it relates to African indigenous people?

Teacher
Okay, the first farmers made use of pastoralism right and growing of crops. So, they relied on sustainable development for survival. Right. And the San and the Khoi Khoi also hunted and gathered, as well as the fished. So, they did very little to damage the environment. So, the indigenous people, when it came to sustainable development, they basically did very less to harm the environment. So, it was good.

Researcher
Okay. All right, then what is education for sustainable development, then?

Teacher
Education for Sustainable Development is teaching learners about many issues, such as poverty, pollution, the scarcity of water, and what we can do to avoid it for the future generations.

Researcher
Okay, then, what opportunities if any, does technology present for you to integrate indigenous technology or knowledge?

Teacher
Okay, let's use recycling for example, right? Indigenous people made use of grass and sticks to create their temporary houses or huts. Also, pottery was created by the indigenous people, which is world famous today. So, we can teach the recycling which

is there's a big need for it in today's society, and also pottery, and those types of stuff that came from indigenous people.

Researcher
All right, then, how could you use the incorporation of indigenous technology or knowledge in technology as a subject to teach towards education for sustainable development?

Teacher
Okay, let's use recycling as an example. Right? So, teaching of recycling is part of the curriculum for Grade seven (7) technology. It is also linked to indigenous technology. So, recycling as in turning old scrap into new reusable items helps to keep the environment clean. And that is how we slowly reach towards the goals of sustainable development. And
then does the current content.

Researcher
But I hear spoke about recycling. So, I just want to confirm again, does the current content of the subject incorporate indigenous technology?

Teacher
It does, like we say recycling. Plus, also in term four (4), they talk about indigenous dwellings, such as the San huts, the traditional Zulu huts, and those type of technologies that they use in the past and we compared to today,

Researcher
okay. So, the teaching of the subjects encourages learners to collaborate and work in groups in their activities. So, what opportunities does it present for you to promote indigenous knowledge or a technology in your teaching,

Teacher
okay, in groups of three or four, they can all be given clay to create something that was made and used by the indigenous people, such as clay pots or jars, that can store water or grain, they can add some traditional designs to it, to also give it that whole traditional effect. Yeah.

Researcher
Okay. All right, then, again, what opportunities does it present for you to transform technology into education for sustainable development.

Teacher
okay, so then here in groups, we can allow learners to collect material such as cardboard, plastic, paper, metal, and then they can collaborate in that groups and make something new out of that old scrap pieces that they brought, such as candle holders, they can make jewellery items with metal, they could make stationery holders, and which plays a major role in sustainable development.

Researcher
Okay, all right. That's good. Then what opportunities does it present for you to consider *Ubuntu* in your teaching activities?

Teacher
Okay, *Ubuntu* is togetherness right. Okay, so group work allows learners to work together in an understanding non-judgmental, and respectful manner. So, they assist each other within the group showing compassion when needed. All of these are the basis of *Ubuntu* in a teaching and learning environment.

Researcher
Okay, then again, what opportunities does it present for you to teach or to accommodate community of practice in your teaching?

Teacher
Okay, while learners are busy with group work, other teachers with similar ideas or roles and responsibilities as me, they can come in and share their ideas based on the topic that learners are working with them. And we could all share our ideas and get a better understanding of the topic. That's how we involve community of practice.

Researcher
Okay, all right, then, do your design and problem-solving activities engage learners in such a way that they will relate to their cultural context?

Teacher

Okay, we said that, when we talk about cultural context, we can talk about people from the past, but bring in also some indigenous knowledge right. So, we can say like, we can ask learners to design a kraal like in a rural settlement, to house cattle in a rural cultural context. And by designing a kraal, they will be solving the problem of cattle getting loose and running away. The kraal must be made using sticks, it must be safe, user friendly, spacious, yeah.

Researcher

Okay, then the design activities that you prepare for learners, allow them to co construct technological knowledge.

Teacher

Okay, in groups, learners will co construct technological ideas of how to separate magnetic metals from non-magnetic metals. This is also part of the curriculum, right? And so, in a scrap yard, there's a whole lot of metal. So, learners will have to give ideas of how people will be able to separate the two from non-magnetic to magnetic, and they will eventually come to a conclusion. That's an electromagnet attached to a crane can do the job successfully.

Researcher

Okay. Then, again, does the design scenarios relate to the cultural context?

Teacher

Okay, yeah, not about the electromagnet or the kraal, well giving another scenario of learners can make use of colour mosaic, I do understand that mosaic is part of the culture, in the past that has had this beautiful mosaic and they were with different colours and things. So, it does come in with the cultural context, right. So, I decided that colour mosaic is part of the learner's cultural context. So, in groups, learners can listen and make notes of scenarios in which informal settlements catch on fire very easily, very often, so learners can come up with ideas on how to decorate houses. with anti-fire paint and add some beautiful mosaic patterns on those houses to give it a nice, aesthetically appealing effect. So those houses will be much more safer to stay in. And also, they've been looking much more beautiful. Yeah.

Researcher
Okay, so in your teaching, do you perhaps involve indigenous knowledge holders? Like for instance, we are having the well-known Doctor Esther Mahlangu. We know her of her works like graphics and all that. And she's using her own knowledge in order to come up with those graphics. So, do you perhaps involve such people?

Teacher
Or at the moment? No, but we can, like I was thinking about when learners need to learn about different farming methods and whatever we can get in a lot of farmers as well. People, older farmers, who has a lot of knowledge based on indigenous technology and modern technology, whereby they can come in and speak to learners about how they can do farming, ensuring less damage to the environment while benefiting from the fertile soil. So, in that way, in terms of technology, learners will know how to make use of technology but in a safer way. Yeah,

Researcher
Okay. All right, then do you maybe I think that there should be a framework that can guide technology teachers to integrate indigenous technology in their lessons and why.

Teacher
Okay, I yes, it can educate learners on various range of skills that can be taught; however, it must be taught practically, rather than theoretically, there's no point sitting and showing them notes to see practice in order to gain that knowledge. And for example, how farming was done in the past using indigenous technology, how they use the ox plough, rather than tractors, things like that. So, it shows them the difference.

Researcher
Okay, so, do you think there should be a framework?

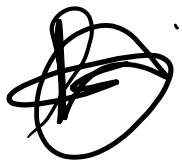
Teacher
Yes, yes. Yes. Yeah, there should be a framework that will bring practicality in the teaching.

Researcher

Okay. All right. Then is there anything else that you want to say which was not covered in the interview?

Teacher
Okay, yes, I say that indigenous technology is important, as it allows individuals to see how things were done in the past and how it was associated to sustainable development, as compared to technology today, learners will also see the advantages and disadvantages of modern technology as compared to indigenous technology. You see, indigenous technology had many advantages and very less disadvantages, but modern technology today, it makes life easier for people, but at the same time, in the in the long term, there is some sort of disadvantage that causes maybe health issues or whatever to an individual. And so, I feel that it is good to learners also need to see and they need to compare indigenous technology as compared to modern technology.

13:10
Okay, all right. Thank you so much.



Signature Date: 07.09.2022

APPENDIX Q: INTERVIEW TRANSCRIPT FOR CURRICULUM SUBJECT ADVISOR (CSA)

Researcher

Sometimes it does some something else. So, I want to catch everything on my phone. So, my, my recording it's on. So, I think we can start with our interview session.

Researcher

First and foremost, let me again, appreciate you for your time. It's much appreciative. So, we are going to start with our first question, the CAPS document, if you check, it includes the term indigenous technology. So, what is your understanding of this term?

CSA

Okay, what I understand about indigenous technology, it is about the technology that was used even before…. By um, let me say in general about a group of people in a community of some kind, where they were using this in their indigenous knowledge. And have you with us in technology, when we deal with indigenous technology, we're looking at how things were done before and how they've improved now, for example, let me just give you an example of a pulley system that was used in the olden days, when they used to draw water from the well, they would tie a bucket. And then they would spin the wheel down then they get the water and spin it up. So, I think if you can ask our grandparents, what was that… they will not tell you about the pulley system, that it is a pulley it must have this and that, all the mechanical systems, but they did it. So yeah. So that was their way. Their own technology Yeah, their way of solving problems using the indigenous ways. For example, the issue of preserving food, it was indigenous technology, because it was solving a problem. Yes, yes.

CSA

In their homes? Yes.

Researcher

Okay. Thank you so much for your response. Then the next one, the term, indigenous technology, it relates to sustainable development, then what does sustainable development mean?

CSA

To me sustainable development, it means it is a principle for meeting human needs, as I've indicated that even the indigenous technology was to meet human needs and to solve problems. So, it is a principle of meeting human needs, meeting human developmental needs and goals. But making sure that we are sustaining the natural resources, while we are still providing for the human needs without undermining the natural system, the way the natural system works.

Researcher

Okay, all right, thanks for that. What is education for sustainable development then?

CSA

When we speak of education for sustainable development, it is that education is about teaching and learning in simple terms.

CSA

So, is that we include this key sustainable development issues into our teaching and our learning. As I've indicated that whatever that affects our natural resources or environment or our society, it has to be taught because knowledge is power, if you want some, if you want people, if you want people not to do anything bad, they must know the effects and the aftereffects of that thing, but if they don't know, you know, ignorance is very, very dangerous. So that's why this topic like climate change, we're dealing with them we were dealing with the issue of biodegradable that is, those are the topics that we have in technology, you know, yeah, those are the issue of electricity. You know, we're dealing with electricity. We don't only deal with the content part but how does it affect the environment, what are the dangers? What can we do in order to sustain all those things. So, it is in simple terms, it is including this key sustainable development into teaching and learning. Okay.

Researcher

Alright, thank you so much for that response again, then since you spoke about sustainable development as being the way in which we sustain our environment, what is it? What is sustainable development relating to African indigenous people?

CSA

Okay, when it refers to our African, our African indigenous people, if you can see that our indigenous ways, let me not say 100%, but it was rare that they will have a negative

impact on the environment the way they did those indigenous ways. So, when it comes to the African indigenous people, sometimes we are ignoring that society because we still have even those who that will call that their indigenous people. And what makes us not to, to recognize them? Is that that information about our African indigenous ways and the people that are still a practicing those things, our, our, our children, they're not exposed to that.

CSA
Yeah, they, I think their exposure is not that much. I believe that my children, if we can ask them about that. It's something that they've seen on TV once or twice, and also thinking about it, but if it is exposed, and it is also, as I was saying that it should, and it needs also to be covered in our curriculum, it needs to be covered even in different subjects. Not only in certain subjects, so I'm not sure other subjects, but if it can be done in all subjects. For example, in social sciences, we know that they might be dealing with that, but also in EMS doing this should be the very same thing just like that. When it comes to the economic part.

Researcher
Yeah, okay. All right. All right, then how would you relate Education for Sustainable Development to technology as a subject?

CSA
Okay, to technology as a subject, I can say that we have tried in technology, because as we aware we got three strands in technology, I mean specific aims. We have three specific aims. So, the third one is about it also includes the issue of the… I will say it relates more to sustainable development, because it is about the impact of technology, the indigenous knowledge, and then also the biases. So, I can say that there is a relationship there. And then also the fact that even our question papers. and then we are teaching it is there how to reduce the negative impact of technology on the environment. And then, so also looking at the ecological risk. For example, we have got plastics in Grade nine (9).

CSA
We look at the plastics, we don't only look at the uses of plastics and the types of plastics but how can we reduce the impact of plastics on the environment? And then also, we look at the issue of substitution. What can you use to substitute plastic that why we have this thing of reduce, reuse? And then the issue of prevention, how can we prevent the

contamination of the environment through plastics. And then also, we also have got the issue of the alternative energy sources that we are doing in Grade 8 when it comes to the efficiency and the efficient use of energy. So, I think we there.

Researcher
okay, so it does relate to education for sustainable development through your explanation.

Researcher
Okay. All right. Then, is education for sustainable development included or implied in the CAPS document? Yeah, you can explain if it's included, or it's not, or yeah.

CSA
As I said that education for sustainable development is where we are dealing with these things that are affecting even our environment and our society, I think that it is included. And also even our assessment, it has been divided into three parts, one activity, for example, if it is a test 20% it should be about the impact of technology, the indigenous and also the biases in technology. So, I think we have, because now educators, they don't have a choice, either they want to teach it or not because it is part of the assessment.

Researcher
Okay, all right, then, what opportunities does indigenous technology present for teachers to teach for education for sustainable development? You can give examples

CSA
Yeah, indigenous technology it present but I think with us, the challenge that we have I don’t think that our educators they even know that what we are doing is for sustainable development. Yeah, they just understand that is just part of the curriculum

CSA
Then this what do we need to do

Researcher
Yeah, yeah. Yeah. Because if they don't understand there's no way in which, they'll be able to do that. So, I think that appears also as a gap
Researcher

Yes. Okay. All right. Then, do technology teachers workshops, incorporate indigenous technology, if yes, you can explain if not explain why. And also, how could the workshops be designed such that it promotes the teaching of a sustainable development within an indigenous context

CSA
our workshops to be honest, we focus more on the content and then when it comes to the sustainable development, as I've indicated that the environmental part, the economic and also the social is just a small part in our curriculum. So, yeah, so it depends it depends on it mainly depends on the on the on topics that we are supposed to cover. For example, now we had workshops. It was for Grade eight (8) and Grade nine (9), Grade nine we are dealing with the electronic systems.

CSA
Although our practical assessment task, practical assessment task it is about solving a problem for a community. I can say that it relates to the social but as I've indicated that we do it as an… as an

Researcher
yeah,
partially,
CSA
on top actually. Meaning you don't go deep. Yeah, we don't go deep. Just an introduction of some kind, okay.

Researcher
All right then.

CSA
because I don't even remember, when we're doing our PAT where we most of the time we incorporate indigenous technology, its rare. We are dealing more with this technology and not the indigenous one, honestly.

Researcher
Okay. Yeah. All right. Okay. So even like the workshops when you do the workshops are not? Are they designed in such a way that it promotes teaching for sustainable development? Or the focus is more on what is there or what is presented by the content?

CSA
Yes, the focus is more on what is presented by the content. As I'm indicating that, for example, even some of these things, the practical's, some of them are prescribed that we have to, for example, in Grade seven, but what we're doing is promoting that is just that we are not aware; you know when you are doing something meanwhile you are not aware. Yeah, yeah.

CSA
You are doing it, but you are not aware. Yeah, that you are doing it. So, you miss some of the important aspects.

CSA
Yes, we are, I can say yes. But if you can ask one of the educators about the sustainable development, I think would say we don't know, but for example, in Grade seven, we are making a crane. What is this crane used for? It is used to attract metals when the when, when they are doing this thing of recycling it Yeah, it's about that.

Researcher
Yeah, yeah. No, I understand.

CSA
Okay, I think we need to take it back again to them.

CSA
Yeah, to conduct them in a way in which teachers will be aware of sustainable issues.

Researcher
Okay. All right. Okay, then from your experiences as you visit classrooms for support how do learners receive the integration of indigenous technology if there is that opportunity to have the integration.

CSA
To be honest, I've never done a class visit where there was that integration of indigenous technology, I would be lying if I said I have observed in I may be forgotten, because since COVID we no longer doing the class visits

Researcher
Oh,

CSA
I think that one no,

Researcher
Okay, then, what mechanism do you put in place to ensure that teachers are assisted to realize the importance of indigenous technology integration in their teaching?

CSA
Yeah, what I think here, when we are having our workshops, as I've indicated, we also touch the issues of the indigenous technology and also the integration in their teaching activities. yeah, we encourage them.

CSA
We encourage them, as I've indicated that this indigenous technology is part of our specific aims. Okay. All right. But what I've realized, is that….is only when I visit schools, we find that most of these learners, they they're not performing well. When it comes to it. So, we've realized that it means that we have to put more effort on the issue of the indigenous. Yeah, yeah. No, okay maybe it will assist the lot in their learning because basically it's about things that are happening in this society of which they are exposed in their daily lives. So, maybe they can assist the lot.

Researcher
okay then the next one, how could you assist the teachers to approach their design activities such that they plan design scenarios that relate to their learner's cultural context?

CSA
Okay, with that one we I think, we, we, we, we when they give the scenarios for the PAT, we tell them that you must give a relevant context for the learners and also, it must also the issue of culture is very, very important. for example, you cannot say to a child who is in the rural areas in Grade nine, we're dealing with electronic systems and then this is from an experience that I have one of the educators give a scenario about the irrigation

system that it will be controlled by also checking about the humidity. So, would use a water sensor what and then when I said you know, you know what, this is not, you know, these learners in deep rural area, they cannot even understand what you are talking about so, we need to give scenarios that are relevant to them. And also, the issue of culture.

CSA
There is this scenario that we have for Grade seven, where, for example, where in term four where they are dealing with the natural disasters, and then the issue of people moving from their countries because of war, we try to explain to the educators that let us try not to, to use a scenario say that would say Zimbabwe's, Mozambicans because our classrooms these days, for example, we are around here in Bushbuckridge there are so many Zimbabwe's learners in our classrooms. So yeah, so if you use those terms, you know, you know learners. So, that one we are trying that the scenario should not be bias should not be even exposing other learners to humiliate. Yeah, and also the, it should not be undermining other people's culture.

CSA
It should not be promoting other people's culture, because others would feel that they…they are being undermined so our scenarios, in in general, we encourage educators to use relevant, the context should be relevant, for example, as I've indicated with our, our electronic systems, we said use a day and night switch you know, in the villages these days we do have street apollo lights. So, they will know that one switch it on it will switch off, they can see they can relate to that, and also the issue of this one, as I was talking about the one of Grade seven, when we're dealing with these gleaners because we speak about the gleaners, let us not speak negatively about them because some of the parents of these learners. They are gleaners they collect all scrapes. So, if you will stand in front in the classroom, so you know cleaners they steal they do what you just look at the negative impact but being careful.

Researcher
Okay. All right. Then next, how could you assist the teachers to approach their design activities in such a way that it promotes interaction with indigenous communities.

CSA
Okay, I think this one as I've indicated it is with us, it depends on the. It depends on the community where you are. And we, we, we try that let them also look at this indigenous

knowledge and then also if you're looking at indigenous knowledge, there's no way that you cannot look at the indigenous of the community.

Researcher
Okay, yeah. All right, then another one. How could you assist the teachers to promote the incorporation of indigenous technology? But I guess maybe is the same response to say that you encourage them to make reference to their learners' cultural context not in a way in which it will cause a biasness, but they need to reflect. So, I guess it's the same response. I don't know if maybe you want to add from my understanding,

CSA
no, I did that is the same response.

Researcher
okay. All right. Okay, then again, how could you assist the teachers to approach their design activities in such a way that they incalculate the principles of *Ubuntu* like especially considering collaborative and teamwork activities as the subject encourages group work and also collaboration or collaborative learning?

CSA
Okay, I think we we've, we, when it comes to our practical activities, we are we are dealing with group work and then on now on that those skills are being developed, for example, the issue of cooperation, the issue of respect, you know, respecting other people's ideas, respecting other people's inputs, for example, we do have activities where learners they come with the initial ideas, and then after they meet as a group and then they choose the best. Yeah. So, in that way, it needs cooperation as one of the principles of *Ubuntu* and then it also needs respect as one of the and also teamwork and also needs collaboration, because at the end of the day, they have to work together to make sure that the assessment all the aspects of the assessment are covered, and they know that they also rely on one another.

CSA
Because that one, it also helps learners, because some of the learners are not good when it comes to the academical part. They are good in drawing. Yeah, all the different learning styles, they are being incorporated and also even the intelligences, there used to correctly, because they are cooperating.

Researcher
Okay. All right, then, again, how could you assist teachers to approach their design activities in such a way that they promote the community of practice in their practice?

CSA
I think our practical assessments, as I've said and some of the activities that we do is apart from that …we are lucky that it has that aspect where for example

CSA
I'm not sure whether I understand it correctly. The community of practice in the practice but what I think I understand about it, is that it still deals with people working together.

Researcher
Yes, it's the same thing.

CSA
our learners for example, in Grade nine they do a tender and then there is also a tender board. A tender board where they've got to go and present so, in that way they're being exposed to those things. And, and they, it helps them also to connect with other stakeholders in education. Because when we tell them that go and ask you have your family members who have tenders, for example, they have to do a budget, they have to go and ask around the, for example, how to do a budget also, if it includes the issue of engineers go and research how to engineers work, what is their salary, how are they paid per hour. So, I think in that way, it includes even other stakeholders as they are doing their research as they approach it, and then also even the educators, I think with that one, they are able to assist these learners on Okay, now we have to work with these people, for example, when it comes to illegal connections, when we're teaching about illegal connections in electricity, we're dealing, it also includes the issue of law enforcement, that they have to find out. What are what, when it comes to law enforcement, what is it about with illegal connections?

Researcher
Okay. All right. Thank you so much for your responses. I think we are almost done. So, do you think there should be a framework to guide to assist you in achieving the incorporation of education for sustainable development? In your planning for teacher support? If yes, what are the suggested elements that can be included in such framework? If no, you can elaborate?

CSA

I think definitely, definitely. Yeah. The first thing that it needs to be included, there it is in the term itself, sustainable development in the framework, as I've indicated, and then also, even the aspects of the sustainable development, how it is integrated and how it links to the subject. I was saying even the term sustainable development, if it can be included, and then also that the, the, even the aspects of sustainable development, they need to be a to be there. Okay, I'm talking about the five pillars, okay. So, that we can do it consciously. And the types, you know, we do it consciously know that there is this or do we are we are dealing with distinctive areas. Okay. All right. So, the five pillars maybe if you can mention them.

CSA

I'm talking about the economic, the environmental and the social, because with us, it is there in the policy document, but we're thinking that we are doing it for technology, you know, not broader in a broader context. Yeah, yeah, it. in a broader context, it is there, as I'm saying, but you know, we if you can go and ask an educator, they will not be able to link these things correctly. So, if there can be a framework, if it can, it can at least give a broader information. Although, I would say now, my eyes are open and I see that it is us, as subject advisors, who need to take this to the educators in a broader form.

CSA

Yeah.

Researcher

All right. Okay. Thank you once more, do you have anything more to say? Which you feel it was not covered in the session?

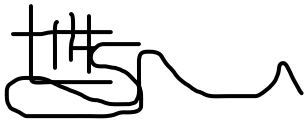
CSA

Let me say thank you very much for the opportunity, you know, it was an eye opener for me. I think it is covered everything. To be honest, I think now, my workshops the way we plan our workshops, you know, it will be different because I'll be conscious of the sustainable development and also with the issue of the indigenous technology. Now, I will understand the why do we have to put more emphasis on it. And also go and look into it and read further on these issues, so that when I go to schools, I will be able to

assist our educators on how to promote and incorporate indigenous technology, and then also the issue of sustainable development.

Researcher

Okay, all right. Thank you so much. I really appreciate your time. The way it is, I feel like we can go on just to talk about these issues. But I hope on my side, when I'm done with the study, I will come up with a something which will assist a lot and hopefully we will continue to engage to ensure that these aspects are recognized in the subject. So, when I'm done with the everything, the analysis definitely I'll come back to you with an update and see how we can take this forward. So, thank you so much.



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APPENDIX R: EDITOR'S CERTIFICATE

EDITING AND PROOFREADING CERTIFICATE

7542 Galangal Street

Lotus Gardens

Pretoria

0008

03 February 2023

TO WHOM IT MAY CONCERN

This certificate serves to confirm that I have language edited P Blose's thesis entitled, **"Incorporation of education for sustainable development in Technology Education for indigenous context."**

I found the work easy and intriguing to read. Much of my editing basically dealt with obstructionist technical aspects of language, which could have otherwise compromised smooth reading as well as the sense of the information being conveyed. I hope that the work will be found to be of an acceptable standard. I am a member of Professional Editors' Guild.

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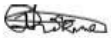

Dr Jack Chokwe (PhD)

Contact numbers: 072 214 5489

jackchokwe@gmail.com

Professional EDITORS Guild

Jack Chokwe
Associate Member

Membership number: CHO001
Membership year: March 2022 to February 2023

076 471 6881 / 072 214 5489
012 429 3327
jackchokwe@gmail.com
www.academicproeditor.co.za

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