SENIOR PHASE TECHNOLOGY TEACHERS' INTEGRATION OF INDIGENOUS CREATIVE DESIGN PROCESSES IN SYSTEMS AND CONTROL

by

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DECLARATION

I declare that the thesis titled "*Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control"* is my work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

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Elliot Charles Ndlovu

JUNE 2023

DEDICATION

I dedicate this project firstly to God Almighty who carried me through the challenging times of this project. Secondly, to my late mother Mvuyazi Linah Mthethwa, and late brother Mbango Isaac Silence Ndlovu, whom both never lived to witness this groundbreaking achievement in our family, may your souls rest in eternal peace.

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ABSTRACT

The body of literature in this study shows that the conceptualisation of Technology in comparison with other subjects, was first in the Western contexts and infiltrated the non-Western contexts ultimately, which are generally described as indigenous. In addition, Technology changes concomitant to human needs due to societal developments. In South Africa, the Curriculum and Assessment Policy Statement (CAPS) is informed by the human rights principles on one hand, and the dominant Western knowledge systems that front the development of the Technology and its curriculum. The principle of valuing indigenous knowledge systems (IKS) in CAPS traced through the aspect of indigenous technology in the technology, society and environment strand plays a pivotal role in this study. It is in this light that this qualitative case study investigated how Senior Phase Technology teachers integrate IKS in the creative design process activities when teaching Systems and Control content. The study was grounded in the situated learning theory and its augmenting theories of legitimate peripheral participation, community of practice and cognitive apprenticeship which contributed to shaping the data collection protocol. The study was conducted in Ehlanzeni and Nkangala districts of Mpumalanga province. Twelve (12) Senior Phase Technology teachers who consisted of six (6) novices and six (6) experienced teachers, four (4) learners, and two (2) curriculum advisors were purposively selected to participate in the study. Data were mainly collected through semi-structured interviews, document analysis and observations, which were analysed thematically. Six (6) themes emerged, which are (1) Technology teacher's understanding of IKS; (2) Opportunities that the third IKS-inspired specific aim presents; (3) Technology teachers' attempt to integrate IKS; (4) Learners' grasp of the integration of IKS; (5) The kind of support that subject specialists give to teachers; and (6) The framework for the effective integration of IKS. This study established that much needs to be done to guide the integration of IKS in creative design activities in the teaching of Systems and Control. There is also a need for the Department of Basic Education (DBE) in Mpumalanga to provide systematic support and train teachers toward the integration of IKS in creative design process activities in Systems and Control. This study also identified content knowledge, context, curriculum support, curriculum materials, formation of a community of practice, IKS and classroom practice as the key aspects in the realisation of the

effective integration of IKS in Technology. These aspects form the basis of the contribution of the study, which is a model for the integration of IKS in Technology (5Cs-IKS-1C).

Key concepts: Creativity, design processes, Indigenous knowledge systems, indigenous knowledge, systems and control, Technology Education, Technology subject, Technology, situated learning, legitimate peripheral participation, community of practice, cognitive apprenticeship.

NGOBUFITJHAZANA

Umzimba womtlolo wobukghwari (*literature*) kulelirhubhululo ukhombisa ukuthi ukwakhiwa komqondo wegama leThekinoloji, nakumadaniswa nezinye iimfundo, lokhu kwakhiwa kwenzeka kokuthoma ngaphasi kobujamo beTjingalanga bese ekugcineni barhatjhekela ebujameni beendawo ezingasizo zeTjingalanga, okuziindawo ezivame ukuhlathululwa njengezendabuko. Ukungezelela kilokhu, iThekinoloji itjhuguluka ngokukhambisana neendingo zabantu ngenca yeentuthuko zemiphakathi. Esewula Afrika, isiTtatimende soMthethomgomo weKharikhyulamu nokuHlola (CAPS) sakhiwa migomo yezamalungelo wobuntu, ngakelinye ihlangothi, kanti amasistimu abusako welwazi leTjingalanga lawo asekela ukuthuthukiswa kwesifundo seThekinoloji kanye nekharikhyulamu yaso. Umgomo wokuhlonipha amasistimu welwazi (IKS) lendabuko ku-CAPS, okumgomo osuka emqondweni wethekinoloji yendabuko kezethekinoloji, emphakathini kanye nakezebhoduluko, udlala indima eqakathekileko kulesisifundo serhubhululo. Kungenca yalokhu ukobana isibonelorhubhululo (*case study*) esikhwalitheyithivu senziwa ngehloso yokuvumbulula ukuhlanganiswa kweThekinoloji yaboTitjhere ku-*Senior Phase* kanye ne-IKS emisebenzini emalungana nehlelo ledizayini yobukghwari bengcondo lokhu okuyindikimba yamaSistimu kanye nekhonthroli. Irhubhululo lalendlalwe ngaphasi kwethiyori yefundo esendaweni ethize kanye nakumathiyori wesimanjemanje/wagadesi wehlelo elisemthethweni elikhambisana nalokhu kanye nokukhombisa ngezenzo okucatjangwa ngengqondo kanye negama lesiqhema sabantu bomnqopho ofanako (*community of practice*), lokhu okufake igalelo ekwakhiweni kwekambiso emalungana nokubuthelelwa kwedatha. Irhubhululo lenziwa kumadistriki weHlanzeni neNkangala eMpumalanga. Abotitjhere abalisuminambili (12) besifundo seThekinoloji eliku-*Senior Phase*, abakhambisana nabotitjhere abasithandathu (6) abasafundako kanye nabotitjhere abanelwazi abasithandathu (6), abafundi abane (4) kanye nabayelelisi ababili (2) bekharikhyulamu bakhethwe ngomnqopho wokobana bazibandakanye kurhubhululo. Idatha ibuthelelwe ikakhulukazi ngokusebenzisa amahlolombuzo aziingcenyembili (*semi-structured interviews*), ukutsengwa komtlolo kanye nokufunda ngokuqalisisa atsengwe ngokwendikimba. Iindikimba ezisithandathu (6) zivele ehlelweni lokutsengwa kwedatha. Iindikimba zibe ngendlela elandelako: (1) Ukuzwisisa i-IKS botitjhere beThekinoloji; (2) amathuba lawo athulwa mnqopho othileko we-IKS; (3)

Umzamo wabotitjhere bethekinoloji wokuhlanganisa i-IKS; (4) Indlela abafundi abazwisisa ngayo ihlelo lokuhlanganiswa kwe-IKS; (5) Umhlobo wesekelo lelo abosolwazi beemfundo abalinikela abotitjhere; kanye (6) nesakhiwo sokuhlanganiswa kuhle kwe-IKS. Leli rhubhululo lafumana bona kunengi okufanele kwenziwe ukukhombisa indlela yokuhlanganiswa kwe-IKS emisebenzini yedizayini enobukghwari bengcondo ekufundisweni kwelwazi elimunyethwe lihlelo lamaSistimu kanye nokuLawula. Begodu kunesidingo sokuthi uMnyango weFundo eSisekelo (DBE) eMpumalanga unikele abotitjhere isekelo lesistimu kanye nebandulo eliqaliswe ekuhlanganisweni kwe-IKS emisebenzini emalungana nehlelo lezedizayini enobukghwari bengcondo kundawana yelwazi elimunyethwe maSistimu kanye nokuLawula. Lelirhubhululo begodu lihlukanise ilwazi elimunyethwe ngaphakathi, ubujamo/isizinda, isekelo lekharikhyulamu, amatheriyali wekharikhyulamu, ukwakhiwa kwesiqhema somnqopho ofanako, i-IKS kanye nekambiso yezinto ezenziwa ngematlasini njengezinto eziqakathekileko ekufikeleleni/ekuphumeleleni ihlelo elihlangeneko le-IKS kezeThekinoloji. Lezi zinto zakha isizathu sokuba negalelo lelo elenziwa lirhubhululo, okuyimodeli yokuhlanganiswa kwe-IKS kuThekinoloji (5Cs-IKS-1C).

Amagama aqakathekileko: Ubukghwari, ihlelo ledizayini, amasistimu welwazi lezendabuko, ilwazi lezendabuko, amasistimu kanye nokulawula/nokukhonthrola, iFundo yezeThekinoloji, Isifundo seThekinoloji, iThekinoloji, ukufunda okudzimelele ebujameni/endaweni, ukuzibandakanya okusemthethweni okukhambisanako, isiqhema sabantu bomnqopho ofanako, ikghono lokwenza okusengcondweni.

SICAPHUNO

Indzikimba yelitheretja kulolucwaningo ikhombisa kutsi kucatjangelwa kweTheknoloji, uma kuchatsaniswa naletinye tifundvo, kwenteka kucala etimeni taseNshonalanga futsi kugcinwa kungene etimweni lekungetona taseNshonalanga, letivame kuchazwa njengetemdzabu. Ngetulu kwaloko, Itheknoloji intjintja ngekuhambisana netidzingo tebantfu ngenca yentfutfuko yemphakatsi. ENingizimu Afrika, Sitatimende Senchubomgomo Yeluhlelo Lwetifundvo Nekuhlola (ema-CAPS) sisekelwe emigomeni yemalungelo ebantfu, ngakulolunye luhlangotsi, kanye netinhlelo telwati lwaseNshonalanga letihamba phambili letingumgogodla wekutfutfukiswa kwesifundvo seTheknoloji kanye nekharikhulamu yaso, ngakulolunye. Umgomo wekwatisa tinhlelo telwati lwendzabuko (i-IKS) ku-CAPS, ulandzelwa ngekwembono wetheknoloji yendzabuko kutheknoloji, umphakatsi kanye nemvelo, ubambe lichaza lelibalulekile kulolucwaningo. Kungenca yalesizatfu lapho kwentiwa khona lucwaningo lwekhwalithi lwekuhlola kuhlanganiswa kwabothishela beSigaba Lesisetulu Setheknoloji se-IKS emisebentini lehlobene nenchubo yekuhlela yekusungula nangabe kufundziswa ikhethenti ye-Systems and Control. Lucwaningo belusekelwe kuthiyori yekufundza lokusendzaweni kanye nethiyori lehambisanako yekubamba lichaza lokusemtsetfweni nekuceceshwa kwengcondvo kanye nemcondvo welicembu lelinenshisekelo lefanako, lofake ligalelo ekulolongeni iphrothokholi yekugcogcwa kwedatha. Lucwaningo lwentiwe etigodzini taseHlanzeni naseNkangala eMpumalanga. Bothishela labalishumi nakubili (12) beSigaba Lesisetulu seTheknoloji, lokuhlanganisa bothishela labasacalako labasitfupha (6) nabothishela labanesipiliyoni labasitfupha (6), bafundzi labane (4) kanye nebaluleki bekharikhulamu lababili (2) labakhetfwe ngenhloso yekubamba lichaza elucwaningweni. Imininingwane igcogcwe ikakhulukati ngetingcogco letingahleleki kahle, kuhlatiya imibhalo kanye nekubukwa futsi yahlatiywa ngekwengcikitsi. Tindzikimba letisitfupha (6) tivele ekuhlatiyweni kwedatha. Letindzikimba betingalendlela: (1) Kuvisisa kwabothishela kwetheknoloji ye-IKS; (2) ematfuba laletfwa yinhloso letsite ye-IKS; (3) umtamo wabothishela beTheknoloji wekuhlanganisa i-IKS; (4) kuvisisa kwebafundi ngekuhlanganiswa kwe-IKS; (5) luhlobo lwelusito lwabocwepheshe betifundvo labaluniketa bothishela; kanye (6) neluhlaka lwekuhlanganiswa ngemphumelelo kwe-IKS. Lolucwaningo lwatfola kutsi kunyenti lokufanele kwentiwe kute kucondziswe

kuhlanganiswa kwe-IKS emisebentini yekuhlela lokusungulako ekufundziseni ikhothenti ye-Systems and Control. Kunesidzingo futsi sekutsi Litiko Letemfundvo Lesisekelo (i-DBE) eMpumalanga linikete bothishela lusito loluhlelekile nekuceceshwa lokuhloselwe kuhlanganiswa kwe-IKS emisebentini lehlobene nenchubo yekuhlela endzaweni yekhothenti ye-Systems and Control. Lolucwaningo luphindze lwatfola lwati lwekhothenti, ingcikitsi, lusito lwekharikhulamu, imethiriyeli yekharikhulamu, kwakhiwa kwelicembu lelinenshisekelo lefanako, i-IKS kanye nekutijwayeta kwaseklasini njengetici letibalulekile ekufezekisweni kwekuhlanganiswa ngemphumelelo kwe-IKS kuTheknoloji. Letici takha sisekelo seligalelo lelentiwa lucwaningo, lokusibonelo sekuhlanganiswa kwe-IKS kuTheknoloji (5Cs-IKS-1C).

Emagama lamcoka: Buciko, inchubo yekuhlela, tinhlelo telwati lwendzabuko, lwati lwendzabuko, tinhlelo kanye nekulawula, Imfundo Yetheknoloji, sifundvo Setheknoloji, Itheknoloji, kufundza kwekuchumanisa, kubamba lichaza lokusemtsetfweni, licembu lelinenshisekelo lefanako, kuceceshwa kwengcondvo.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE	Advanced Certificate in Education
ATP	Annual Teaching Plan
BEd	Bachelor of Education
BEd Hons	Bachelor of Honours in Education
CAPS	Curriculum, Assessment Policy Statement
CA	Cognitive apprenticeship
CoP	Community of Practice
CD1	Curriculum Advisor District 1
CD2	Curriculum Advisor District 2
DBE	Department of Basic Education
D1/A	District 1
D2/B	District 2
ET	Educational Technology
GET	General Education and Training
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
IT	Information Technology
ITEEA	International Technology and Engineering Education Association
LA1	Learner 1 District 1
LA2	Learner 2 District 1
LA3	Learner 3 District 1
LB1	Learner 1 District 2
LB2	Learner 2 District 2
LB3	Learner 3 District 2
LED	Light Emitting Diode
LTSM	Learning and Teaching Support Material
LPP	Legitimate Peripheral Participation
MEd	Master of Education
Mini-PAT	Mini Practical Assessment Tasks
NCS	National Curriculum Statements

SLT	Situated Learning Theory
TA1-E	Teacher 1 District 1 - Experienced category
TA2-E	Teacher 2 District 1 - Experienced category
TA3-E	Teacher 3 District 1 -Experienced category
TA1-N	Teacher 1 District 1 - Novice category
TA2-N	Teacher 2 District 1 - Novice category
TA3-N	Teacher 1 District 1 - Novice category
TB1-E	Teacher 1 District 1 - Experienced category
TB2-E	Teacher 1 District 2 - Experienced category
TB3-E	Teacher 3 District 2 - Experienced category
TB1-N	Teacher 1 District 2 - Novice category
TB2-N	Teacher 2 District 2 - Novice category
TB3-N	Teacher 3 District 2 - Novice category
TE	Technology Education
TSE	Technology-Society-Environment

CHAPTER 1

ORIENTATION OF THE STUDY

1.1 Background to the problem

The purpose of this study was to establish how Senior Phase Technology teachers can integrate Indigenous Knowledge Systems (IKS) in the creative design process activities when teaching Systems and Control content area in the classroom. It was motivated 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 Technology Education curriculum. To this effect, internationally, Technology Education was first conceptualised in the Western (developed) contexts and infiltrated the non-Western (developing) contexts, which are generally described as indigenous (Gumbo 2015:15). In comparison with other subjects, Technology Education's underpinning philosophy and its emergence emanate from the background of technological practices and engineering, though it is relatively young (Jones, Buntting & De Vries 2013:192). The engineering influence in the conceptualisation of Technology Education, with its antecedent, the science, has not embraced the creative designs found in indigenous contexts. The investigation was carried out in South Africa; it targeted Technology teachers in two districts of the Mpumalanga Province rich in indigenous knowledge experiences.

Mpumalanga Province is one of South Africa's nine provinces. The province comprises four educational districts, which are Bohlabela, Ehlanzeni, Gert Sibande and Nkangala. It covers both the lowveld and the highveld areas of South Africa. It shares its borders with Gauteng, Limpopo, KwaZulu-Natal and Free State provinces. Mpumalanga also shares its African borders, with Eswatini and Mozambique. The province is well known for its rich multi-indigenous cultures of Ndebeles, Swatis, Pedis, Tsongas, and Zulus. The province is a tourist destination due to its remarkable caves, mountains, landscape, minerals and nature reserves such as Kruger National Park. Its cultural heritage sites, stalls and caves are endowed with creative artefacts in display. Creative designs in this province are also associated with the iconic graphic artist, Dr Esther Mahlangu of Nkangala District of Mpumalanga Province (Van Vuuren 2012:332). Dr Mahlangu is well known worldwide and in the body corporates due to her skills in art drawings. She could be regarded as the indigenous technology creative design resource based on her experience, talent, and creativity. Technology Education curriculum also encourages learners to be creative as defined in the subject's unique features and scope (Department of Basic Education [DBE] 2011:9).

In the South African context, the Technology Education curriculum is the product of National Curriculum Statements (NCS) Grades R-12. The NCS Grades R-12 comprises five general aims which are the kind of knowledge, skills and values; intended purposes; underpinning principles; envisaged leaners; and inclusivity. The focus of this study was more on the general aims of the kind of knowledge, skills and values and the underpinning principles (DBE 2011: 4-5). The knowledge, skills and values are aimed at ensuring that learners "acquire and apply knowledge and skills in ways that are meaningful to their daily lives based on their local contexts, while being sensitive to global imperatives" (DBE 2011:4). Furthermore, the underpinning principles are identified as social transformation; active and critical learning; high knowledge and high skills; progression; human rights, inclusivity, environmental and social justice; valuing indigenous knowledge systems; credibility, quality, and efficiency (DBE 2011:5). These principles are addressed through the overall specific aims of the Technology Education curriculum as outlined in Section 1.2 below. The principle, valuing indigenous knowledge systems, could be traced through the aspect of indigenous technology which plays a crucial role in this study. This principle assisted in the investigation of the integration of indigenous knowledge in the creative design process and the understanding of technological content such as Systems and Control.

The technological content and processes play an important role in the teaching and learning of the Technology subject. The technological content and processes complete the intellectual development and practical component of Technology Education.

The concepts and knowledge in Technology constitute the content, whereas the design process, which is described shortly hereafter, also constitutes the content but largely the processes. The content and process concepts are classified within the conceptual and procedural knowledge respectively. Conceptual and procedural knowledge play an important role in problem-solving through design. The term 'design' is normally used to express a process and a product (Hamza & Hassan 2016:588). The Senior Phase Technology teachers are required to teach the Technology subject through the 'design process' which encapsulates the application of problem-solving, development of practical skills, and knowledge and application of knowledge (DBE 2011:8). The design process plays a central role as the backbone for teaching and learning of Technology. It is also at the centre of the decision-making process during design. In a design decision-making situation, one of the sources of information highlighted by Markus in Lawson (2005:133), is the designer's own experience to balance the qualitative and quantitative criteria during the process. The decision-making process plays itself within the design process as designers have their own motives, reasons, sets of beliefs, values and attitudes for wanting to design (Lawson 2005:165).

In this case, the researcher's view is that the approach to understanding the design process is through critical and creative thinking skills. These critical and creative thinking skills play a major role in the design process. In this study, the researcher focused more on the creative thinking skills where creativity is closely associated or linked with design as it helps in designing activities to solve technological problems. Wong and Siu (2012:439) view creativity as an essential feature to problem-solving as designers do, which corresponds with its (creativity) basic nature. Hamza and Hassan (2016:587) describe creativity as an original cognitive ability and problem-solving process, which enables one to use intelligence in a way that is unique and directed towards following the steps of a design process to come up with a product.

The nature of the product and its design should be per human needs and wants, as part of addressing societal issues and values. The researcher views societal issues and values as some of the factors of indigenous knowledge systems (IKS). Hattingh (2004:194) attests that humankind has needs and since the existence of technology, people used a combination of knowledge, skills and available resources to develop solutions to address them. In addition, that does not exclude indigenous people from whose technological designs, the Technology Education curriculum and teaching stand a chance to benefit. This is especially so considering the decades of marginalisation of the IKS.

Technology and its development changes continually as human needs develop due to their interaction with societal and technological developments (Ankiewicz, De Swardt & De Vries 2006:118). This claim by Ankiewicz et al. (2006) is corroborated by the view that technology as a characteristic of humanity is reflected in the values that are related to the design process (Jones, Buntting & De Vries 2013:194). The values in this context are ethical and moral responsibility that need to be taken into consideration when dealing with the design process in order to sustain people and communities for the well-being of the ecological and social environment (Fleer 2015:35). These values as embedded in the human rights principles in the design and are important for Technology Education because values inform how technology is shaped by, but also it shapes, humans, human culture, and society (Jones et al. 2013:194).

According to Fleer (2015:35), Technology Education has both an ethical and moral responsibility to support imaginings that sustain people and communities in sociocultural settings. Culture is learnt and is dynamic as it varies from one society to another (Gumbo 2015:61). Gumbo further posits that Technology Education, amongst others, is one of the human enterprises that involve the transmission of cultural heritage and should thus consider IKS. As a result, it is very prudent that when learning progresses, Technology teachers should take learners through the understanding of the interrelationship between technology, society, and the environment, and make them aware of coexisting knowledge systems on how indigenous cultures have used specific materials and processes to satisfy their needs and wants (DBE 2011; Ndlovu 2012). This approach could allow teachers to address the learners' understanding of societal and technological developmental issues through the classroom environment (Ndlovu & Gumbo 2018:385). Therefore, if Technology teachers could understand this societal and technological development in the context of IKS and could integrate them into creative design process activities in their teaching, then the aims of the curriculum intentions could be met with success (Gumbo 2015:61). This claim is motivated by the fact that most learners in South African schools are African indigenous learners. This does not mean ignoring non-indigenous learners (as they stand to benefit by being exposed to alternative knowledge and forms of technology), therefore, there is need for integration of IKS not to the exclusion of other knowledge systems. It was against this background that this study investigated Technology teachers' integration of IKS in the creative design process activities in their teaching of Systems and Control content, and suggested an integrative framework to that effect.

1.2 Rationale for the study

The general aim of introducing Technology Education in its national curriculum in South African schools was to produce engineers, artisans, technicians, and a technological literate society (DBE's 2011:8). This aim can only be achieved through the development and application of skills to solve technological, social and political problems. There are also three specific aims of the Technology curriculum outlined as deliverables to realise the overall aim which are outlined in the preceding paragraph. The specific aims give learners an opportunity to (1) develop and apply specific design skills to solve technological problems; (2) understand the concepts and knowledge used in Technology Education and use them responsibly and purposefully; and (3) appreciate the interaction between people's values and attitudes, technology, society, and the environment. The third specific aim further comprises three aspects, which are indigenous technology, impact of technology and bias in technology.

Technology Education comprises three fundamental dimensions, which are knowledge, processes and skills, and, values and attitudes, which are the mirror of the three specific aims mentioned above. Knowledge in this case defines the concepts involved in teaching Technology, processes and skills, describes the design approach towards teaching Technology, and values and attitudes define the context in which concepts are applied towards the design (Ndlovu & Gumbo 2018: 379). Technology teachers are required to teach Technology through the design process development of practical skills and knowledge, and application of knowledge (DBE 2011:8). In the process of applying problem-solving skills, and, practical skills, and knowledge, IKS should also be integrated. IKS forms part of the technology, society and environment strand in the CAPS document for Technology Education. This strand caters for the recognition of IKS in the Technology curriculum of which indigenous technology is part (Gumbo 2015:62).

Technology, society and environment (TSE) sets the context for teaching Technology at Senior Phase (DBE 2011:8). Setting the context requires consideration of the value judgements towards designing artefacts (Dakers 2006: 209). Value judgements are identified as, technical, economical, aesthetical, environmental, moral, spiritual/religious, intellectual, and social (Dakers 2006; Reiss 2009; Calado 2018). These values are further categorised into two, i.e., technical, economical, aesthetical, and environmental which are applicable during the design process; and moral, spiritual/religious and social which are meant for society (Dakers 2009: 209). Values are distinguished from virtues as personal qualities and attitudes (acquired tendencies) to make judgments (Reiss 2009:309). These value judgments resonate well with indigenous knowledge (IK), which is defined as a distinct body of knowledge and skills that indigenous communities accumulated over time and adapt to the local cultures and environment and which is also dynamic and changing (Moalosi, Marope & Sethlathlanyo 2017:17). In line with the focus of this study, which was on the integration of IKS in the creative design process activities in Systems and Control, it is very important to take into consideration that the teaching of Technology should consider creativity, imagination and aesthetics as factors of society's innovation and social progress (Moalosi et al. 2017:66).

The researcher's observation though was that teachers seemed to neglect the importance of this aspect of the third specific aim in their teaching. Teachers need to display knowledge and level of competence in this regard, especially teachers who hail from indigenous backgrounds. This knowledge and competencies are required to enable teachers to integrate IKS when teaching Technology in Senior Phase (Pool, Reitsma & Mentz 2013:457). However, earlier and recent studies (Howie 2003; Nkosi 2008; Ndlovu 2012; Mapotse 2012; Gumbo 2015; Moalosi et al. 2017) suggest that Technology teachers in South Africa still face challenges in realising these competences as far as integrating IKS is concerned. It is evident from these studies that even though Technology

Education has been taught in South African schools since 1998, the majority of Senior Phase Technology teachers still find it difficult to integrate IKS in creative design activities or tasks in their classrooms. It is against this background that a need for the present study arose.

1.3 Statement of the problem

In line with Section 1.2 above, Technology teachers are required to integrate IKS in their teaching of creative design processes in Systems and Control. However, it seems that Technology teachers are not adequately equipped with the appropriate knowledge and skills to integrate IKS in the creative design process. As a result, most teachers seem to find it difficult to integrate IKS in creative design activities or tasks when teaching Systems and Control content in their classrooms. This created a knowledge and practice gap that needed to be investigated. An effort, if any, by teachers to integrate IKS by way of incorporating it into the creative design process activities in Systems and Control at Senior Phase, should be investigated to establish their knowledge and methodology of their attempts level. The main research question that this problem raised is stated thus, How can Senior Phase Technology teachers integrate IKS in the creative design process activities when teaching Systems and Control content in the classroom? This main question led to the following sub-questions:

- What is the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs contained in the third specific aim of CAPS?
- What opportunities does this third IKS-inspired specific aim present to the Senior Phase Technology teachers regarding the teaching of creative designs?
- How do Senior Phase Technology teachers attempt to integrate IKS into the creative design process?
- How do Senior Phase learners receive the integration of IKS into the creative design process when learning Systems and Control?
- What support do subject specialists for Technology Education give to teachers towards the integration of IKS in creative design process activities in Systems and Control?

- How can the teaching of Technology be framed such that it guides Senior Phase Technology teachers' effective integration of IKS into the creative design process?

1.4 The aim and objectives of the study

The study aimed to establish how Senior Phase Technology teachers can integrate IKS into the creative design process activities in the classroom. To achieve this aim, the study's objectives were to:

- Establish the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs as contained in the third specific aim of CAPS?
- Identify the opportunities that the third IKS-inspired specific aim presents to the Senior Phase with regards to the teaching of the creative designs.
- Explain how Senior Phase Technology teachers, attempt to integrate IKS into the creative design process.
- Establish how Senior Phase learners, receive the integration of IKS into the creative design process when learning Systems and Control.
- Determine the kind of support subject specialists for Technology Education, give to teachers towards the integration of IKS into creative design process activities in Systems and Control.
- Design a framework that can guide Senior Phase Technology teachers towards the effective integration of IKS into the creative design process.

1.5 Motivation for the study

Technology in Senior Phase in South African schools is a compulsory subject (Mathumbu, Rauscher and Braun 2014:4). The subject promotes critical and creative thinking skills towards problem-solving during design activities. These thinking skills are the attributes of different types of cognitive processes (Chermanhini & Hommel 2012:635). Three studies were conducted in Mpumalanga Province by Nkosi (2008); Mathumbu, Rauscher and Braun (2014); as well as Ndlovu and Gumbo (2018). Nkosi' s study focused on the "Teachers' need to be assistants to understand the thinking processes" in Ehlanzeni district. The findings showed teachers' lack of understanding of the content knowledge in planning lessons and the relationship between conceptual knowledge and procedural knowledge towards planning for the lesson. Mathumbu et al.'s (2014) study focused on the "knowledge and cognitive process dimensions of Technology teachers' lesson objectives" in Ehlanzeni, Gert Sibande and Nkangala districts. The study established that teaching Technology at the high level of the cognitive domain was found only in lessons where learners were given assessment activities without clearly stated objectives, and the ones that are inferred from specified activities that are integrated in nature. Ndlovu's and Gumbo's (2018) study focused on the "Technology teachers' integration of technology-society-environment in teaching-learning activities" conducted at Bohlabela sub-district of Ehlanzeni district. Their study established that the lesson plans, learners' workbooks and project portfolios offer minimal opportunities for learner cognitive development and skills as teachers are not fully showing the command of integrating the aspect of technology-society-environment to set the context. All three studies focused on teaching–learning activities since they looked at the various components of lesson activities.

Based on the IKS perspective, there is however a gap identified on how teachers integrate the IKS in the creative design activities in Systems and Control differently at Ehlanzeni district of Mpumalanga. Hence, this study aimed to establish how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control section in the classroom. Pursuing a study on creativity and IKS in design was influenced by the gap that seems to exist which in turn assisted to develop an interest in the understanding of how Technology teachers attempt to integrate IKS in creative design process activities in Systems and Control in the Senior Phase classroom. This is in consideration of how teachers teach and how learners learn creative design activities in Systems and Control, which are based on the IKS, put together from their own local context. This process can enable learners to transfer their creativity from the familiar (basics) to unfamiliar (advanced) situations based on what they learned in the Technology classroom. The contribution of this study is that it enables Senior Phase Technology Education teachers to realise the relationship that creativity, design process and IKS have when dealing with Systems and Control activities. It is important to note that IK should be viewed as crucial resource for creativity and innovation

(Ogunbure 2011; Moalose et al. 2017).

Consequently, the current study enables the policymakers and curriculum specialists to help in the proper implementation of the Technology Education policy by ensuring that teachers integrate IKS for the benefit of the learners during design. In practice, this study contributes towards addressing the problems Technology teachers and policymakers might be experiencing towards the integration of IKS into creative design activities when teaching Systems and Control. Also, the current study increases the awareness of integrating IKS in Technology teaching between the classroom and the immediate society. It further contributes to the existing literature through the suggested framework about the relationship between the teaching of Technology and learners' creative design processes within the context of IKS through the teaching of Systems and Control.

1.6 Delimitations of the study

This study focused on the qualitative case study design. Its findings are confined to two districts in Mpumalanga province that involved a few selected teachers, learners and curriculum specialists which constitutes a small sample size. The sample size was not as big as other studies due to the nature of the research design chosen. The current study was confined to situated learning theory with its associate theories of Legitimate Peripheral Participation (LLP), Community of Practice (CoP) and Cognitive Apprenticeship (CA) (Chapter 2) and grounded in the interpretivist and postcolonial paradigms only. This study targeted the Senior Phase Technology teaching of Systems and Control (Mechanical, Electrical and Electronic Systems and Control sections). The conditions set in the ethics section did not guarantee whether the purposefully selected participants would complete the research process during the data collection period.

1.7 Overview of research methodology

This study followed a qualitative approach, which is interpretative in its nature (Baxter & Jack, 2008:545). A case study as a research design was adopted in order to describe how Technology teachers integrate IKS into their creative design process activities when teaching Systems and Control content in the Senior Phase classroom using a variety of data sources. The study adopted a non-probability sampling. The study purposively selected twelve Technology teachers - novices and experienced, two curriculum advisors and four learners with the help of the district officials and principals to participate in the study at Ehlanzeni and Nkangala Districts of Mpumalanga Province. The reason for this selection criterion was to better understand and come to terms with the participants' reality and to obtain an in-depth description of the context in which they teach Technology.

This study used document analysis, semi-structured interviews, and non-participatory observation as part of data collection strategies. Each of the data collection strategies was aligned to address a particular objective identified in the current study. This study employed a thematic analysis strategy on the documents and the semi-structured interview data, corroborated with the observation data and field notes. The themes emanated from the notes of the coded transcribed semi-structured interviews, documents and observation data. In every research, process validity and reliability play a pivotal role in making the study or research credible. In addressing the validity and reliability, the study observed the four standards of rigour in qualitative research to ensure that the processes of research, data collection and data analysis were credible and trustworthy, and these are credibility, transferability, dependability and confirmability (White & Mash 2006:38). The University of South Africa and Mpumalanga Department of Basic Education granted the ethical clearance and permission to conduct the study in schools in the district cited above. The ethical protocol to protect the rights of the participants, ensured participants' confidentiality and voluntary participation was observed.

1.8 Definition of Key Concepts

The subsections below outline the definitions of the concepts of indigenous knowledge systems, creativity and creative thinking, design processes, Technology and Technology Education as used in the current study.

1.8.1 Indigenous knowledge systems

The term indigenous knowledge systems (IKS) is defined from different perspectives in different dynamic contexts. However, Muchenje, Gora and Makuvaza (2016:81) view indigenous knowledge definitions as having common themes such as localised forms of knowledge that have provided people with solutions as they interact with their environment. Two of the definitions that resonate with this present study are the ones by Masoga (2007); and Mazonde and Thomas (2007) (in Muchenje, Gora & Makuvaza 2016:81). Their definitions commonly define the IKS with reference to the knowledge and technologies around indigenous communities and in relation to particular spaces and contexts. The definitions as cited in this section cover IKS broadly in their relevance to TE with an emphasis on indigenous communities. Hence, this study focused more on indigenous technology; and how Technology teachers integrate this aspect of IK into their creative design activities. In this study, the IK and IKS are used interchangeably.

1.8.2 Creativity and creative thinking

The concept of creativity comprises innovation and suitability (Atkinson 2000; Howard, Culley & Dekoninck 2008). Wong and Siu (2012:439) note the important aspects of creativity, such as helping to solve problems in various fields and to learn to be creative in design activities, and as the integral and essential part of designing. Hamza and Hassan (2016:588) define creativity as a "phenomenon in which a person communicates a product after completing a mental process within their implicit press". Creativity is at the heart of cognition that engages the mental processes during design (Zabelina & Ganis 2018:20). This description of creativity is within the context of the present study.

Creative thinking is the ability to switch from one thinking mode to the other thinking mode without difficulty (Wong & Siu 2012:440). The thinking modes referred to in this regard are convergent thinking and divergent thinking, which play a very important role during idea generation when designing. Convergent thinking requires focusing on one possible response or finding a single response and it benefits from a low-level thinking task (Chermahini & Hommel 2018:635 & 639). Divergent thinking, on the other hand, often leads to originality and is best with medium- to high-level thinking tasks as it engages cognitive control processes (Runco & Acar 2012; Chermahini & Hommel 2018; Zabelina & Ganis 2018). Convergent and divergent thinking are the mechanisms for the creative thinking process. Moalosi et al. (2017:66) suggest that IK should be an important resource for creativity and innovation.

Hence, the creative thinking process with the integration of IK could inspire learners towards achieving creative design outcomes. This sentiment is shared by Luo and Dong (2017:499), when they indicated that more and more local designers search for inspiration from ancient cultural artefacts to generate unique cultural-oriented products. In this study, ancient cultural artefacts could be located within the IKS. The integration of IKS into creative design activities could enhance products, context identity, and core values and stimulate emotions (Moalosi et al. 2007:36). Technology teachers need to vary the technological tasks integrated with IK to set the context of promoting creativity in design starting with focused tasks to inculcate soft skills to complex tasks that would inspire and encourage thinking at a higher level at Senior Phase level. Hence, the present study was aligned with creativity and creative thinking that would promote the integration of IKS in creative design activities.

1.8.3 Design process

The process of design in TE begins with a problem and the solution to the problem is determined through the design process in the form of design output (Wong & Siu 2012:442). Lawson (2005:48) describes the design process as a negotiation between a problem and a solution through analysis, synthesis and evaluation using a three-dimensional diagram. However, there is still a need for the design process to reflect some of the traditional ideas and perspectives so as to strike the balance between Western and African knowledge systems towards problem-solving (Obikeze 2011; Gumbo 2015). The design process, in the phase of using and assessing technology, can be the technological process as well as the making process (Mitcham 1994). This technological process, as well as the making process, needs to be interpreted through the three levels of basic assumptions, values and artefacts, which form part of cultural characterisation (Chang & Hsu 2011:5). Furthermore, Hamza and Hassan (2016:588) view the term "design" as usually used to express a "process" and a "product". As a result, one can conclude that the product is the output (results) of the design process. In line with the present study, the four views on the design process above share the same sentiments around the fact that the design process is at the centre of a problem and its ultimate solution, which is the result of a creative process. Creativity in the design process is seen as the co-evolution of the problem to find the solution (Dorst & Cross 2001:426). Hence, the study is looking at the integration of IK in the creative design process. Therefore, the study was confined to the definitions mentioned above.

1.8.4 Technology

Technology is viewed from different points such as historically, anthropologically, sociologically, philosophically and educationally as the entire system of people and organisations, knowledge, processes and devices that go into creating and operating technological artefacts and artefacts (Varnado & Pendleton 2004:1). Technology is different from most other subjects in that its existence is as the result of human activity; also, it is used and developed in contexts which depends on values (Gibson 2008:10). Various authors define the concept Technology in diverse ways in and outside the field of Technology Education. Mitcham (1994:157) defines technology as a “human activity that fits better with human needs through the utilisation of various kinds of information and knowledge, natural and cultural resources”. Thomas (in Reddy 1995:14), defines the concept of Technology as involving a creative human activity that brings about desired changes through making, controlling things, or making things work better by carefully designing, making and evaluating, using relevant knowledge and resources. Ogungbure (2011:89) defines Technology as “the application of human intellectual ability to the task of human nature in its entirely for humankind development and sustenance; it is further seen as the intermediary between human and the vast resources available from nature”. Ogungbure further highlights the fact that a human is known to be the only creature that has been endowed with the capacity to think systematically and creatively about experience and environment. All three definitions put “human” at the centre of Technology. A person has culture, and culture is not static but dynamic – a way of life that evolves amongst people in an attempt to meet the challenges and or needs of living in their environment or society (Obikeze 2011; Ogungbure 2011). Culture is also regarded as a ground norm of technological and scientific development, and further viewed as the pattern of behaviour that allows people to live in social groups where they exchange ideas that give birth to creative innovations (Ogungbure, 2011:88). Culture embraces the technological artefacts (Chang & Hsu 2011; Gumbo 2015). Chang and Hsu (2011:5) further allude that culture indicates an organised system of knowledge and beliefs and the lifestyle of the entire society. Gibson (2008:5) and Chika (2019:3) view knowledge as something that refers to a familiarity with subject disciplines, things, places and people, which offers the ability to use it in order to attain a specific goal. According to Gumbo (2015:63), Technology is part of the knowledge domain, hence indigenous technology is part of IKS. Therefore, the present study resonates well with the authors above on the definitions of the concept, technology; as well as Chang's and Hsu's (2011); and Gumbo's (2015) view of the importance of culture as organised system of knowledge within the context of IK, as it sought to investigate how Technology teachers integrate IKS in the creative design activities at Senior Phase classroom.

1.8.5 Technology Education

Technology Education entails investigating people's needs in the context of home, school, community and the larger environment (Reddy 1995:14). Technology Education forms part of the body of knowledge. The knowledge in Technology Education comprises concepts, design skills as well as values and attitudes (set the context) (Pudi 2007; Ndlovu & Gumbo 2018). Similarly, IKS is a body of knowledge and skills accumulated over time and adapted to the culture and the environment which means knowledge is dynamic and changing (Moalosi et al. 2017:17). In investigating people's needs, learners should identify, design, make and evaluate their ideas taking into consideration the economic, moral, social and environmental consequences of their ideas and innovations (Reddy 1995; DBE 2011). These explanations of Technology education define the context in which this study seeks to investigate the understanding of the integration of IKS into creative design activities in Systems and Control.

1.9. Chapter Outline

Chapter 1

The chapter introduces and provides the background for the study that discloses the rationale as well. This chapter also covers the statement of the problem, research questions, aim and objectives, motivation for the study, limitations and delimitations of the study, definition of key terms or concepts and the outline.

Chapter 2

This chapter outlines the theoretical framework and the research paradigms that ground the study on the understanding of the Senior Phase Technology teachers' integration of IKS into the creative design process activities when teaching Systems and Control in the classroom.

Chapter 3

This chapter adopts a critical approach towards scholarly literature review surrounding and relevant to the research problem. This chapter is based on the conceptual arrangement to explore the grounding concepts towards addressing the aspects outlined in the aim of the study.

Chapter 4

This chapter focuses on the research approach and methods, sampling, data collection methods, credibility and trustworthiness and ethical considerations. Choices and decisions made are motivated.

Chapter 5

This chapter presents data analyses and findings. The analyses and interpretation of data assisted in understanding Senior Phase Technology teachers' integration of IKS into the creative design process activities in the classroom.

Chapter 6

This chapter presents interpretation and discussion of the findings. The discussion of findings assisted in understanding Senior Phase Technology teachers' integration of IKS into the creative design process activities in the classroom.

Chapter 7

This chapter concludes the study and makes the necessary recommendations related to the research questions of the study.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1 Introduction

This study explores the phenomenon of Senior Phase Technology teachers' integration of IKS into the creative design process activities. Precisely, the purpose of this study is to describe how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control content in the classroom. The study is grounded on the Situational Learning Theory (SLT), the lens through which data are interpreted and analysed later. Hence, in this chapter, the SLT is discussed and justified. The chapter comprises five sections which are (1) Introduction: (2) The description of SLT; (3) Rationale for the SLT in the study; (4) Role of SLT with other related theories in the teaching and learning of Technology Education; (5) Application of the SLT theory in the study. All these sections pave the way towards achieving the aim of the study.

2.2 The Situated Learning Theory

Situated learning or situated cognition is the pillar of the Situated Learning Theory (SLT) which focuses on the whole process of learning (Sanga 2017; Pengiran & Besar 2018). Kurt (2021) views situated learning as a theory that is based on ideas from different disciplines such as psychology, sociology, cognitive science and anthropology. The SLT, according to Pengiran and Besar (2018), is founded on situated cognition or situated learning, which was first defined by Brown, Collins and Duguid in 1989 and then expanded by Lave and Wenger in 1991. Since then, the SLT had a significant effect on educational thinking and has also appeared as an alternative to the dominant cognitive viewpoint on learning (Nicolini, Scarbrough & Gracheva 2016). Literature shows that the essentials of the SLT are developed as a possible option to revitalise the understanding and the prescriptions of how knowledge is developed and organised in an authentic context (Lave & Wenger 1991; Handley, Sturdy, Finchman & Clark 2006). In addition, in the situated learning environment, knowledge and skills are attached to the context of real life (Lave & Wenger 1991; Sanga 2017; Chiou 2020). Consequently, the context of real-life places the SLT in the sociocultural perspectives of learning (Polly, Allman, Carto & Norwood 2018). The SLT also represents some of the most influential attempts to overcome the dualistic tendencies of the dominant theoretical paradigms of educational research such as the structuralist theories and educational theories which place cognition at their centre (Bruner 2006; Arnseth 2008).

Furthermore, Lave and Wenger (1991) assert that practical knowledge is situated in relations among practitioners, social organisation and the communities of practice where learning involves knowledge and practice. Hence, Shizha (2014) posits that learning and curriculum in schools should continue to recognise the local knowledge (indigenous knowledge) towards cultivating the contextual learning of the creative design process in Technology Education. Consequently, it could yield positive learning outcomes towards the stages of the design process. For example, the outcomes are determined through calls to pay attention to the possibilities for learners' variations and intra-community that bring with it the complementing or conflicting norms from a personal history of involvement with social and familial groups into the classroom (Handley et al. 2006).

Hence, context is vital for the understanding, learning and practice, as knowledge cannot be just acquired mechanically (Handley et al. 2006: 643). This assertion resonates well with the demands of new teaching approaches in terms of contextualisation and indigenisation of Technology Education curriculum in the South African context. In the context of the present study, community refers to a school and practice in the context of the classroom. Hence, the rationale for selecting the SLT in this study is outlined in the next section.

2.3 The rationale for SLT in the study

The SLT became one of the theories amongst others that contributed towards the reformulating of educational activities as universal social and cultural phenomena (Lave & Wenger 1991:35). Hence, the rationale for selecting the SLT is because of its appropriateness and density to assist in describing how Senior Phase Technology teachers integrate IKS in the creative design process activities when teaching the concepts Systems and Control.

In the context of the present study, the SLT creates a good opportunity for the recognition of indigenous knowledge (IK) during the teaching of creative design process activities in Systems and Control in the Technology Education classroom. Subsequently, learning is a situated practice in which cognition and social interaction are connected (Lave & Wenger 1991). Olakanmi and Gumbo (2017) note three forms of interaction during learning as (a) taking place between a person and behaviour as the influence of thought and actions, (b) between a person and environments where beliefs and conceptions are developed and modified by social influences and structures within the environment; and (c) between the environment and behaviour as behaviour determines the aspects of the environment and in turn, the environment modifies the behaviour. Hence, it should be noted that through interaction, the interplay of personal, behaviour and environmental contribute to teaching and learning processes.

According to Hanna, Crittenden and Crittenden (2013:19), behaviour is the result of both the person and the situation and does not result from either factor or environment alone. As a result, learning should be perceived and viewed as an ongoing and evolving creation of identity with the social practices (Henning 2004:143). Hence, learning should happen in a social context (Cakmakci et al. 2020). Furthermore, learning that is embedded in the social, cultural and physical contexts is more effective than non-situational learning (Arnseth 2008; Pengiran & Besar 2018; Cakmakci et al. 2020). However, Arnseth (2008) argues that even though the SLT emphasises that learning, and teaching are entrenched in historical, social and physical contexts there is no agreement as to how these processes relate to and or are shaped by these contexts.

The present study context is located within classroom practice in the community of practice. Accordingly, classroom practice should be given a primary role in shaping and constituting knowledge and knowing (Lave & Wenger 1991; Mudau 2016). Subsequently, the concepts of social and cultural practices are at the centre of the classroom and community which comprise learners and teachers in the Technology classroom environment. The notion of social and cultural practices is rooted in Dewey’s (1998) and

Mead's (1934) pragmatist theory and the neo-phenomenological tradition represented by social theorists such as Berger and Luckmann (1966), Vygotsky (1998); and Kozulin, Gindis, Vladimir, Ageyev and Miller (2003). Practice is a way of gaining experience through meaningful structured situations that are crucial for real-life contexts (Lave & Wenger 1991). Moreover, social and cultural practices contribute towards theoretical accounts of classical topics such as the creative design process in Systems and Control, that has to do with mind, rationality, knowledge and also emphasises how social order could be produced and reproduced in a real context. Hence, community, culture and school cannot be separated from teaching creative design activities in the Technology classroom. Thus, the engagement of IKS in creative design activities would be critical in this instance (Kupe 2020).

Furthermore, the concept of IKS helps with the re-thinking of individual cognition as the only primary ingredient of the method of educational phenomena but also regards social practices as the primary essentials of inquiry (Henning 2004). The re-thinking of cognition and social practices in educational phenomena resonates well with the nature of theory and practice in Technology Education as it is a practical subject for the teaching of problem-solving and design skills (Kumar & Roberts 2002; Gumbo 2018). Consequently, Arnseth (2008), in agreement with Pickering (1995), postulates that practice is concurrent with a general tendency in the social and human sciences where approaches are also emphasising practice and social interaction.

Arnseth (2008:289) alludes that the idea of knowledge in the community of practice has been revisited during the last decades to fundamentally rethink the analytical commitments. Furthermore, Henning (2004:143) posits that there are ways of knowing that emerge from specific social and cultural contexts such as communities and schools where there is a big influence on teaching and learning. The social and cultural contexts constitute human mental processes that are situated in historical, cultural and institutional settings such as schools and classrooms (Wertsch 1991, Mudau 2016, Mavuru & Ramnarain 2017, Kupe 2020). The IK could be a pillar of social and cultural contexts that in turn can harness the content knowledge towards learners' understanding of the creative design activities in Systems and Control.

Accordingly, the knowledge of the socially constituted world is mediated and open-ended due to its meaning, furnishings and relations to some players both in the school or classroom context and outside the school context as it produces, reproduces and changes in the progression of the activity during teaching and learning (Henning 2004; Arnseth 2008). By the same token, SLT places knowledge and community of practice into perspective towards overcoming the dualistic tendencies of the dominant theoretical paradigms of educational research (Arnseth 2008; Pengiran & Basar 2018). Hence, the next section delves more into the role of SLT in teaching and learning.

2.4 The role of SLT with other related theories in teaching and learning

In the quest to determine how Technology teachers integrate IKS in creative design process activities, the SLT is at the centre of the enquiry. The role of SLT in the teaching and learning of Technology might be useful to point out the common features which represent an idea that learning and thinking could be seen as the integral aspects of teaching creative design process, taking into consideration the social and cultural contexts in the Senior Phase classroom (Arnseth 2008). Moreover, the SLT emphasises that human activity is mediated and situated in a social context that comprises notions, values, history, development, transitions and change factors amongst others (Lave & Wenger 1991; Korthagen 2010).

In light of the above, Lave and Wenger (1991:15) posit that social collaboration takes into consideration the emphasis on issues of meaning-making. The idea of knowledge and meaning stems from interaction and experiences associated with situated learning and the constructivist view (Lave & Wenger 1991). Situated meaning is a specific pattern of experiences tied to specific sorts of contexts such as social, cultural and physical contexts (Cakmakci et al. 2020). Hence, learning that is embedded in the social, cultural and physical contexts is more effective than non-situational learning (Pengiran & Besar 2018; Cakmakci et. al. 2020). Furthermore, participation in such contexts could always be based on situated negotiation and renegotiation of meaning in the Technology classroom.

Nevertheless, such practices could contain inherent contradictions and tensions that can again motivate change and further development (Handley et al. 2006; Arnseth 2008). The idea of context in the SLT, where meaning is constituted and negotiated in the social interaction, involves content, incentives and environment as fundamental processes of learning (Arnseth 2008; Hanna, Crittenden & Crittenden 2013). This does not mean that situations can determine meaning in the sense that learners every time should reinvent the meaning afresh (Arnseth 2008). On the contrary, based on the study, learners in social and cultural contexts that embrace IKS could attempt to engage with cultural experiences that they have developed historically, but also their meaning and significance could be produced and reproduced in the classroom situation.

In light of the foregoing paragraphs, classroom practice is not limited to an isolated domain of social interaction, rather, learning is a situated practice in which cognition and social interaction are connected (Lave & Wenger 1991). In addition, Henning (2004) perceives learning as the ongoing and evolving creation of identity and the production and reproduction of social practices within the classroom, school and community interaction. Furthermore, learning is an integral and inseparable aspect of social practice that involves the construction of identity through changing forms of participation in the community of practice (Handley et al. 2006:643). In relation to situated learning, Chiou (2020) posits that learning is necessarily a process of participation in practice for solving practical problems. Thus, cognition and situated learning are both essentials of learning in a social phenomenon that takes place at the interval of everyday interactions (Henning 2004:143).

In this study, cognition refers to understanding while the cognitive process is concerned with how learners learn (Masilo 2018). Cognition is seen as distributed across the group of collaborating individuals and the artefacts that they employ which represent the aspects of the processes of their collaboration (Kerne & Koh 2007). Creativity is an original cognitive ability and problem-solving process towards producing a product (International Technology and Engineering Educators Association [ITEEA] 2007; Hamza & Hassan 2016). Creative cognition psychologists identify specific cognitive processes and structures that contribute to creative processes and products (Kerne & Koh 2007). The creative process comprises ideation, incubation and provocation stimuli (Kerne & Koh 2007; Wong & Siu 2012).

Furthermore, creativity plays an important role at a metacognitive level in design (Cramer-Petersen, Christensen & Ahmed-Kristensen 2019:39). Vygotsky's definition of metacognitive is related to school learning supporting the need for self-reflection, thus, reflective thinking process comes to the picture. According to Antonietti, Confalonieri and Marchetti (2014:1), reflective thinking comprises metacognition, theory of mind (reflective thought) and narration which appears in informal settings and formal contexts such as the classroom environment. Antonietti et al. (2014) further describe metacognition in three ways such as (a) conceptions about mental activities and abilities in people's minds when engaged in intellectual tasks; (b) theory of mind, as concerns with the realm of social interactions and relationships-deals with mental epistemic behaviours; and finally, (c) narration as reflection on self and other's mental lives in order to make sense of what is happening within and around people.

The three thinking processes form competencies towards facing the demands of classroom realities around societies or environments. Reflection plays an important part at this level. The reflection of the process, notions, or concepts become interrelated. The teacher relates the effectiveness of his/her teaching to the concept of learners' prior knowledge and their prior knowledge of their previous experiences about the activities associated with the creative design process and the role of IK. It means that if the teacher reacts without much reflection, the reaction is based on unconsciously and momentarily triggered images, feelings, notions, values, needs, or behavioural inclinations often on combinations of these factors. These factors relate well to the present study's endeavour to recognise the integration of IKS in creative design activities in Systems and Control content.

Metacognitive is thinking towards understanding an analysis of creative thinking processes using the appropriate skills and strategies to solve problems through designing (Antonietti, Confalonieri & Marchetti 2014). Similarly, design processes comprise of investigation, designing, making, evaluation and communication stages (Department of Basic Education 2011). These stages resonate well with the creative process at the metacognitive level. In social interaction, design as a practice is shaped and rooted in culture (Moalosi, Marope & Sethlathlanyo 2017). Furthermore, design is a social process that promotes an argumentation amongst the different perspectives and values towards finding a solution to the problem (Cramer-Petersen, Christensen & Ahmed-Kristensen 2019). The design process is a referent social practice in Technology Education (Middleton 2009; Marzin & De Vries 2013). It also values the act of designing and the contingent social practice of creative thinking. Design in Technology Education is set to stimulate creativity and problem-solving skills. The design process is a response to dynamic changes in the broader social and cultural context in which design is practiced.

Social and cultural practices are also associated with IK in this study. IK is the people's knowledge and practices because of their interaction with nature in a common environment such as the classroom (Nakashima 2000; Hart 2010). IK is a very important resource to enrich creativity and innovation (Moalosi et al. 2017). The dynamic changes in the broader social and cultural context occur in the cases where design is practiced, which resonates well with the SLT (Lave & Wenger 1991; Lawson 2005). Consequently, the SLT does not simply represent attempts to study social and cultural practices as constitutive, something which is distinct from the worlds of scientific theories or material objects. On the contrary, the SLT treats the field of social and cultural practices as the place to study the nature and transformation of the subject matter towards integrating IKS to facilitate learning in the classroom.

According to Lave and Wenger (1991:35), learning is not merely situated in practice but also is an integral part of generative social practice in the lived-in world. This assertion confirms Sanga's (2017:30) opinion that learning is an integral part of what is to be learnt and cannot be separated from, the context in which learning is taking place. In this study, the Technology classroom becomes a site of the lived-in world of everyday activity, where teaching and learning of creative design process in Systems and Control take place. In the classroom is where identities, knowledge and communities are produced and reproduced. Furthermore, the classroom is where concepts, roles, identities, rules and social structures are comprehended through authentic activities.

Similarly, the SLTs recognise the role of social interactions and cultural influences towards cognitive development and the interdependence in the construction of knowledge through engagement with the social processes (Vygotsky 1986; Polly, Allman, Casto & Norwood 2018). The aspects tie well with the fact that learners are exposed to the teaching prevalent in their cultural environments on which teaching in the Technology classroom should be built to form the community of practice. This would help learners to learn the creative design process in Systems and Control with understanding. As Vygotsky's social theories stress that learners are supposed to interact with one another for their cognitive development in the learning processes, it becomes crucial that in the design process, the tasks of the creative designs should be drawn from their diverse cultural environments. Nurtured this way, learners' cognitive perspectives can promote the relevancy of knowledge acquisition through meaningful learning.

The teacher could develop creative design process activities that will enable learners to process, elaborate and interpret the information through their experiences based on their interaction with their sociocultural environment (Murdoch 2000; Henning 2004; Pengiran & Basar 2018). On the other hand, it should be considered that cognitive learning emphasises the complex, abstract and intellectual processes such as thinking, problem-solving, perception and insight (Gagne 1980). These cognitive learning aspects resonate with the nature of Technology Education, especially the design process towards building technological capability. However, it can be argued that the cognitivists tend to focus more on abstract knowledge that overlooks other knowledge practices such as IK which is so misleading (Handley et al. 2006). Calliou (2020) posits that a circular relationship within knowledge that extends to all aspects, collection, transmission, analysis and understanding exists.

Consequently, knowledge should not be perceived as primarily abstract and symbolic, but in a real sense, it should be regarded as provisional, mediated and socially constructed (Vygotsky 1986; Handley et al. 2006; Polly, Allman, Casto & Norwood 2018).

Technological capability is the holistic approach to knowledge, skills and values within the design framework; also, it is considered as an active, synthetic, integrative capability that exists in a social context (Department of Basic Education 2011). Hence, the integration of IKS and how IKS can enhance learners' understanding in the teaching and learning of the creative design processes, is explored in this study. Consequently, SLT could play a more principal role towards the integration of IKS into the creative design process if associated with the aspects of culturally orientated creative design process product models (Moalosi et al. 2010; Wong & Siu 2012). The subsequent section explores the SLT theoretical models that resonate with this study towards the development of a data analytic framework.

2.5 The application of the SLT theory in the study

A theoretical model creates a platform for theoretical thinking that makes education more relevant and practical (Mwinzi 2015:677). Brown, Collins and Duguid (1989) postulate that the model of situated learning or cognition is grounded on the view that knowledge is contextually situated and is fundamentally influenced by the activity, context and culture in which is used. In the prior sections, it was established that SLT embraces learning as a social activity that happens in the social context and in the learning environment that embraces social, cultural and physical contexts (Cakmakci et al. 2020).

SLT is a well-grounded and well-researched theory with established models that represent it in various research contexts. There are three crucial constructs that define the SLT models, namely, the legitimate peripheral participation (LPP), the community of practice (CoP) and the cognitive apprenticeship (CA) (Lave & Wenger 1991). In addition, McLellan (1996:7) identified eight key components that are involved in situated learning such as stories, reflection, cognitive apprenticeship, collaboration, coaching, multiple practice, articulation of learning skills and technology. Therefore, the preceding three constructs from SLT models and some of the additional eight key components of the SLT, play an important role towards establishing how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control content in the classroom in this study.

Hence, the articulation of SLT models in relation to the study, could assist towards establishing the Senior Phase Technology teachers' understanding of IKS with respect to the creative design process; the opportunities that IKS presents towards the teaching of the creative design process in Systems and Control; the attempts made to integrate IKS in the creative design process in systems and control; and lastly but not least, how can the teaching of Technology framed towards the effective integration of IKS into the creative design process in systems and control. It should be noted that the preceding mentioned aspects emanate from the study's objectives. Thus, the SLT models in relation to the study are addressed in the subsequent subsections.

2.5.1 Legitimate Peripheral Participation (LPP)

Legitimate Peripheral Participation (LPP) is an anchor of situated learning (Brook, Grugulis & Cook 2020:1045). The LPP is embedded in contexts, culture and activity in which learning occurs (Lave & Wenger 1991). In addition, LPP defines the environment within which the aspects of situated learning occur where learning is taking place within the context in which it is applied, such as social, cultural and physical contexts (Herrera 2020; Kurt 2021). Bonnette and Crowley (2020: 145-146) further suggest that to achieve LPP, a learner must engage the following practices on an ongoing basis: (1) engage with the CoP; (2) acquire skills and knowledge requisite of the practice; and (3) develop an identity as a full participating member within the CoP. Based on the mentioned practices, in the Technology classroom, learning should be viewed as a social process where novices gain skills and knowledge through participation within a community of practitioners and eventually more towards full participation in the sociocultural practices when dealing with creative design process activities (Lave & Wenger 1991; Bonnette & Crowley 2020).

Moalosi et al. (2010) identified some of the social practice factors as material factors, emotional factors, Technology/Design factors which are more in line with the creative design process skills. One fundamental thing is that the teacher as an expert should be a full participant towards integrating IKS in teaching creative design processes in Systems and Control, not the other way around. As a result, this brings us to the point that the teacher is an expert not a novice in this case.

However, the application of LPP, for instance, can be represented in two scenarios, (1) the Technology teacher is regarded as an expert and learners are regarded as novices who are the LPPs, (2) the curriculum specialists can be regarded as the experts and the novice teachers regarded as the LPPs. These two scenarios could be established through individual interviews (Boylan 2010). Furthermore, learning happens because of participating actively in a CoP which includes LPP as its central defining characteristic through reflections, articulation of learning skills, collaboration, activity and stories (Herrera 2020). These characteristics were checked through interviews and class observation.

Consequently, the Senior Phase Technology teachers' understanding of IKS with respect to the creative design process in Systems and Control was critical at this stage. It is assumed that LPP has not been fully applied in the Technology classroom to learners on how they learn as part of CoP and similarly to new teachers (Korthagen 2010). Hence, the integration of IKS in creative design activities can provide an authentic learning environment that can promote the development of critical and analytical skills in learners and novice teachers through LPPs as IKS form part of people's social, economic scientific and technological identity (Odora Hopers 2002; Mavuru & Ramnarain 2017). The next section deals with the SLT model on CoP.

2.5.2 Community of Practice (CoP)

Learning, whether intentionally or not intentionally occurs through LPP in CoPs (Lave & Wenger 1991). The CoP knowledge is context-depended and situated within group members learning from each other (Brooks, Grugulis & Cook 2020:1047). The SLT defines learning as the process that happens because of participating actively in a CoP (Lave & Wenger 1991; Herrera 2020). CoPs are defined as shared activities and identities, not as physical boundaries of the community (Bonnette & Crowley 2020; Herrera 2020). The shared activities can be identified as artefacts, practices, knowledge, customs, relationships, roles and identities in CoP. Hence, these shared activities could assist the present study to establish the attempts teachers make to integrate IKS in the creative design process activities in Systems and Control content. However, Brooks et al.

(2020:1049) argue that CoPs are a complete community that is composed and dependent on both novices and experts. Hence, the interaction between the novices and experts is common and informal with members usually co-located either in the classroom (learners and teachers) or educational cluster structure (teachers and curriculum specialists).

The present study recognises novices as learners and new teachers in the field of Technology Education teaching creative design processes in Senior Phase classrooms on the Systems and Control content. The expert is an experienced teacher who has been teaching creative design processes in the topic of Systems and Control in the Senior phase Technology Education classroom as well as the Curriculum specialists in Technology subject. The learners and or new teachers (novices) are peripheral members of the group in the sense that they yet required to learn or to teach the required skills towards integrating IKS in creative design activities in the Systems and Control activities to be fully functional members at the same time, playing an important role in the way groups work. It is against this background that Brooks et al. (2020:145) suggest that novices need to gain skills, as established members of a community that are required to demonstrate, model, or teach those skills, explicitly articulating them, not taking for granted their assumptions, and remembering important incidents to relate towards developing own praxis through dialogue and or interaction.

As it might be expected that the novices learn from more experienced experts, Brooks et al. (2020) caution that while novices may be inexperienced in the work of CoP, they are not devoid of knowledge, skills, or viewpoints and can also serve to consolidate and reaffirm expert knowledge. Subsequently, learning and knowledge transfer within a CoP should be seen as a mutual process, which challenges the notion that CoP learning occurs linearly and chronologically (Lave & Wenger 1991; Brooks et al. 2020). Furthermore, Brook et al. (2020: 1058) posit that working and learning are integrated and inseparable in CoPs. It is within the integrated context where everyone learns, where knowledge and skills are shared, and where both novices and experts contribute. Hence, learners should learn through collaboration, in groups, observing existing practices, supporting expert teachers, taking basic tasks and gradually assuming responsibility for their learning in the creative design process.

The same process would apply to the newly appointed teachers and curriculum specialists. Expert teachers or curriculum experts should create a conducive environment where learners or new teachers should be allowed to express their shared practices, knowledge, customs, relationships, roles and identities. This is a way of integrating IKS into the CoP through narrative, storytelling and discussion to enhance the learning of the creative design process in Systems and Control in the Senior Phase. Subsequently, the importance of interaction through narrative, storytelling and discussion amongst others which resonate with indigenous people could be part of learning in CoP (Smith 2008; Brook et al. 2020). Hence, Vygotsky (1978) points out that interacting with others in the CoP could create growth by making connections between concepts as the result of cognitive development.

Ultimately, the development of cognitive concepts could become handy in the learning contexts that recognise social and cultural factors towards promoting the spirit of *botho* in the CoP through collaboration amongst members. *Botho,* generally known as ubuntu globally, but has cognates in related Bantu languages, is the African philosophical notion that values the *botho* principles towards emphasising interdependency and forming relations amongst novices and experts (Mavuru & Ramnarain 2017:180). The *botho* principles of solidarity, harmony, tolerance, sharing, care and mutual support are values crucial for the enhancement of teaching and learning also in the CoP (Lephoto 2021; Thomas 2021). Therefore, there is a need for *ubuntu*-oriented approaches and strategies towards facilitating teaching and learning to resonate with the socio-cultural contexts in the SLT, which is appropriate with CoP (Lephoto 2021:3). Furthermore, Lephoto (2021) postulates that taking into consideration the *botho* principle could in a way cultivate a conducive and friendly environment for CoPs that is characterised by positive relationships between the novices and expert.

Similarly, the *botho* principles totally embrace SLT, CoP and social constructivism when it comes to knowledge construction. Foregoing, knowledge is socially constructed through personal experiences and collaboration in a sociocultural context, where participants support and encourage one another throughout the learning process (Kupe 2020; Rannikmäe et al. 2020; Lephoto 2021; Thomas 2021). Consequently, learning contexts that promote the spirit of *botho* have the potential to positively influence the attitude and confidence of a learner towards the learning of the IKS-creative design process-oriented content. Therefore, the subsequent sections deal with the cognitive apprenticeship construct of SLT.

2.5.3 Cognitive Apprenticeship

Cognitive apprenticeship (CA) learning is a vital construct towards cognition and social growth in children but also reflects SLT (Cakmakci et al. 2020: 294). In addition, Cakmakci et al. (2020) postulate that, in SLT, learning is a social activity that takes place when someone is doing something in a social context; accordingly, the learning environment has social, cultural and physical contexts. Furthermore, Collins and Greeno (2010:2) posit that cognition is fundamentally a social activity and is distributed across members of a learning community and that knowledge is situated in the contexts, cultures and activities in which is produced and used. Hence, Pengiran and Besar (2018) suggest that learning that is situated in the social, cultural and physical contexts is more effective than non-situational learning. Therefore, cognition is the dialectic between persons acting and the settings in which their activity is established.

Roth and Jornet (2013:2) emphasised two assumptions about the Situated cognition theory (1) cognition arises in and for action, this cognition is enacted, and it is distributed across material and social settings because of features, (2) cognitive becomes distributed within a team of people engages in problem-solving through talk, questioning and coordination of cultural and representational tools. The two assumptions resonate with the fact that the creative design process is an integral part of Systems and Control content in that learning activities should be developed to enable learners to process, elaborate and interpret the information through their experiences based on the interaction with their socio-cultural environment (IKS) background.

On the other hand, De Bruin (2019:263) elucidates the understanding of cognition to be dependent on the process of knowledge acquisition, whereas apprenticeship is the interaction between an expert and a novice in CoP. Consequently, the notion of apprenticeship seems to have been influential in teaching and learning throughout history with more emphasis on traditional apprenticeship (Collins, Brown & Holum 1991).

However, Cakmakci et al. (2020) argue that there has been a move in education from the traditional apprenticeship model to the CA model, which is more applicable towards teaching and learning across the Science, Technology, Engineering and Mathematics (STEM) disciplines. De Bruin (2019) further confirms that the utilisation of the CA structure in teaching and learning brings special unique benefits for both teachers and learners. CA focuses on enculturing learners into adapting the cognitive process and skills of those who are LPP of a community through different methods (Brown, Collins & Duguid 1989:37). For instance, in this study, when we teach Technology, we are enculturating learners into the community of technologists, at the same time expect them to acquire epistemology, knowledge skills, ways of thinking and tools of the STEM community.

In this study, the CA is used within the context of social interaction to give an analysis of the case study data that sought to explore how Senior Phase Technology teachers integrate IKS into the creative design process activities in Systems and Control content in the classroom. CA model also contributes towards exploring the opportunities IKS presents regarding the teaching of the creative design process in Systems and Control in Technology Education. This is in line with the basic underlying principle that all knowledge, including IK, scientific and technological knowledge is originally grounded in personal encounters with concrete situations (Korthagen 2010:103). Consequently, the learning environment should be designed to make targeted cognitive processes explicit and visible so that learners can observe, enact and practice in contexts that make sense to them and can also enhance their domain-specific as well as domain-general knowledge and skills.

However, in this study, knowledge has its roots in practical situations such as creative design process skills and socially constructed that bring in the IK aspects. According to Korthagen (2010), the SLT tries to explain the role of embedded social learning and the characteristics of knowledge and knowledge development. Hence, this contributes to a better understanding of the relationship between theory and practice in the Technology classroom (Korthagen & Lagerwerf 1996; Korthagen 2010). Consequently, the teacher as an expert is required to show expertise in the knowledge of the domain – involving concepts, facts and procedures; heuristic strategies – involving techniques and approaches for accomplishing tasks; and the control of learning strategies (De Bruin 2019: 264). These knowledge types are important in determining a conducive learning environment for the expert teacher/curriculum specialist and the novices. By the same token, the expert teacher should be acquainted with the intrapersonal and social process of situated learning, i.e., classroom practice. Korthagen (2010) reinforced Epstein's (1991) view that human behaviour is mediated by the mind systems processing information in a very rapid manner. The mind systems involve cognitive, emotional, motivational and behavioural factors which are also applicable to the teaching and learning of Technology in the classroom.

The CA offers an integrated approach considering the shift in the purpose of knowledge that can take place during the teaching of creative design activities in Systems and Control. Consequently, the CA builds onto four fundamental dimensions and a pedagogical frame with six processes to promote teaching learning in the creative design process. The four fundamental dimensions are identified as content, method, sequencing and sociology; and the six pedagogical processes as modelling, coaching, scaffolding, articulation, reflection and exploration (Collins et al. 1991). These four dimensions and six pedagogical processes should be considered in developing learning environments for creative design process activities in Systems and Control content considering aspects of IKS. The descriptions of the four dimensions and six pedagogical processes are as shown in Table 2.1. below.

Table 2. 1: Four dimensions CA and six pedagogical processes promoting students learning (Collins et al. 1991; Tariq et al. 2021)

Dimension	Description	Example
Content	Domain expertise and strategic knowledge	-Concepts, facts and procedures -Techniques and approaches -Control of learning strategies.
Method	Teaching and learning domain-six pedagogical processes.	-Modelling -Coaching -Scaffolding -Articulation,

		-Reflection -Exploration
Sequencing	Complexity of the tasks Diversity of the tasks Global to local skills	-Regulate the teaching and learning tasks. -Inclusive tasks to accommodate experts and novices -Tasks that develop skills across.
Sociology	Focuses on the teaching and learning tasks	-Situated teaching and learning - realistic tasks -Development of CoPs and intrinsic motivation -Cooperation

Table 2.1 above affirms that CA instructional model for situated learning could be more beneficiary to the present study that seeks to explore some of the opportunities IKS presents to the Senior Phase teachers regarding the teaching of the creative design process in the Systems and Control content. This requires Technology teachers as experts to be well grounded in the content domain with a clear understanding of content knowledge involving concepts, facts and procedures of the creative design process in Systems and Control content; and strategic knowledge that involves techniques and approaches as well as having the ability to control of the various learning strategies that also involve integrating IK.

In the *method domain,* the expert teacher should be well grounded on the application of the teaching and learning pedagogical processes either through modelling, coaching, scaffolding, articulation, reflection, or exploration. The development of such approaches or pedagogies could be an advantage to the integration of IK in the creative design process activities in the System and Control content of the Technology Education classroom as it enables the learner and the expert teacher to explore, discover and apply new knowledge. In the *sequencing domain*, tasks can be sequenced and regulated to reflect the changing demands of learning and extend the learning of the creative design process in Systems and Control to diverse settings so that the application of knowledge and skills is diversified.

In the case of *sociology domain*, the focus of creative design process learning tasks should be realistically situated in teaching and learning. The tasks should also promote the development of CoPs, intrinsic motivation and cooperation amongst the novices and experts alike. Therefore, it can be concluded that the CA model builds on the situated knowledge perspective. Furthermore, the model helps to reconcile the situated learning perspective with the perspective of theory which represent the complementary ingredients of an integrated view of learning to teach.

2.6 Conclusion

SLT in this study is the theoretical framework through which the study seeks to explore how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control content. SLT is the theory that creates an environment where knowledge and skills can be organised in an authentic context. Context is vital for understanding, learning and practice of knowledge, hence SLT puts the study in its context. As learning is the situated practice in which cognition and social interaction are connected, the rationale for SLT in this study is that it creates a good opportunity for the recognition of IK during the teaching of creative design process activities in Systems and Control. Situated learning and cognition are essentials of learning in a social phenomenon that takes place at the interval interaction.

The social and cultural contexts constitute human mental processes which are situated in historical, cultural and institutional settings such as schools and classrooms where IK could be a pillar. Learning is described as an integral part of the generative social practice in the lived world and notice the concerned characteristic of the situated activity. Hence, this has strong implications for a Technology teacher and learner in the classroom. Technology is a viable subject for teaching problem-solving skills and design skills due to its nature of theory and practice. Technology Education comprises cognitive aspects such as knowledge and skills towards the learning process. In this case, knowledge is associated with the knowledge of the subject content and its pedagogy and IK; skills involve design process skills, problem-solving, and critical and creative thinking. Creativity is an original cognitive ability in problem-solving processes towards producing a product and the design process is a referent social practice in Technology Education. The chapter further looked at the application of SLT models in the study in order to properly contextualise the study within the SLT parameters to align data collection and analyses.

The SLT models explored in this chapter are LPP, CoPs and CA. Summarily, each model is described as follows, in the LPP model, LPP defines the environment within which the aspects of situated learning occur where learning is taking such as social, cultural and physical contexts. The LPP is a central defining characteristic for CoP towards active participation in the learning process through reflection, articulation of learning skills, stories, etc. Therefore, the LPP model helps to explore the teachers' understanding of IKS with respect to the creative design process in Systems and Control. Furthermore, in the CoP model, learning occurs through LPP. Knowledge is context-based and situated within group members (novices and experts) learning from each other in the CoP. CoPs are shared activities and identities. The shared activities and identities could help to establish the attempts teachers make to integrate IKS in the creative design process activities in Systems and Control content.

In the CA model, learning is vital towards cognition and social growth and reflects SLT. Cognition is a social activity and is distributed across members of a learning community. Knowledge is situated in the contexts, cultures and activities in which it is produced and used. In this study, knowledge has its roots in the creative design process and it is socially constructed. The CA model offers an integrated approach considering the shift in the purpose of knowledge. Hence, there are four dimensions of content, method, sequencing and sociology together with six pedagogical processes of modelling, coaching, scaffolding, articulation, reflection, and exploration are identified towards the development of learning environments. The learning environments will create conducive environment to learn creative design process activities in Systems and Control content taking into consideration the aspects of IKS. The CA model benefits the present study that seeks to explore some of the opportunities IKS presents to Technology teachers regarding the teaching of creative design processes in Systems and Control content.

Consequently, the LPP, CoP and CA models point towards the need to take immediate teacher content knowledge towards classroom practice more seriously to address the development of conducive classroom interaction. This calls for a rethink of the classroom practices in the confines of the SLT. The situated learning perspective drives a realistic approach towards Technology Education through the distributed nature of knowledge which needs to be considered in this study with reference to the creative design knowledge in Systems and Control content and the IK.

There is a need for group or peer support amongst the teachers and learners learning in the Technology Education classroom regarding integrating the IK into creative design process activities. Therefore, there is a need for a framework that can assist the rethinking of an approach towards teaching the design process stages in situated learning which would be possible based on the current case study. This will contribute towards teachers' pedagogy of teaching creative design activities at a concrete level, but also contributes towards a theoretical foundation for the realistic Technology classroom which could build on the analytic framework.

CHAPTER 3

TECHNOLOGY EDUCATION AND INDIGENOUS CREATIVE DESIGN PROCESSES IN SYSTEMS AND CONTROL

3.1 Introduction

This study aimed to establish how Senior Phase Technology teachers can integrate IKS into the creative design process activities in Systems and Control. Hence, the literature review in this chapter is based on the conceptual arrangement to explore the grounding concepts towards addressing the aspects outlined in the aim of the study. Section 3.2 of the chapter deals with the nature of Technology and related concepts, knowledge and philosophy that the Senior Phase teacher needs to be grounded in before integrating them with other knowledge systems such as local knowledge. Section 3.3 discusses the Technology principles of creativity and indigenous design processes in Systems and Control. Section 3.4 deals with the Technology Education curriculum transformation with specific reference to IKS and the creative design process. This section delves into the education transformation as an attempt to decolonise the school curriculum – in the creative design process in Systems and Control in relation to the indigenous worldview. Section 3.5 deals with Technology Education and the integration of IKS – IKS and IK concepts are clarified and how they can be integrated with the creative design process in Systems and Control is fully discussed. Section 3.6 deals with the implications of integrating IK into the creative design process in terms of learning Systems and Control – this section looks at the challenges that are faced by teachers when integrating IK and the possible solution for addressing the identified challenges.

3.2 The nature of Technology and Technology Education

This section discusses the nature of Technology and Technology Education with its philosophical underpinning and knowledge to provide the context in which the present study unfolds. The section unfolds in the subsections below.

3.2.1 The evolution of the concept technology

The concept of technology has developed through time, culture, space and context, presenting challenges to describe this concept. This subsection attempts to describe the concept considering varied scholarly views. Ngetu and Gumbo (2019) unpack the concept of evolution as a continuous phenomenon partly because the human mind keeps searching for improvements in the areas of business, health, food, transport and most importantly lifestyle. In the current discourses, the concept of technology has narrow and broad meanings dictated by different contexts, cultures, and sectors (Zuga 1997; Mapotse 2015; La Shun 2017; Gumbo 2018). The concept technology evolved as early as 1829 when it was understood to consist of principles, processes, nomenclature of arts which involved the application of science which might be considered useful and beneficial to society (Bigelow 1829; La Shun 2017). Defining the concept of technology has, therefore, not been easy as technological activity is so all-embracing, which in some instances leads to misconceptions (Banks 1994; Gumbo 2018). There are strong views about the misconceptions of the concept of technology and, also, that the concept is poorly understood and ill-defined with both material and non-material aspects confused or studied in isolation (Bleed 2008; Gumbo 2018). La Shun (2017:9) posits that there is more to the concept of technology than the physical manifestations to which it is accustomed, but a lack of proper description prevents progress towards understanding the essence of the concept itself. Gumbo (2018:134) warns that perceiving technology from the Western industrial perspective only could limit and contribute towards its misunderstanding, especially in the developing indigenous contexts where technology could have a contextual meaning that is informed by local forms dynamics. Gumbo further suggests that other forms of knowledge such as IK that help in building a contextual understanding of Technology Education should be integrated into the definition and knowledge construction. Hence, the subsequent paragraphs look deeper into the concept in relation to the present study.

La Shun (2017:6) postulates that there are different words mostly used concerning the clarification of the concept of technology such as technology, science, philosophy, knowledge, culture, social, human, material, system, process, and power. However, despite the different views concerning how to frame the description of the concept, there are core aspects such as technology, science, philosophy and knowledge. In light of the above, one can still argue that the concept depends on the viewpoint from which it is looked at. Hence, the subsequent paragraphs address the core aspects of technology, science, philosophy, and knowledge as highlighted.

3.2.1.1 Technology

Technology does not exist in a vacuum; it has always been entrenched in people's lives as part of their ethos. Technology has significantly changed how human beings perceive the world, how they relate to one another and how they live their lives. According to LaShun (2017:7), technology has certain material manifested by the plethora of commonly agreed-upon examples that surround people in the physical world. In the South African context, the nature of Technology is associated with the comprehensive approach to knowledge, skills, and values within the framework of the design process which is the backbone for teaching the subject (DBE 2011; Ndlovu 2012; Mapotse 2015; Gumbo 2018). Through the design process, learners are expected to progress through a design task, and this could be by the teaching of the associated knowledge and the skills needed to design and create a solution (DBE 2011:12). The associated knowledge, in this case, should embrace all knowledge systems as technology embraces knowledge, technical skills and resources available in people and natural, and man-made environments to meet human needs (Gumbo 2020:9). In addition, Ogungbure (2011:89) perceives technology as the human activity that encompasses materials, social and communication which are further sub-divided into materials and social intellectual amenities. These materials, social and intellectual amenities are mostly used for goods or services such as soap, food, values, norms, ideas, cognitive knowledge. In addition, two usages of the concept technology from the engineers' and social scientists' points of view are highlighted (Mitcham 1994). The author further points out that the concept engineer has etymological and sociological connotations over technology. Etymologically, the concept engineer is rooted in Latin *'ingenerio*', meaning to implant, generate, or produce, readily connoting producing or making but not only of an artificial sort but also associated with nature as well as with 'ars' or 'techne'. It is against this background that technology can be regarded as technical knowledge, which is naturally less sophisticated in comparison with the engineer who establishes protocols and methods that the technician employs to conduct designs formulated by the engineer (Mitcham 1994; DeVries 2017). The author's view is that the technologist knows how to perform a test, operate a machine, assemble a device but not necessarily how to conceive, design or think out such an artifact.

Hence, the concept of technology with its cognates in this instance could be viewed as directly involved with material construction and the manipulation of artifacts than nature and its laws (Mitcham 1994; Rauscher 2009). However, such descriptions are more Western orientated if the factors of human activity are not considered so that indigenous perspectives are infused which resonate well with the material, social and intellectual amenities identified by Ogungbure (2011). Eggleston (1996) also supports the notion by Zuga (1997), and O'Riley (2001), as highlighted by Gumbo (2017), who argue against the Western perspectives on technology.

On the other hand, technology is seen as a human activity. In this light, Naughton (1994) highlights two distinct points which are practical activity and application of knowledge. The author further describes the goal of practical activity as solving a problem to make something happen. Also, describes the application of knowledge as not just scientific knowledge but also other types of knowledge such as theoretical, practical, and other knowledge sources of which in this study the other knowledge sources could include IK. Mitcham (1994) looks at the concept from the narrow engineering view which is more Western-oriented. On the contrary, Gumbo (2018:134) pokes the engineering perspective which discredits indigenous forms of technology as it requires learners to gain the job skills such as communication, analysis, problem-solving and creative and critical skills that position them to perform and fit well into the job market. It is against this background that Gumbo (2018:134) strongly argues that an attempt to define technology through subjects such as engineering and others which portray indifference between technology and other subjects is undesired and could add to the factors that cause its misunderstanding, hence, Technology needs to be related to the other subjects showing points of convergence and divergence with them. He further suggests that technology should be understood from the point of view of the ecosystem of knowledge that helps build and improve the subject. Naughton (1994) looks at the concept of technology from the scientific point of view which contributes to the concept's marginalisation effect on IK. Naughton (1994:8) classifies technology into two distinct aspects such as "things" and "human activity". About technology as things, Naughton (1994) elaborates on three categories, that is goals, people, and knowledge. Consequently, a goal is defined as a series of practical tasks; people as scientists, engineers, technicians, and computer experts – this list of professional technologists excludes the IK holders. Knowledge in Naughton's aspects is of certain kinds which depend on the context. IK can be accommodated to form part of this aspect. The contextual perspective views technology as part of society's culture, values and beliefs; technology as a reflection of the human-made world; and technology as enhancing living conditions, which plays a significant role in human activity (Gumbo 2019:13). Human activity could be associated with practical activity and application of knowledge as alluded to in the preceding paragraph. This viewpoint is discussed further later in the study when dealing with the transformation of the Technology Education curriculum and other knowledge sources.

3.2.1.2 Science

Science is seen as the determining factor of how we come to know about the physical world and its laws (LaShun 2017). Science encompasses the systematic study of the structure and behaviour of the physical and natural world through observation and experiment, while technology is the application of scientific knowledge for practical purposes (UKEssays 2018). Science, innovation and technology are all interconnected. Science provides knowledge that is a direct source for new technological possibilities and inventions (Barlex & Pitt, 2000; Barucija, 2020). Without scientific knowledge, there is no information or knowledge gained which can be applied through scientific methods. Scientists use their theoretical knowledge to develop technology, and then use technology to develop science; for this reason, science and technology are an integrated concept in today's world. However, science, design and technology are different from one another, and the only appropriate relationship is coordination and collaboration in problem-solving. Mitcham (1994:151) interprets the social scientist's usage of the concept of technology to have a broader meaning as it includes all that the engineer calls technology, engineering included. He further posits that according to social scientists, technology in its broader meaning means the practical arts. These arts range from hunting, fishing, gathering, agriculture, animal husbandry and mining through manufacturing, construction, transportation, and provision of food, power, heat, light, etc., to means of communication, medicine, and military technology. A social scientist further perceives these technologies as bodies of skills, knowledge, and procedures for making, using and doing useful things which are more Western-oriented. Science is framed within the Western scientific worldview (Mpofu 2014). Hence, it could be argued that science contributed to the marginalisation of IK, which brought the cultural differences between the Western and indigenous cultures into conflict. Furthermore, the science content or discipline is more of Western orientation than African indigenous orientation which created the imbalances. These imbalances came as the result of the colonial pragmatic approach towards the ways of knowing at the expense of IK (Shizha 2010).

3.2.1.3 Philosophy and knowledge

Philosophy and knowledge contribute towards the conceptualisation of technology. La Shaun (2017) posits that philosophy and knowledge determine the ultimate success in arriving at such knowledge that may be attributed to the power of reasoning. However, it should be further noted that the underlining principle from the philosophical perspective of technology is what might be referred to as the history of ideas which determines how different periods and individuals conceived and evaluated the human making activity; also, the way ideas have interacted with technologies of various sorts (Mitcham 1994; De Vries 2005; 2017). Additionally, Mitcham (1994:114) notes that the history of the philosophy of technology has emerged from engineering and humanities philosophies, which also emanated from the internalist and externalist histories arising from the contextualist approach. This emanation of technology particularly from engineering confirms its sidelining effect on IK as engineering is heavily perceived from the modern industrial perspective. Davis (2005:29) posits that the contextualist theory of knowledge hypothesises that the true conditions of knowledge claims depend on contextually varying standards towards accounting for the variation in what people claim to know and the difficulty people have in resolving skeptical paradoxes. The varying standards such as what needs to be ruled out by the subject, the subject evidence, the reliability of their beliefs, the subject's required degree of belief and the required type of the subject's epistemic positions (Baumann 2016; Kyriacou 2020). Hence, the contextualist approach perceives technology as a social construction at the level of both internal developments and external relations (Mitcham 1994; Gumbo 2019). Moreover, the contextualist approach is built on making and using artifacts and it has the influence of technology among those with trans-technical interests respectfully. However, it can be argued from this discussion that, whether internalist, externalist, or contextualist, most histories of technology are limited in what they can contribute to an understanding of pre- and post-modern ideas about technology and other knowledge systems such as IKS.

3.2.2 Categories of technology

Technologies are techniques and meanings for accomplishing recognised purposes. In the same light, Bunge (1979) categorises the concept technology into four embracive dimensions i.e material, social, conceptual, and general. In addition, two usages of the concept technology Bunge (1979) associate the material branch with the traditional forms of engineering; the social branch with psychology, sociology, economics, and military science; the conceptual branch with computer science; and the general branch with automata, information and optimisational theories. Furthermore, the above three dimensions can be compared to Ogungbure's (2011) as discussed in Section 3.2.1.1 in which Ogungbure expanded the social dimension to the sub-division, social and intellectual amenities which can be embracive of IK rather than Bunge's as they include aspects of values and norms which resonate well with the indigenous African view.

Bunge (1979) tries to approach the description of the concept holistically from all aspects of society as it engages with the human in relation to philosophical anthropology (the use of tools and reliance on technology throughout human history). Its differences are drawn between its manifestation in the mind through bodily activities and independent objects that take place in the physical and social worlds. However, it can be argued that the social worldview of technology is more orientated towards the Euro-Western perspective than the African indigenous perspective. La Shun (2017:18) holds that despite the great ideas on the philosophical conceptualisation of technology, it remains unclear whether there was a fundamental description that was consistent with the rest of the descriptions in the literature. La Shun suggests a comprehensive framework in which technology can be conceptualised.

The comprehensive framework describes technology as: a) something which is always inherently intelligent enough either to function, to be used to function, to be imbued with or to be interpreted as having a function that only intelligent beings can comprehend; b) something devised, designed or discovered to serve a particular purpose from a purely secular stand-point without requiring that mankind be responsible; and c) significant beneficiary of rationally derived knowledge, which is used for a purpose without itself necessarily being translated into something physical or material that does, e.g., instructional methodologies in education, processes, ideas (La Shun (2017:18). The framework embraces a wide range of aspects that the description of the concept technology should cover for it to be understood within its context in which is intended for. Context is an important aspect of technology (Gumbo 2019:13). However, the three descriptions of technology were framed from the ethological perspective which shows a lack of all-inclusiveness of other knowledge perspectives such as IK. Hence, Obikeze (2011) and Gumbo (2018) tried to close this knowledge gap in that they view technology as any human or culturally generated devices, formulations, or organisation that may be used to produce or create the needed goals and services. Gumbo (2018:134) reformulates Obikeze's definition to make it more inclusive by referring to technology as the knowledge, technical skills, and resources available in a certain community and the environment which the community occupies and is used to meet its needs to ensure its sustainable development. Gumbo (2018) further addresses the factors responsible for the misunderstanding of Technology Education with other subject fields. Gumbo (2018:134-140) identifies these factors as misleading internet searches that yield more about educational technology than Technology Education; unqualified teachers teaching technology education due to its newness in the curriculum; educational technology researchers being ill-informed about Technology Education; under-representation of IKS in the CAPS; Technology Education being confused with other subjects such as educational technology, engineering education; and names of academic associations identifying Technology Education as Technology in Education and educational technology.

The literature in this section exposed different descriptions of technology from different perspectives, that is, scientific perspective, engineering, social scientist perspective, ethological perspective, contextual and IK. However, the majority of the perspectives represent the Western worldview of technology, but some took the IK perspective that takes the African worldview into consideration (Mpofu et al. 2014). The two perspectives combined help to describe the concept of technology within the context of the present study.

Given the scientific and engineering perspectives discussed above, it can still be argued that the epistemology of technology has proven that technology is not just an applied science as been suggested since the 1950s (De Vries 2017). Furthermore, engineers have knowledge of functions and an opinion about reality, meaning that they tell what the artefact can do as a desired reality rather than describing the behaviour of the artefact which is the actual reality. On the contrary, Gumbo (2018:134) confronts the engineering perspective which discredits indigenous forms of technology as it requires learners to gain job skills that position them to perform and fit well into the job market. According to De Vries (2017:21), the fact that technology is an integral part of human existence, its descriptions cut across both analytic and continental as well as IK from a philosophical perspective. However, concerted research work to confront the Western perspective of technology is needed to ensure no further marginalisation of IK.

The analytical philosophical dimension which comprises the scientific and engineering perspectives deals more with the conceptualisation of technology, while in the continental philosophical dimension which entertains the social scientist perspective, values play a vital role in technology which bring in the normative dimension in technology (De Vries 2017:28). Furthermore, De Vries (2017) postulates that the notion of normativity in technological knowledge stimulates a view of technology in which values are an integral part than was thought previously that technology is neutral. Therefore, the understanding and use of the concept of technology in the current study are within the philosophical perspective of technology with the normative dimension to embrace IKS views. The subsequent subsections and paragraphs deal more with technology and knowledge.

3.2.3 The relationship between technology and knowledge

Technology has its own knowledge base (Williams & Williams 1996; Jones & Moreland 2004). This concerns the knowledge of the nature and content of Technology itself (content knowledge), pedagogical knowledge of approaches and practices to teach Technology or technology subjects, and pedagogical content knowledge (Gudmundsdottir & Schulman 1987; Mishra & Koehler 2006). According to La Shun (2017:7), seeking knowledge is a philosophical inquiry that may consist of abstract thinking which is highly organised, called metaphysics, and is commonly practiced in many areas of philosophy including IKS. IKS is known as indigenous ways of knowing or ethnoscience (Gaotlhobogwe 2017:286). Furthermore, La Shun (2017) highlights that metaphysics concerns the fundamental reality and the nature of what is real.

This brings the understanding that technology can be articulated in four fundamental modes, i.e. knowledge, activity, object, and creative knowledge (volition) as these define the underpinning philosophy of technology (Mitcham 1994; Jones, Buntting & de Vries 2013). The modes of knowledge and creative knowledge (volition) are more dominant in this study. Knowledge is fundamental in any subject matter as it is regarded as an integrated body of information in a subject (Maluleka, Wilkinson & Gumbo, 2006). Knowledge is not void but value-laden (Dakers 2006). Gumbo (2015:60) identifies two kinds of knowledge, i.e., specialised knowledge and experiential knowledge. Gumbo (2015:60) further describes the specialised knowledge amongst others as “indigenous medicine and spirituality” and experiential knowledge as knowledge “acquired through exploration and practicality based on everyday life experiences”. Knowledge is also regarded as an essential ingredient of technology (Naughton 1994:8).

The views of Dakers (2006), Gumbo (2015) and Naughton (1994) emphasise knowledge in Technology as mostly based on experiential knowledge than specialised knowledge of which IK is part. However, it should be taken into consideration that knowledge is a complex body of several socially constructed ideas validated by the dominant intellectual persuasion at each point in time at which technology can be described as knowledge (Mitcham 1994; Ezeanya-Esiobu 2019).

In the same light, technology as knowledge and the mode in which it manifests can be classified as the subject of analytical investigation in the epistemology or theory of knowledge (Mitcham 1994; De Vries 2005). Furthermore, the literature alludes that the scientific theory level was changed to technological theories for technological theories to be placed at the highest level of technological knowledge in view of its normativity (Mitcham 1978; Bunge 1979; Vincenti 1994; De Vries 2006; De Vries 2017). In addition, Vincenti (1994:201) categorises the forms of technological knowledge into descriptive, prescriptive and tacit. Vincenti (1994) describes these categories as follows: descriptive knowledge describes things as they are; prescriptive knowledge is what is to be done to achieve the desired results; and tacit knowledge is what is contained in an activity.

In contrast, De Vries (2006) categorises the forms of technological knowledge into three, which are physical, functional and the relationship between them. The categorised forms of technology knowledge as identified by Vincenti (1994) and De Vries (2006) also have an impact on understanding the technological knowledge levels and types. The knowledge levels are identified as artisan skills, technical maxims, descriptive laws and scientific theory, structured from little to more conceptual knowledge, and the knowledge types are identified as conceptual knowledge (knowing that) and procedural knowledge (knowing how to) (McCormick 2004; Pavlova 2005). McCormick (2004) further outlines procedural knowledge as associated with aspects such as design, problem-solving, planning systems, analysis (or systems approach), optimisation, modelling, and strategic thinking; and conceptual knowledge as concerned with the relationships amongst items of knowledge, such as systems concepts.

All the forms, levels and types of technological knowledge posited by Vincenti (1994), McCormick (2004), Pavlova (2005) and De Vries (2006) in the preceding paragraph drive the understanding of the nature of technology in this study. The forms, levels and types of technological knowledge are grounded in the four fundamental modes of technology as knowledge as activity, object, and creative knowledge (Mitcham 1994; Jones, Bunting & De Vries 2011) as mentioned earlier in this section.

However, the articulation of technological knowledge in the preceding paragraphs is dualistic towards "knowledge in action" and "knowledge in the head" (Fleer 2015:38). This articulation does not factor in the role of IKS in the process, which opens a gap in the present literature. Therefore, this gap in a way creates an opportunity for an investigation into how Senior Phase Technology teachers integrate IKS into the creative design process when teaching Systems and Control.

3.2.4 Systems and Control

Technological systems can be classified as communication, physical, as well as biological systems that contribute towards human needs and wants (Gumbo 2019:11). Systems and Control in the South African Technology Education curriculum comprises two sections, that is, Electrical Systems and Control, and Mechanical Systems and Control taught in Senior Phase (Table 3:1). Consequently, this would require teachers to master the technological knowledge and its creative knowledge components factoring in the fundamentals of IKS in Systems and Control, hence, a clear background and understanding of IKS is crucial at this stage. However, Systems and Control is too abstract which could create challenges in finding the IKS example. Consequently, some of the examples that could be used in a house are steepness or ramp which is the application of the inclined plane, the use of wood to form hinges as well as the lifting of heavy loads using logs.

The discussion of the concepts of electrical systems and control and mechanical systems and control from the perspective of the indigenous people must be understood from their African psychology (Masaka 2018). African psychology can be understood as thinking of rehabilitation of the culture (Nwoye 2015). The dominant indigenisation discourse in South Africa could consider the process of decolonising Systems and Control. However, in this study Systems and Control involves input-process-output towards the integration IK in the technology classroom.

An electrical system and control, within the context of a building, is a network of conductors and equipment designed to carry and distribute (input) and convert electrical power safely (process) from the point of delivery or generation to the various loads (output) around the building that consume the electrical energy (Wiki 2020; Thomson & Khumalo 2019). Electrical system design is the design of the electrical system. This can be as simple as a flashlight cell connected through two wires to a light bulb or as involved as the space shuttle. Electrical systems are groups of electrical components connected to carry out some operation. Often the systems are combined with other systems. They might be subsystems of larger ones and have subsystems of their own. For example, a subway rapid transit electrical system is composed of a wayside electrical power supply, a wayside control system, and the electrical systems of each transit car. Each transit car's electrical system is a subsystem of the subway system. Inside each transit car, there are also subsystems, such as the car climate control system.

Mechanical systems and control in any building service use machines which include plumbing, elevators, escalators and heating and air-conditioning systems. It is a system of elements that interact on mechanical principles. Multimedia, Design and Technology Education (2020) regards a mechanical system as a set of physical components that convert an input motion and force into a desired output motion and force. Mechanical systems subscribe to a systems approach that comprises three elements: input, process and output. The input part of the system is any type of motion and force that drives the mechanical system. The input motion and force may be from any power source including human effort, energy from the wind, water, heat, etc., from a chemical reaction, or an electrical, pneumatic, or hydraulic device. The process part of the system is where mechanisms are used to convert the input motion and force into an output motion and force. The output is the change created in the input motion and force by the mechanism.

Hence the understanding of electrical and mechanical systems and control in the context of IK could assist during the application of creative knowledge towards design when handling creative design activities in Senior Phase Technology Education. The latter can create a conducive environment for learners to do systems and control activities that take into consideration the context in which they operate or learn and live (Mitcham 1994; Varnado & Pendleton 2004; Gibson 2008; Ogungbure 2011). Furthermore, a clear distinction must be explored around the concepts of technology and Technology Education internationally, regionally and locally to properly locate their context in this study.

3.2.5 Relationship between technology and Technology Education

Technology Education is neither Educational Technology nor computers technology. It is necessary to mention this point to clear the many misconceptions around the concepts of technology, Technology Education and Educational Technology (ET) (Brown & Brown 2010; Gumbo 2018). Furthermore, Gumbo (2018) posits that the misconception of Technology Education and ET went to the extent of shadowing the internet space as results weigh towards ET and information technology (IT). However, enlightenments of Technology Education are mostly found in books, book chapters, academic journal articles and publications than in general internet search though Technology Education has been named differently in different contexts both internationally and locally.

Internationally, in New Zealand and Australia, Technology Education is commonly known as Technology just like in South Africa (Forret, Edwards, Lockley & Nguyen, 2013; Gumbo 2018). In the Netherlands, the subject is called Natuur en techniek (Nature and Technology) (Rohaan, Taconis & Jochems 2012). Lastly, it is also part of the curricula in countries such as Canada, England, Finland and France ultimately and South Africa. In sub-Saharan Africa, Technology Education is named differently. In Botswana and Swaziland, it is called Design and Technology Education. This is because in these contexts, Technology Education was founded on the culture, history and philosophies of Euro-Western thought and content which is indigenous to Western culture and its institutions (Gaotlhobogwe 2012; Fleer 2015; Moalosi et al. 2017; Yisak & Gumbo 2017). In Malawi and Zimbabwe, Technology Education is known as Technical Education, and in Kenya, it is referred to as Art and Design (Chikasanda, Otrel-Cass & Jones 2011; Gaotlhobogwe 2012; Kwaira & Gumbo 2017). In South Africa, as stated above, it is called Technology. The sub-Saharan countries mentioned above share similar sub-regional conditions such as socioeconomics, postcolonial context, and socio-cultural practices. The clarification of the concept of Technology Education from various contexts is important as a result of it being an official curriculum in schools (Brown & Brown, 2010). In this study, Technology Education is used.

Technology Education in the countries mentioned above has an official curriculum in both primary and secondary schools and is not to be confused with educational technology (Brown & Brown, 2010). There are also different descriptions of the concept of Technology Education posited in the section above. However, some of those descriptions take into cognisance the concept as that which refers to the identification of a need to promote the capability of learners to use, evaluate and design appropriate technological solutions to technological problems (Ankiewicz, Adam, De Swart & Gross, 2001). Furthermore, Naughton (1994:8) describes technology as the application of scientific knowledge to practical tasks by organisations that involve people and as well as machines informing the ways of doing things that define complex interaction. Lee (2011) describes Technology Education as an age-old task of innovation and adaptation with a focus on the process by which products are developed and used.

Consequently, based on the descriptions of the concept of Technology Education, a common feature or thread from the different authors is that it involves the ‘people’ who seek solutions to a technological problem. However, there is no mention of context and IK in these descriptions. The one description that resonates with and sets the context of the present study is what describes Technology Education as “the use of knowledge, skills, values and resources to meet people’s needs and wants through the development of practical solutions to problems, taking social and environmental factors into consideration” (DBE 2011:8). What comes out clear from this description is that it takes ethical and contextual issues such as people, values, social and environmental factors into consideration to give room for the accommodation of all kinds of knowledge, IK included (Naughton 1994; Fleer 2015; Gumbo 2015). Technology Education is part of the IK knowledge domain; hence, it is part of IKS (Gumbo 2015:63). The backbone for teaching Technology is the design process which embraces critical and creative thinking skills. In the subsequent subsection, the discussion turns to the Technology principles of design processes, problem solving and creativity in systems and control.

3.3 Principles of design in relation to problem solving and creativity

3.3.1 Principles of Design and design process

The concept of 'design' is normally used to express a process and a product (Hamza & Hassan 2016:588). The general structure of the design is usually to analyse the problem, synthesise the possible solution, evaluate it against the criteria and choose a suitable solution to the problem for further elaboration (De Vries 2017). The design process plays a central role as the backbone of teaching and learning Technology in South Africa. It identifies foregrounds investigation, designing, making, evaluation and communication skills as a framework for solving technological problems (DBE 2011). However, some authors dispute the notion of frameworks in design, as the concept is too domain-specific to make such schemes or frameworks (De Vries 2017; Sables 2017). Furthermore, De Vries (2017) argues that even within one domain, design problems and designerly ways of thinking differ so much that such schemes are too abstract and idealised to work in concrete and complex reality. Hence, the design process should be as flexible as possible in decision making towards problem solving in Technology Education.

In a design decision making, one of the sources of information is the designers' own experience (Lawson 2005:133). Pahl and Beitz (1996) distinguish four types of designs, that is, original, adaptive, variant and routine designs, which are categorised based on the engineering design products. In addition, Gumbo (2018:140) posits that Engineering Education influences meaningful learning in Technology Education on design products as it elevates Technology Education by the addition of process to design which makes it more befitting to Technology Education. However, this categorisation can still apply to the products or projects produced by learners in the Technology Education learning environment. Lawson (2005:23) argues that classifying design by its product seems to be rather narrow thinking, he suggests that the solution should be viewed as something which is formed and has not existed before. It is in support of this criticism of a narrow approach to the design process that Kayas, Seitamaa- Hakkarainen (2013:165) note that design should be the process that involves parallel working through conceptual reflections and material implementation. Hence, efforts should be made to alert learners to be aware of the view that the design process has always changed as there are signs that many designers are starting to search for a new yet defined role in societies as societies are dynamic and not static in terms of transformation. The transformation could be brought into action in this study by integrating IK into design activities towards producing designed products. Therefore, the integration of IK into creative design process activities in the systems and control can play an important part in this regard. The effort of integrating IK into creative design process activities will eventually help teachers and learners to understand that the separation of design from making had the effect not only of isolating designers but also of making them the centre of attention in their society (Lawson 2005:25).

3.3.2. The principles of design process and problem solving

Traditionally, the process of design begins with a problem and the problem is solved through the output design from the design process as is more systematic. In addition, the design process can be viewed as the process consisting of stages or steps to be followed towards solving the problem, hence it forms part of the problem-solving approach (Lawson 2005; Wong & Siu 2012). Given the description of the design process above, it can still be argued though, that the design process as it is known in recent times has come about not only as the result of careful and wilful planning but rather as a response to dynamic changes in the broader social and cultural context in which design is practiced (Lawson 2005:24).

However, it should be noted that design and problem solving are components of Technology and Technology Education (Kwaira & Gumbo 2017:8). Furthermore, Kwaira and Gumbo (2017:7) posit that problem solving and design should be understood within the context of a creative design process that integrates IK. Kwaira and Gumbo (2017) further highlight four important aspects of design as an activity that uses amongst others a wide range of experiences, knowledge and skills to solve problems; the way to combine known facts or solutions to solve problems that require thinking; the whole process of solving the problem identification stage up until evaluation stage; and the thinking process in problem solving. These aspects give a clear view of the nature of Technology as a school subject. Taking these four aspects of design into consideration, Technology Education becomes a viable subject for the teaching of problem-solving skills and design skills due to its nature of theory and practice (Hong, Hwang, Wong, Lin & Yau 2012:452). However, it should be noted that design as a practice is rooted in culture (in this case IK), often in cultural myths, and it can be changed and/or be shaped by culture itself (Moalosi, Marope & Setlhatlhanyo 2017:73).

The fact that design process practice can be shaped by culture implies that culture gives designed products meaning and provides the rituals within which artefacts are used and the values that are reflected in its form and function (Moalosi et al., 2017:73). The word 'culture' is described in two ways, i.e., an organised system of knowledge and beliefs and the style of the entire society that includes the various societal activities (Ogungbure 2011; Ezeanya-Esiobu 2019). In addition, cultural characterisation could be interpreted on three levels: (1) a multiple-level scale where are basic assumptions, values and artefacts, and further basic assumptions and values; (2) comprise of beliefs, attitudes and conventions' systems and institutions; and (3) level is artefacts, products, rituals and behaviour (Trompenaars 1997; Ezeanya-Esiobu 2019). Given the description of culture above, there is a need for advocacy to encourage local designers to search for inspiration from the ancient and present cultural artefacts in their own societies to generate unique culturally oriented technological products based on their contextual features and through the teaching of creative design activities in systems and control in the Technology Education classrooms (Moalosi et al., 2007:499).

In Technology Education, the design process is a referent social practice that values the act of designing and contingent activity of creative thinking (Middleton 2009; Marzin & De Vries 2013). One of the sources of information in a design decision making is the designers' own experience, that is, design should be aligned to the people's experiences with the values they prefer (Lawson 2005:133; Moalosi et al. 2017:74). In Technology Education, the human experience should be seen at the centre of the design process so as to attach meaning and add value on the designed products through the integration of IK. Marzin and De Vries (2013:362) describe the design process as a referent activity or social practice in Technology Education. Hence, there is a need that whenever engaged in creative design, activities should reflect some of the traditional or cultural ideas and perspectives considering IK (as discussed above), to strike a balance between the Western and African knowledge-oriented views (Gumbo 2015:60).

3.3.3. The principles of design process and creative thinking

The typical design process is inevitably one of the subjects that should be examined to understand the creative design process (Wong & Siu 2012:438). The creative design process as one of the components in Technology Education, leads to creative output in that the design process plays a crucial role and is also viewed as a framework in this regard. Personal design experience can therefore boost understanding of creative design activities. The approach to understanding the design process is through critical and creative thinking as they involve thinking processes (Stempfe & Badke-Schaub 2002:473). However, critical thinking and creative thinking as well as ingenuity are important life skills that are intellectually challenging key aspects of Technology Education (Gaotlhobogwe 2017:288). Critical and creative thinking skills are integrated skills that involve generating and evaluating ideas around knowledge (Hamza & Hassan 2016:588). Haupt (2018:207) posits that designing is an act that involves dynamic processes and sub-processes in which adaptive and flexible thinking is required. Thinking in Technology Education is the approach to understanding the design process. Thinking is associated with critical and creative thinking skills in design, which play a very important role in the design process (Stempfle & Badke-Schaub 2002:475; Lawson 2005:32; Atkinson & Sandwith 2014: 163; Yu, Lin & Fan 2015:343).

The approach to understanding the design process is through critical and creative thinking skills. However, in this study, the focus is mainly on creativity and creative thinking, but without divorcing or ignoring critical thinking completely as these two function together in a thoughtful exercise. Creativity is closely associated with or linked to design as it helps in designing activities to solve technological problems and is an integral part of the design process (Howard, Culley & Dekoninck 2008:160). Wong and Siu (2012:437) view creativity as an essential feature of problem solving, as what designers do correspond with its (creativity) basic nature. Hamza and Hassan (2016:587) describe creativity as an original cognitive ability and problem-solving process, which enables one to use intelligence in a way that is unique and directed towards producing a product.

Christensen, Jorgensen and Madsen (1997) associate creativity with innovation, invention and problem solving in design. Wong and Siu (2012:442) view design as closely related to creativity as it is involved with the generation of new ideas and problem solving. In addition, creativity plays an important role at a metacognitive level in design (Christensen et al 1997; Wong & Siu 2012). Etkina, Karelina, Ruibal-Villasenor, Rosengrant, Jordan and Hmelo-Silver (2010:57) emphasise that learners are required to engage in metacognitive thinking during design. Pesut (1990:106) views metacognitive as thinking towards understanding and analysis of the creative thinking process, using the appropriate skills and strategies to solve problems through design. This emphasis, though, is viewed as a preliminary stage to the construction of design-based learning situations in which learners are accorded an opportunity to plan, monitor and evaluate investigative tasks for cognitive analysis purposes (Middleton 2008; De Vries 2006). This might mean that cognitive analysis in Technology Education should play an important role in building creative knowledge through creative design activities of systems and control core content.

Furthermore, design in Technology Education is set to stimulate creativity and problem-solving skills in the design process through a creative thinking process. Creative thinking designates a special class of activities and is also seen as a special kind of problem-solving behaviour (Newel, Shaw & Simon 1958:3). Furthermore Newel et al. (1958:4) argue that for problem solving activities to be called creative should satisfy the following conditions: the product of the thinking must have novelty and value (either for the thinker or for culture); the thinking requires high motivation and persistence – either taking place over a considerable period or occurring at high intensity; the thinking is unconventional in the sense that it requires modification or rejection of previously accepted ideas. However, creative thinking towards the problem or solution should be aligned to the available resources in the immediate environment, if not so the whole thinking process becomes fruitless (Kwaira & Gumbo 2017:9). IK is an important resource that can enrich creativity and innovation (Moalosi, Marope & Setlhatlhanyo 2017:66). Nevertheless, for this to be realised, the concept of design should extend beyond the conventional engineering conceptualisation to creative industries in indigenous contexts as well. The learners' creative thinking processes should thus be developed in the context of these dual environments. Hence, the first condition by Newell et al. (1958) gives room for the integration of IK in creative design activities. There is however a gap in how this stimulation of creativity and problem-solving skills in the creative design process could integrate the aspects of IKS during the teaching and learning of systems and control core content.

3.4 Technology Education and curriculum transformation

3.4.1 Curriculum reforms

From a pragmatist's point of view, education should not be the transfer of a priori truth but the development of insights through trying out what works and what does not work. "What is at stake is not the establishment of 'truth' but the attainment of success and effectiveness" (Verillon 2009:181). Educational reforms took place towards the end of the 20th century and the beginning of the 21st century in Africa and globally. Most African countries are transforming towards decolonising their curricula both in primary and secondary school education as well as at higher education institutions (Smith 2008; Msila & Gumbo 2016). According to Yishak and Gumbo (2017:246), socio-cultural and structural contexts play a vital role in making education and curricula culturally relevant and fundamental. However, the curriculum reforms in some of the developing societies in Africa are still Euro-Western oriented, disregarding the inclusion of IK until in recent two decades (Smith 2008; Goatlhobogwe 2017; Moalosi, Maropeng & Setlhatlhanyo 2017; Yishak & Gumbo 2017). Yisak and Gumbo (2017:246) further argue that even though there is transformation towards decolonising the curricula, there are subject curricula content that still uphold the Western cultural influences embedded in the Eurocentric foundations.

In South Africa, the Department of Basic Education (DBE) introduced a new curriculum in 1998 called Curriculum 2005. This marked curriculum transformation from the Apartheid Bantu education system to outcomes-based education (OBE). Later, the new curriculum was revised twice, and it resulted firstly in the National Curriculum Statements (NCS), then Curriculum Assessment Policy Statement (CAPS). One of the products of this process of curriculum transformation was the subject called Technology Education which is generally known as Technology in the South African context (Van Niekerk, Ankiewicz & de Swart 2010; De Jager 2011). Technology Education was however affected by the revisions of the curriculum. It was then in a better space to transform towards re-aligning its relevancy based on the philosophical grounds to be inclusive to meet the needs of society more specially the indigenous societies (Ndlovu & Gumbo 2018:384).

In South Africa, Technology Education is part of the CAPS framework in three phases, i.e., Intermediate, Senior and Further Education and Training Phases. However, in the Intermediate Phase (Grades 3-6) it is integrated with Natural Science and is called Natural Science and Technology, but it is a standalone subject in the Senior Phase (Grades 7-9) and in Further Education and Training Phase where it is taught in specialised fields such as Electrical Technology, Civil Technology, Mechanical Technology. This study focuses on the Senior Phase. Table 3.1 below gives a summary illustration of the Senior Phase Technology Education curriculum in South Africa in its present form:

Table 3. 1: Technology Education as outlined in CAPS (DBE 2011:10-12)

Purpose	Specific aims	Unique features	Main focus areas in Technology Education	Core content	Issues to teach
Technology education was introduced into the South African curriculum in recognition of the need to produce engineers, technicians, and artisans needed in modern society and the need to develop	Develop and apply specific design skills to solve technological problems.	To solve problems in creative ways; To use authentic contexts rooted in real situations outside the classroom;	The design process skills (non-linear): • Investigation skills • Design skills • Making skills • Evaluation skills • Communication skills	Structures Processing of materials Mechanical systems and control	Problem solving using the design process Practical skills

Purpose	**Specific aims**	**Unique features**	**Main focus areas in Technology Education**	**Core content**	**Issues to teach**
a technologically literate population for the modern world. The subject stimulates learners to be innovative and develops their creative and critical thinking skills. It teaches them to manage time and material resources effectively, provides opportunities for collaborative learning and nurtures teamwork. These skills provide a solid foundation for several FET subjects as well as for the world of work.	Understand the concepts and knowledge used in Technology education and use them responsibly and purposefully.	To combine thinking and doing in a way that links abstract concepts to concrete understanding; To evaluate existing products and processes; and to evaluate their own products; To use and engage with knowledge in a purposeful way; To deal with inclusivity, human rights, social and environmental issues in their tasks; To use a variety of life skills in authentic contexts (such as decision making, critical and creative thinking, cooperation, problem	Structures Processing of materials Mechanical Systems and control Electrical Systems and control	Electrical systems and control	Knowledge and application of knowledge**.**
	Appreciate the interaction between people's values and attitudes, technology, society, and the environment.		Technology, society and environment • Indigenous technology • Impact of technology • Bias in technology		

Purpose	Specific aims	Unique features	Main focus areas in Technology Education	Core content	Issues to teach
		solving and needs identification); While creating positive attitudes, perceptions and aspirations towards technology-based careers.			

Table 3.1 highlights the curriculum components, i.e. purpose, specific aims, unique features, main focus areas, core content and issues to be taught in Technology Education. These curriculum components are grounded in the principles of social transformation; active and critical learning; high knowledge and high skills; progression; human rights, inclusivity, environmental as social justice; valuing indigenous knowledge systems; credibility, quality and efficiency undergirding the curriculum (DBE 2011:5). The developers of the Technology Education curriculum took into consideration the three aspects highlighted in Ndlovu and Gumbo (2018:383), which are skills, knowledge and values and attitude. The three aspects allow integrating IK in the teaching of Technology Education towards fulfilling the specific aims which ultimately will achieve the purpose of the curriculum. Furthermore, the curriculum purpose and specific aims can only be achievement if the teachers can observe the issues to be taught which comprised problem solving using the design process, practical skills, knowledge and application of knowledge as highlighted in Table 3.1. It should also be noted that learners progress through a task and this could be by the teaching of the associated knowledge and the skills needed to design and create a solution (DBE 2011:12).

3.4.2 Technological literacy and IK

The specific aims of Technology Education are meant to contribute towards learners' technological literacy which is difficult to assess now as it requires valid and reliable standards and more resources which do not come cheap. The international Technology and Engineering Educators Association (ITEEA) developed standards for assessing technological literacy to cover three main components, that is, knowledge capabilities, critical thinking, and decision-making set (ITEEA 2007). In addition, the three components are interconnected, coordinated, and create additional synergies. Furthermore, ITEEA (2007) suggests that to acquire technological literacy, cognitive and procedural knowledge are required to enable the creation of proper technological products in design. According to Avsec and Jamšek (2016:43), technological literacy is identified as a vital achievement of technology that engages intensive education towards the design of technology and technical components of educational systems, and, also defines competitive employment in technological society. De Vries (2017:29) highlights that technological literacy implies that citizens are not just able to use technological devices as property but also make sophisticated judgements about various aspects and phases of technological development. However, the description of technological literacy above and the standards set by ITEEA to assess technological literacy excluded the creativity aspect and the context in which technological literacy can be achieved in society.

In response to technological literacy, DBE developed the nature of technology categories which include the design process as the backbone for the teaching of Technology Education (DBE 2011). However, to achieve the curriculum aims, the design process should be handled within the context of the main area of technology, society and environment (TSE), where the aspect of IK is catered, also taking into consideration the unique features (Ndlovu 2012). This brings us to the fact that all Technology Education specific aims can be met provided the specific aim three which states, "*appreciate the interaction between people's values and attitudes, technology, society, and the environment".* Table 3.1 above is used to set the context for teaching Technology Education (DBE 2011, Ndlovu 2012, Ndlovu & Gumbo 2018). However, all about technology literacy and the intended specific aims are easier said than done as Technology teachers find it challenging or difficult to integrate the design skills and core content specified in Table 3.1 from the context of TSE which contains the elements of IK

(Gumbo 2017:4). Furthermore, as much as the Technology curriculum presented in Table 3.1 recognises TSE as a strand to set the context for Technology teaching, there is however no clear framework to support teachers to develop design activities that embrace the context of their classrooms in relation to the local practised knowledge (IK). Hence, the present study seeks to investigate how Senior Phase Technology teachers integrate IKS into creative design activities in system and control. This notion brings us to the conclusion that Technology Education's core content in Systems and Control cannot be taught theoretically without the authentic context as its nature promotes critical and creative thinking to execute design projects (Gumbo 2018:133). The next section focuses on the clarification of the concepts of IKS and IK in order to understand them within the context of the present study.

3.5 Technology Education and the integration of IKS

The concepts IKS and IK in this chapter are used interchangeably. However, even though the two concepts are used interchangeably in this study, IKS is regarded as the foundation from which IK emerged, hence IK is commonly referred to as IKS (Mpofu, Otulaja & Mushayikwa 2014). Consequently, the two must be clarified as they dominate the discussion in this chapter. Although varied, there is enough literature that deals extensively with the concepts of IKS and IK, however, this chapter concentrates on the selected few as in the afore paragraphs.

IKS is a body of knowledge or bodies of knowledge of the indigenous people of a geographical area that have survived for a long time (Mapara 2009; Gaotlhobongwe 2017). According to Gumbo (2017:12), indigenous people are described as descendants of peoples who inhabited the present territory of the country wholly or partially at the time when persons of different cultures or ethnic origins arrived from other parts of the world aiming to marginalise them educationally, culturally, socially, economically and so forth. The concept of indigenous refers to the cultural roots of knowledge, which is described as IK or IKS, also linked to native locals (Loubser 2005; Odora-Hoppers 2002; Mpofu et al., 2014). In addition, IKS is described as an emerging field which is also known as the indigenous way of knowing or ethnoscience (Ogunniyi 2007; Gaatlhobogwe 2017). Chilisa (2012:23) views IKS as another epistemology and another way of knowing which has become important in the emerging global economy.

IK is described as a body of knowledge and skills accumulated overtime and adapted to culture and environment and is dynamic and changing (Mapara 2009; Moalosi, Marope & Setlhatlhanyo 2017; Ndlovu & Gumbo 2018). It is designated as the peoples' cognitive (knowledge) and practices because of their interaction with nature in a common territory or environment (Nakashima 2000; Hart 2010). Furthermore, De La Tore (2004) describes IK as the established knowledge of indigenous peoples their world views, and customs and traditions that direct them. In contrast, Battiste and Henderson (2000:4) argue that it is pointless to rely on the definition of IK; instead, what is important is the process of understanding the 'what' in IK, as understanding requires the inquirer to be open to accepting different realities regardless of how one uses the concept. This study adopted Hart's (2010) and Nakashima's (2000) description of IK as the concept that reflects the relationship between people's use of cognitive and practices through their interaction with environment.

In light of the above descriptions of IK and IKS, this has led to the use of the concepts interchangeably in this study as they represent the indigenous world view. According to Hart (2010:2), two worldviews challenge each other, the indigenous view (African) and the non-indigenous world view (Western). Magni (2016:29) notes that since the development of knowledge systems rarely occurs in isolation, seeing indigenous knowledge and scientific knowledge as two separate and isolated entities does not describe the real situation as there is no clear divide. Contrarily, Gumbo (2017:121) argues that knowledge resonates with technology in that technological knowledge is practical and holism in its nature, hence IK is technological due to its practical nature. In the same light, if we take an analysis of the descriptions of the concepts IKS and IK in this section, there is an element of normativity (De Vries 2017:28) as the concepts display a rich culture loaded with values. Hence, technological knowledge fits well in indigenous knowledge systems (IKS) of which the integration of indigenous knowledge (IK) into creative design activities in systems and control could make learning meaningful.

Furthermore, the literature has shown that the integration of IK into the school curriculum in Botswana, Kenya, Swaziland and South Africa is a constraint and challenge especially in the discipline of Design & Technology Education, Technology Education, Science Education and Mathematics Education respectively (Goatlhobogwe 2017; Gumbo 2017; Kaino 2017; Moalosi et al., 2017).

In the South African context, Technology Education is comprised of three fundamental contents which are the knowledge that describes the concepts; processes and skills that describe the design; and values and attitudes which define the context in which concepts are applied towards the design (Ndlovu & Gumbo 2018:383). Values and attitudes are rooted in IKS as every society is governed by its culture, beliefs and norms. Values are experimentally and contextually unique as people normally perceive and determine them (Maolosi et al., 2017:91). Hence, IKS should inform the development of modern science, sustainable technology and innovation (Maolosi et al., 2017:72). In the light of the above there is a need therefore for Technology Education to integrate IK rather than glorify Western design philosophy.

Moalosi et al., (2017:67) view the integration of design education in learners' context (in this case Technology Education) with IK has the potential to become a preserving agent of society's norms and conventions which could offer a new approach to tackling the society's social problems. Furthermore, Moalosi et al. (2017:67) suggest that the approach towards integrating Technology Education with IK can assist to deliver the new and more sustainable ways of living and build on cultural authenticity. The sustainable way of living could be based on the five key components of IK which are traditional knowledge, technology, specific community, informally developed work experience and provision of sustainable livelihoods to society (Moalosi 2017:71). In addition, Oguamanam (2006:8) suggests that IK is gained through observing and participating in simulations, real-life experience and trial and error founded on spirituality. Oguamanam (2006) furthermore views the world as interrelated, integrative and holistic and rooted in a culture of kinship between the natural and supernatural. In consideration of the latter, IK seems to be rich in shaping the values and attitudes of the society's culture, as alluded to earlier in this chapter.

The values and attitudes of society can have an impact on producing technological products (Dakers 2006). Ideally, according to Maolosi et al. (2017:73), culture gives products meaning and provides the rituals within which artefacts are used and the values that are often reflected in their form and function. Subsequently, Gumbo (2015:61) posits that technology is inherently cultural and that indigenous knowledge in this instance comprises the complex set of technologies developed and sustained by indigenous civilisation. Onwu and Mosimege (2004:8) highlight that indigenous knowledge supports a combination of traditional knowledge and other knowledge systems like technology, social, economic and philosophical learning or educational legal and governance systems. Onwu and Mosimege (2004:8) note that this inclusive knowledge is essential for existence, survival and adaptation in different environments. Therefore, there is a need for learners to promote cultural values through contextual learning based on the wisdom of local culture (Triyanto & Handayan 2020:3). This resonates well with the fact that technology as a human activity engages information, knowledge and cultural resources to meet human needs and wants (Mitcham 1994; Naughton 1994; Odora-Hoppers 2002). De Vries (2005:6) points out that different philosophical traditions have developed their own perspective on the interactions between humanity and technology.

In light of the above, the designers in technology need to take into consideration issues of indigenous technology as part of IK. Integrating IK into creative design activities of Systems and Control could have a stimulating effect on learners' appreciating of the value and maintaining the knowledge of the indigenous community (Kasanda, Lubben, Gaoseb, Kandjeo-Marega & Campbell 2005; Triyonto & Handayan 2020). However, there is a likelihood that Technology teachers might underplay the difficulties or challenges that might be faced in teaching and learning required in creative design integrating IK in the activities or tasks. Fleer (2015:35) highlights the three important concepts drawn from cultural-historical theory which are interrogated to develop an orientation to Technology Education, that is, tools and signs as cultural practice; everyday concepts and technological concepts; and imaginings and creativity in design and Technology

Education. Fleer (2015) furthermore suggests that bringing the three orientations of the cultural-historical theory together in Technology Education can offer a way for teachers and learners to both consider the way cultural, historical and future ecology of societies can be realised through knowledge base and value orientated activity as well as to understand that technological activity is embedded in a deep knowledge of an individual and community. Fleer's (2015) suggestion, if taken into consideration, might assist in overcoming the difficulties and or challenges that Technology teachers might face in integrating IK into creative design activities. In the subsequent section, the focus is on the implication of integrating IKS with the creative design process in teaching and learning Systems and Control. This might assist in the development of an indigenous creative design framework for Senior Phase Technology education.

3.6 The implication of integrating IKS during teaching and learning

Literature shows that the challenge of integrating IK in different disciplines, including Technology Education, has remained a problem for many teachers in South Africa. Jacobs (2015:50) highlights the main contrasting sentiments by teachers towards the integration of IK into the teaching and learning activities about the science curriculum, which are not foreign to Technology Education.

Thus, the issues are: (1) many teachers in South Africa are trained or schooled through a curriculum which is oriented in Western worldview than the indigenous worldview (Emeagwali 2003; De Beer 2015); (2) the new curriculum demands new teaching approaches and goals in terms of contextualisation and indigenisation; (3) lack of clarity on how Technology Education and IK could be integrated; (4) lack of explicit examples of IKS activities in the curriculum compared to the conventional design activities; (5) having a different worldview of the subject between the teacher and the learner; (6) teachers' knowledge and understanding of the subject content influence the way they teach design in the classroom (Jacobs 2015). Therefore, based on the outlined issues above, South Africa has diverse cultures with their respective locally owned knowledge (Vamanu 2014; Jacobs 2015), hence, that could mean materials developed for one local community are not transferable to the other (context is important).

The issues raised above could contribute to the reluctance of teachers to integrate IK into creative design activities. However, Ogunniyi and Ogawa (2008); Jacobs (2015); and Ndlovu and Gumbo (2018) came up with some suggestions that could aid the integration of IK in creative design activities through varying the teaching strategies. These may include the use of integrated approaches. For example, starting with prior knowledge before introducing new knowledge in design activities; engaging learners in problem-solving activities which can encourage discussions that include the IK mode of enquiry; and allowing dialogue and arguments in the process that involves design and local knowledge. This would assist learners to express themselves freely on the issues of Technology Education content in relation to their contexts. Hence, there is a need for a guiding framework on how to integrate IK in the teaching of creative design activities in the Senior Phase. The established relationship between the creative design process and the aspects of IKS concepts within a well-defined theory can contribute towards the establishment of a framework in this study. The framework would harmonise the issues of epistemology based on the concepts of creativity, design process and IK and further realise the integrated approach towards them in the Senior Phase Technology Education curriculum systems and control content activities.

3.7 Conclusion

The literature review in this chapter was generated on a conceptual basis. Technology Education's underpinning principles of technology, knowledge and philosophy set a clear context for the grounding of the present study. The broader clarification of these concepts in the literature bears narrow and broad meanings from different contexts, cultures and sectors. which in turn could result in clarifying the misconceptions about the current discourse. The literature review also highlighted the principles of the design process, problem solving and creativity in Systems and Control in which the concept design is associated with a process and a product. The design process is a referent social practice that values the act of designing and the contingent activity of creative thinking. The process of creative thinking should culminate in the Technology Education classroom activities. Technology Education is the product of the curriculum reform process in South Africa in the sense that its curriculum was in the best space to transform towards the re-aligning of its relevancy based on its philosophical grounds to be inclusive to meet the needs of society more especially the indigenous societies.

The Technology Education curriculum is structured in three aspects of skills, knowledge and, values and attitudes which create a window of opportunity for the integration of IK in teaching and learning activities in Systems and Control. The literature review showed the need for learners to cultivate cultural values through contextual learning even in systems and control, as technology is a human activity that engages knowledge and cultural resources to meet human needs. Teachers do face challenges as they are supposed to be instrumental in integrating IK within the creative design activities in Systems and Control. The literature review lined up some challenges that might contribute to teachers' hesitancy towards integrating IK in creative design activities as teachers are trained in a curriculum that is Western world-view oriented and; also lack practical examples of activities that integrate IKS through engaging varying strategies involving various epistemologies. Therefore, a need from the literature arose for the framework that could bridge some of these challenges to enable the Senior Phase Technology teachers to find it easier to teach creative design processes within a context that resonates well with learners.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

The orientation, theoretical framework and the literature review done this far helped to set the stage for addressing research questions outlined in Chapter 1, Section 1.3. The objectives aligned to the research questions guided the development of the data collection instruments which are summarised in Table 4.1 below. In addition, this chapter outlines the methodology of the research process that informs the present study. It focuses on the research paradigm and approaches, research design, selection of participants, data collection methods, data analysis strategies, ensuring the trustworthiness of the study and ethical considerations. The research takes the form of a qualitative enquiry of multi-case studies to establish how Senior Phase Technology teachers can integrate IKS in the creative design process activities when dealing with Systems and Control content in the classroom.

4.2 Research approaches and paradigms

The study follows the qualitative research approach/methodology and is grounded in the situated learning theory (SLT). SLT embraces the theories that promote the development of the teaching approaches that assist in the learners' conceptual development such as building knowledge, but it also emphasises the social and cultural influences of cognitive development (Piaget 1985; Vygotsky 1986; Yu, Lin & Fan 2015). SLT suggests the grounding of this study in the interpretivist and postcolonial indigenous paradigms in order to understand the world and meaning of the participants' shared experiences as shaped by their sociocultural contexts (Cohen, Manion & Morrison 2018).

Furthermore, research paradigms represent a fundamental model through which to observe and understand, as well as the model that organises our view of the truths and knowledge (Babbie 2010:33). Consequently, the truths and knowledge aid to frame how we view and interpret the world around us (Schwandt 2001; Bertram & Christiansen 2020). Perera (2018) expounds on research paradigms as ways scientists respond to four basic questions of ontology, epistemology, methodological and ethical/axiological questions (discussed fully in Section 4.3). Research paradigms represent a worldview that informs the acceptability to, and the way research is done (Bertram & Christiansen 2020). There are several identified paradigms such as positivism, constructivism, interpretivism, transformation, emancipation, criticality, pragmatism and deconstructivism and postcolonial indigenous (Mackenzie & Knipe 2006; Chilisa & Kawulich 2012) which one can choose from depending on the nature of the study.

Subsequently, the first six identified paradigms are mainly Euro-Western oriented, based on the colonial culture that has been made static and essentialised (Chilisa 2012). However, the postcolonial indigenous paradigm is flexible and caters for the views of indigenous cultures and methodologies that can be interrogated and opened to include the voices and knowledge systems of the marginalised indigenous cultures (Chilisa 2012: 25). Therefore, both interpretivist and post-colonial paradigms played a role in this study. The study is entrenched in the interpretive and postcolonial indigenous paradigms to establish how Senior Phase Technology teachers can integrate IKS in the creative design process activities when teaching the content of Systems and Control in the classroom.

Substantially, this ties well with the fact that learners are exposed to the teachings prevalent in their cultural settings, on which teaching of creativity and design process skills in the classroom should be built towards the understanding of the content learnt in Systems and Control easily. During the learning process, learners are expected to interact through collaboration with one another for their cognitive development. Therefore, the creativity and design activities in Systems and Control content must be drawn from the design process tasks involving learners' diverse cultural environments.

Nurtured this way, learners' cognitive perspectives can promote the relevancy of knowledge acquisition through meaningful learning. Teachers can create an enabling environment for learners to process, elaborate and interpret the information through their experiences based on their interaction with their socio-cultural contexts (Blythe 1998; Murdoch 2004). Hence, the paradigms are briefly discussed in the subsequent subsections.

The study is embedded within an interpretive paradigm (as a major) and a postcolonial indigenous paradigm (as a supporting paradigm). The interpretivist paradigm is the worldview that seeks to understand and describe human nature with the assumptions that there are multiple socially constructed realities (Chilisa & Kawulich 2012:55). Accordingly, Henning, Van Ransburg and Smit (2010) say an interpretivist paradigm concerns itself with social phenomena that require an understanding of the social world that participants live in. It emphasises experiences and interpretation. Moreover, it is concerned with meaning, and it seeks to uncover the way participants define and understand their situation, i.e., in the current inquiry, refers to the meaning of the lived experiences of the Senior Phase Technology teachers, learners and Curriculum Specialists (Creswell 2008; Henning, Van Rensburg & Smit 2010; Chilisa 2019).

Hence, within the interpretive paradigm, researchers do not aim to predict what people will do or to understand regular causality, but rather to describe and understand how people make sense of their worlds or contexts and make meaning of their actions (Bertram & Christiansen 2020:30). Interpretivists' characteristics are subjective, relativist and use ideographic methodology; these characteristics resonate well with the postcolonial indigenous paradigm as a supportive paradigm in this study (Chilisa 2012; Bertram & Christiansen 2020). However, the core difference between the dominant paradigm (interpretivism) and the indigenous paradigm (postcolonial indigenous paradigm) in this study, is that the dominant paradigm is built on the fundamental belief that knowledge is an individual entity, i.e., the researcher is an individual who searches, gains and owns knowledge as an individual, which is Euro-Western oriented. Contrary, the indigenous paradigm comes from the belief that knowledge is relational and embracive/shared with all of creation, i.e., it goes beyond an individual's knowledge which brings an element of *Botho*/*Ubuntu* (Chilisa 2012:21).

Furthermore, Chilisa (2012) argues that the postcolonial indigenous paradigm creates a space for the cultural-integrative framework that brings the balance to Euro-Western knowledge and its democratic and social justice elements and combines it with the best of democratic, laboratory, social justice essentialised IK and subgroups' knowledge. In this study, the social justice essentialised IK, and subgroups' knowledge, bring the position between the two paradigms to equal footing.

The postcolonial indigenous paradigm contributes to participatory, liberating and transformative research approaches and methodologies that draw from IKS. Hence, the postcolonial indigenous paradigm is the African worldview that values IKS and philosophies (Chilisa & Kawulich 2012:58). Consequently, the techniques of gathering data are based on philosophic understanding, ethnophilosophy, language frameworks, IKS and talk stories and talk circles (Odora-Hoppers 2002; Chilisa 2012). The subsequent section delves more into the philosophical assumptions.

4.3 Philosophical assumptions

Philosophy signifies the nature of reality, ways of knowing, and ethics and value systems which are described as the ontological, epistemological and axiological assumptions (Patton 2002; Creswell 2008; Kumatongo & Muzata 2021). Hence, in the context of the preceding paragraph, the philosophy of Technology is premised on the related aspects of reality, which are reflected within the distinction among the fields of ontology, epistemology, methodology, metaphysics and ethics of this study (Mitcham 1994; De Vries 2007). Furthermore, Mitcham (1994:158) associates ontology (theory of being) with the objects characterised by the essence of technological artefacts, epistemology (theory of knowledge) with knowledge, where epistemological studies are expected, methodology (theory of how things are done) with actions, which define the viewpoint and metaphysics with volition, which defines the approach. These associations make Technology be understood as artefacts, knowledge, activities and part of being human (Mitcham 1994:160) and are identified as the pillars of the philosophy of technology (De Vries 2005, 2007).

Consequently, this implies that multiple realities should be constructed and elaborated through subjective experiences. One can argue that such experiences of realities form part of humans since technological activity is connected to societal conditions and their needs as they continuously evolve (Fleer 2015: 37). How these realities play themselves out in indigenous contexts should inform the content and teaching of Technology in a socio-cultural context classroom in South Africa (Odora-Hoppers 2002; Bonnette & Crowley 2020). Furthermore, Keirl (2015:16-17) identified four theories, i.e., critical, actor-network, variational and narrative that contribute towards realising a novel way to engage these realities in Technology Education. Teachers are supposed to associate with these realities taking into consideration learners' real and socio-cultural contexts when integrating IKS in their creative design process activities in Systems and Control content. Subsequently, the ontology, epistemology, axiology and methodology of the study, are discussed in detail in the subsequent subsections.

4.3.1 Ontology

Ontology refers to a set of philosophical assumptions on the nature of reality and its characteristics; a theory of being, and how we perceive ourselves in our context (Creswell 2007; Mapotse 2012). It offers the answer to the question "what is real" and the philosophy of reality (Krauss 2005; Hesse-Biber 2010). Furthermore, ontology is concerned with the assumptions and beliefs that form and inform reality (Hesse-Biber 2010). Consequently, the ontological assumptions on the interpretive approach believe that reality is socially constructed (Mertens 2005).

Similarly, in the context of the postcolonial indigenous paradigm, social reality can be understood in relation to the connections that human beings have with the living, the non-living, the land, the earth, the animals, and other beings (Chilisa & Kawulich 2012). Hence, the emphasis is always on the I/We relationship in indigenous societies compared to the I/You in Western societies. Consequently, the notion that translates to I am because we are – *Botho*/*Ubuntu* principle. Hence, the two paradigms, interpretive approach and postcolonial indigenous resonate well towards describing the nature of reality in this study.

Accordingly, in this case, reality is limited to context, space, time and individual or groups in each situation and cannot be generalised into one common reality (Chilisa et al. 2012). This implies that multiple realities may be possible in any given situation. In the study, realities include the life-world reality of the researcher, the curriculum experts, teachers, learners, or the individuals being investigated, and that of the reader interpreting the study. Hence, from the subjectivist position, reality is neither objective nor singular but created in one's mind to become an individual's consciousness (researcher or participant) which in turn influences the social occurrences, and ultimately, a group of individuals' consciousness (researcher and participants) constructs multiple realities of a specific event (Bertram & Christiansen 2020).

Given the above, the study comprised twelve teacher participants (novice and experienced), four learners and two curriculum advisors in their natural setting (Ehlanzeni and Nkangala districts) to determine how Senior Phase Technology teachers integrate IKS in the creative design process activities in Systems and Control content in the classroom. To form ontological assumptions in this study, the researcher chose multiple realities based on subjective experience (Botha 2010).

The researcher's role was to report faithfully on these realities in the research and to rely on the voices and the interpretation of the curriculum specialists (advisors), learners and teacher participants. The researcher interviewed participants in different settings (schools) and each of their transcripts showed evidence of different perspectives (Creswell 2007:17). The researcher also interacted with the data to construct themes that were acceptable to the internal reality of the participants based on the researcher's ontological stance. Therefore, the researcher's ontological stance influenced the researcher's theory of knowledge (epistemology) discussed in the next subsection.

4.3.2 Epistemology

Epistemology inquires into the nature of knowledge and truth. It concerns itself with ways of knowing and how we know; it concerns itself with the methods, resources, scope, and limitations of knowledge (Mertens 2005). Epistemology also addresses how we come to know that reality (Krauss 2005:758). Krauss further views epistemology as closely related to ontology and methodology. The epistemological assumptions underlying this study are drawn from the interpretive and the postcolonial approaches.

The epistemological view on interpretivist paradigm is that knowledge of reality is gained through social constructions such as language, shared meanings, tools and document and the social contexts in which they are constructed and reproduced through the participant's activities (Smith 2008; Chilisa et al. 2012). On the other hand, the postcolonial indigenous paradigm knowledge is relational, and is shared with all of creation (Wilson 2008:56). Hence, the technique of gathering data from the relational epistemology should include language, stories, talk cycles and IKS (Smith 2008; Chilisa & Kawulich 2012).

Therefore, using these epistemological assumptions enabled the researcher to confirm through subjective experiences over interacting with the participants in their socio- cultural contexts to capture and describe their experiences through observations and interviews (Pontoretto 2005). The researcher observed the way the participants addressed and interacted with their reality during their lessons to gain deeper insight into their experiences on how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control content in the classroom. The observations and interviews conformed to the idea that reality is socially constructed (Nieuwenhuis 2007). The subsequent subsection addresses the axiology part of this study.

4.3.3 Axiology

The axiology assumption formulates the fundamental question of ethics and value systems (Patton 2002). In both interpretivist and postcolonial indigenous paradigms, reality is socially constructed, and knowledge is subjective. Therefore, social inquiry is value-bound and value-laden (Dakers 2006, Creswell 2007). Chilisa (2012:20) argues that ethics, values, and beliefs that define the relations and responsibilities of a researcher and participant, should be addressed before ontological and epistemological questions. That should drive the research process from the formulation of the research findings. Hence, the values and ethics informed the paradigms chosen for the study, the choice of topic, the methods used to collect and analyse data, the interpretation of the findings, and the ways they are reported in the study (Chilisa et al. 2012).

In this study, the researcher constantly reported the value nature of the information that was collected in the field while avoiding the biases that were present (Creswell 2007). Most importantly, the emphasis on the respect for the marginalised groups' belief systems and equality was important in building the relationship between the researcher and participants. Hence, the researcher valued socio-cultural ways of understanding the world (Smith 2008; Chilisa & Kawulich 2012).

In this regard, Chilisa et al. (2012) highlight the assumptions of axiology standpoint as, to be honest with what values are, and that it enhances the awareness of the value in judgments in making conclusions on data collected; be clear about the position of the values and taking appropriate ethical measures when collecting data from participants; and consider values of other relevant parties connected with the research. That includes the supervisor and the University of South Africa Research Ethics Committee. These parties are of relevance on ideas about the role of values in issues related to how Senior Phase Technology teachers can integrate IKS in the creative design process activities in Systems and Control content in the classroom.

A relational axiology is built on the concept of relational accountability, respectful representation, reciprocal appropriation, rights and regulations (Chilisa 2012:22). Consequently, the process of establishing how Senior Phase Technology teachers integrate IKS in the creative design process activities in Systems and Control was grounded on the *Ubuntu* principle. The researcher ensured that all parts of the research process were related and accounted for all relations. The researcher listened, paid attention to, acknowledged and created space for the voices and knowledge systems of the participants. The researcher researched to benefit both the Senior Phase Technology classrooms and developed a framework that would assist teachers towards the integration of IKS in their teaching and learning process ultimately. The researcher also created the ethical protocol that accorded the participants ownership of the research process and knowledge produced.

4.3.4 Methodology

From the interpretivist view, methodology concerns how researchers go about obtaining knowledge about the world (Bertram & Christiansen 2020) from sources such as participants. Furthermore, methodology includes how data are collected, described and explained based on the researcher's ontological and epistemological stance in relation to the study being conducted. The nomothetic and ideographic methodologies dominate the mode of knowledge gathering (Bertram & Christiansen 2020). Consequently, the nomothetic methodologies are aimed at developing general laws or theories, and in contrast, the ideographic methodologies are aimed to explicate the consequences of specific meaning, are unique, and are often subjective.

The ideographic methodologies resonate with the postcolonial indigenous view and third space methodologies. The third space methodologies represent the amalgam of the uniqueness of each person or participant in their context (Bhabha 1994; Kalua 2009). Even if the postcolonial indigenous view embraces the ideographic methods and holds on to its subjective view, its research techniques include the process of decolonising the conventional interview and observation techniques to inform alternative research methods compatible with the worldviews of the colonised (Henning et.al. 2010; Chilisa 2012; Chiliba 2019; Bertram & Christiansen 2020).

Consequently, nomothetic and ideographic methods are at the centre of interpretivist and postcolonial indigenous paradigms that influence the data collection methods and interpretation. Thus, in this study, the data collection methods utilised were semi-structured interviews, observation, and document analysis to collect data guided by the SLT that involves CoP, LPPs, and CA. The data collection methods were discussed in detail in Section 4.6.

4.4 Research design

The study was conducted following a qualitative research approach which is rooted in the understanding of SLT that knowledge and meaning stem from interactions and experiences associated with social, cultural and physical contexts. The reason for the qualitative research approach in the study was to enable the researcher to give a description and analysis of participants' social actions, believes, perceptions and thoughts about the study phenomenon taking into consideration the content, method, sequencing and sociology in their teaching (Creswell & Poth 2016). In addition, Kumatongo and Muzata (2021) posit that a qualitative research approach seeks to explore the understanding of a social phenomenon. Hence, the researcher makes sense of social phenomenon through the means of contrasting, comparing, replicating cataloguing and classifying the object of the study (Creswell & Creswell 2018).

The study also embarked on the case study design to make sense of the phenomenon of how Senior Phase Technology teachers can integrate IKS into the creative design process activities in Systems and Control lesson delivery in the classroom. The reason for a case study design in the study was to gain in-depth, rich descriptions of the phenomenon in socio-cultural contexts. Foregoing, Baxter and Jack (2008:545) describe a case study as a phenomenon of some sort occurring in a bounded context, whereas Creswell (2009:13) describes a case study as a strategy of enquiry in which the researcher explores in-depth a particular programme or event as the present phenomenon under study. In addition, Zainal (2007:2) posits that case studies help in exploring and investigating real-life phenomena through a detailed contextual analysis of a limited number of events. All these three descriptions of the case study agree with the fact that in a case study, data are examined within a specific context (Zainal 2007, Kumatongo & Muzata 2021).

Subsequently, case study research can be a single or multiple case studies (Zainal 2007; Yin 2009). Accordingly, a single case study's events are limited to a single occasion whilst multiple case studies have numerous sources of evidence through replication. Furthermore, case studies are categorised as exploratory, explanatory and descriptive (Zainal 2007, Kumatongo & Muzata 2021). In the same token, Zainal (2007:1) describes each category thus: an exploratory case study explores any phenomenon in data that serves as a point of interest before research questions, or hypotheses are proposed; an explanatory case study examines data closely both at a surface and deep level in order to explain the phenomenon in the data; and descriptive case study describes the phenomenon which occurs within the data in question.

This study adopted a descriptive multiple case study approach involving two districts, as it allows establishing how Senior Phase Technology teachers integrate IKS in the creative design process activities in Systems and Control content in the classroom using a variety of data sources (Baxter & Jack 2008:546). The reason for the choice of the multiple case study was to accord the researcher an opportunity to have numerous sources of evidence through replication (Ndlovu 2012). Therefore, this allowed the researcher to engage with multiple cases through the SLT constructs of LPP, CoP and CA outlined in Chapter 2 of the present study.

The foregoing researcher's engagement with multiple cases, assisted in coming up with a suggested integrative framework to that effect. So far, what has been already achieved in this instant is that the theoretical framework is in place for the collection and analysis of data. Hence, in the construction of the conceptual framework appropriate to this study, the following issues were considered content knowledge, context, curriculum policy, curriculum resources, collaborations, IKS and classroom. The next section delves into the selection processes for the participants.

4.5 Selection of participants

4.5.1 Population

The population of the study is comprised of two education districts in Mpumalanga Province involving two curriculum advisors, twelve teachers, i.e., six novices and six experienced, and four Senior Phase learners, which translate into eighteen participants – nine participants per district. The two districts formed the cases.

4.5.2 Sampling

This study used non-probability sampling with purposive sampling as the choice (Cohen, Manion & Morrison 2007). Purposive sampling was used to select the participants who provided insight and understanding of how Senior Phase Technology teachers integrate IKS in the creative design process activities when dealing with Systems and Control content in the classroom (Ary, Jacobs & Sorensen 2010; Creswell 2012). The process of selection went as follows:

Firstly, twelve Senior Phase Technology teachers (novices and experienced) were purposefully selected, with the help of the principals and district officials. The teachers were categorised into two, i.e., experienced and novice teachers. The first category included experienced Technology teachers; it comprised six most senior and experienced Technology teachers with postgraduate diplomas or Honours qualification in Technology Education and at least three or more years of teaching Technology at school. The second category included six novice Technology teachers with one year to two years of teaching Technology and a qualification in Technology Education. These two sets of categories of Senior Phase Technology teachers demonstrated an understanding of cultural background and traditions related to IKS. The category of teachers with a variety of experiences contributed to rich and valuable information that provided a deep insight into the understanding of how they integrate IKS into the creative design process when dealing with Systems and Control activities.

Secondly, two curriculum specialists (one per district) from the two districts have the post-graduate qualification in the subject and worked with and supported teachers for at least two years or more. The two curriculum advisors were purposively selected to establish how the curriculum experts approach the integration of IKS in creative design activities in Systems and Control content in the Senior Phase during training, workshop or teacher support. Thirdly, the four learners from the two districts (two per district) were Senior Phase learners who are performing well in Technology and are familiar with the local socio-culture practices of their communities.

The aim of choosing the two curriculum specialists, as well as the six novices, six experienced teachers and four Senior Phase learners, was to better understand and come to terms with their reality in the classroom and data saturation. Similarly, semi-structured interviews were used to obtain an in-depth description of the context in which participants teach, work and learn. Also, document analysis and lesson observations were used to interact with the curriculum materials and how participants used the curriculum material to teach or train or learn in the classroom. Subsequently, the above sample size helped to determine the community of practice per district in Mpumalanga Province which comprises four experts (one curriculum specialist and three experienced teachers), and five novices (two novices' learners and three novice teachers).

4.6 Data collection methods and procedures

Document analysis, semi-structured interviews and non-participant observation were used to collect data. Afterward, a brief discussion of each aligned with a specific research objective in the subsections.

4.6.1 Document analysis

Document analysis was carried out based on the study objectives that sought to establish the Senior Phase Technology teachers' understanding of IKS regarding creative design activities; as well as to establish how Senior Phase learners, receive the integration of IKS into the creative design process during Systems and Control lessons. This was also done to determine the kind of support subject specialists for Technology Education give to teachers towards the integration of IKS in creative design process activities in Systems and Control. Document analysis was carried out from the learning and teaching support material (LTSM), the workshop or training materials provided to the teachers by the Mpumalanga Department of basic Education, learners' workbooks and teachers' lesson plans.

Silva (2015:141) classifies curriculum documents, workshop materials and teacher's lesson plans under the public and private documents. Furthermore, Silva (2015:141) categorises public documents into four as closed, restricted, open-archival and open-published. In this study, the focus was on open-published documents.

However, the private documents that comprise the sample of the work produced by learners, such as projects and written work in Technology Senior Phase classes were also looked at (Silva 2015:141). The documents as categorised in this study are collected as entities of data, which are subjected to the same process of analysis and interpretation with interviews and observations (Henning et al. 2010:98). The analysis of these documents provided an opportunity to determine and establish the effective ways in which the aspects of IKS are integrated into both planned and written creative design activities in Systems and Control content.

4.6.2 Interviews

Semi-structured interviews were conducted in order to establish the Senior Phase Technology teachers' understanding of IKS for the creative design process activities in Systems and Control; to identify the opportunities that the third IKS-based specific aim presents to the Senior Phase with regards to the teaching of the creative design process in Systems and Control; to establish how Senior Phase learners receive the integration of IKS in creative design process in learning Systems and Control; to determine the kind of support that Technology Education subject specialists give to teachers towards the integration of IKS in creative design process activities in Systems and Control; to explain how Senior Phase Technology teachers attempt to integrate IKS in the creative design process; and to determine a framework that can guide Senior Phase Technology teachers towards the effective integration of IKS in the creative design process.

The qualitative enquiry seeks to establish meaning in a context that requires a data collection instrument such as interviews that will be sensitive to underlying meaning when data are gathered and interpreted. Nieuwenhuis and Smit (2012:133) posit that the main aim of an interview is to obtain rich descriptive data that help to see the world through the eye of the participant. Qualitative research offers different forms of interviews, such as structured interviews, unstructured interviews, semi-structured interviews and focused group interviews (Nieuwenhuis 2007; Ary et al. 2010).

Semi-structured interviews were used in this study as they enabled the researcher to formulate the questions and modify them to suit the context as new information emerged during the interview process.

Subsequently, the data generated from semi-structured interviews were captured and analysed in line with the SLT framework. Consequently, assisted to establish the CoP amongst the participants to share knowledge and experiences known as the shared activity (Bonnette & Crowley 2020). The shared activities were identified as artefacts, practices, knowledge, customs, relationships, roles and identities.

Hence, the shared activities assisted the present study to establish the attempts teachers and curriculum experts make to integrate IKS in the creative design process activities in Systems and Control content. Therefore, the role of the researcher was to facilitate the process to allow the participants to reflect on their experiences of the phenomenon under study through reflections, articulation of learning skills, collaboration, activity and stories, which are defining features of LPP in the CoP (Bargate & Maistry 2015; Herrera 2020).

The semi-structured interviews further probed the participants' experiences of the understanding of the integration of IKS into the creative design process activities in Systems and Control content to add to the richness and depth of the descriptions (Bargate & Mainstry 2015:41). Hence, the semi-structured interviews were conducted to 18 purposefully selected participants as explained in the preceding sections. However, it should be noted that the number of participants was not static but dynamic, in that the number of participants might be reduced or increased depending on the saturation of information (Botha & Lather 2012:88). The interview schedules comprised the elements of design process skills, creativity, creative thinking skills, systems and Control content and elements that define IKS in Technology Education as registered in Chapters 2 and 3 within the SLT framework. The interview guide was generated based on the research questions guided by the theoretical framework highlighted in Table 4.1 and the literature. The questions were minimally adjusted as a result of the pilot.

4.6.3 Observations

Observations in this study were undertaken to achieve the objectives stated in Section 4.6.2. Observations are described as the method used to collect data about people, processes, and cultures (Kawulich 2012:150). Furthermore, Kawulich identifies two types of observations as participant observation, which takes the position of an observer and a participant simultaneously, and non-participant observation, which takes the position of a passive observer (neither involved in teaching nor co-teaching).

In this study, non-participatory observation was administered during classroom teaching. The observation schedule comprises the learning environment; subject content; teacher and learner participation; teaching strategies, interactions and type of activities that includes the aspects of the design process and skills along with the elements of creativity and integration of IKS; and teacher and learner lesson reflections. Table 4.1 below summarises the data collection methods indicating the research question, data source, theoretical framework aspects addressed, methods of collecting data and expected information.

Table 4. 1: Summary of data collection methods

Research Question	Data Source	Theoretical framework	Method(s) of collecting data	Expected information
What is the Senior Phase Technology teachers' understanding of IKS with respect to the creativity and design process contained in the third specific aim of CAPS?	Novices and experienced Teachers, learners, curriculum experts	LPP-learning taking place in social, cultural and physical context. CA CoP	Interviews (individual & focused group), observations	Understanding of IKS; creativity; and design process concepts in Systems and Control and integration of IKS; reflection on learning skills. Understanding of social practices through reflections, articulation of learning skills, promotion of collaboration, activity, and stories. Role IKS plays in teaching Technology and nature of creative design process activities in Systems and Control.
What opportunities does this third IKS-inspired specific aim present to the Senior Phase Technology teachers with regards to the teaching of the creativity and design process in Systems and Control?	Teachers Learners' work/curriculum expert	CA LPP	Interviews (individual & focused), observation and documents analysis	Technology teaching activities so that they show understanding of relationships between content and strategic knowledge that involve strategies to integrate IKS. Learners' activities which reflect the ability to control various learning and teaching strategies that integrate IKS. Kinds of activities or work given to learners and their relation to IKS.
How do Senior Phase Technology teachers attempt to	Teachers Curriculum specialists	CoP CA	Interviews (individual & focused) and observations	Strategies teachers use to teach Technology from IKS perspectives.

Research Question	Data Source	Theoretical framework	Method(s) of collecting data	Expected information
integrate IKS in the creativity and design process in Systems and Control?				Strategies used to integrate IKS during the facilitation of Systems and Control learning activities.
How do Senior Phase learners receive the integration of IKS in creative design process when learning Systems and Control?	Learners Curriculum Teachers	CA	Interviews Observations Document analysis	Knowledge of the subject from the IKS perspectives. Mastering of content from IKS perspectives during learning. Experiences about how the content is taught in recognition of IKS.
What support do subject specialists for Technology Education give to teachers towards the integration of IKS in creativity design process activities in Systems and Control?	Curriculum/subject specialist	LPP CA	Interviews Document analysis	Strategies to support teachers to integrate IKS in their lessons. Information about the type of curriculum materials teachers are exposed to during training/workshops towards facilitating the integration of IKS. Understanding of Systems and Control in creativity and design process and integration of IKS.
How can the teaching of Technology be framed such that it guides Senior Phase Technology teachers' effective integration of IKS in the creativity and design process in Systems and Control?	Teachers, Curriculum specialist and Researcher	CoP CA	Interviews (individual & focused), and observations	Successes and failures of teachers' strategies to plan and teach Technology. Framework to integrate IKS in teaching.

4.7 Data analysis

Data analysis and interpretation are the nerve centre of a research process. It is against this background that Maree and Pietersen (2007:179) hint that the analysis of texts and narrative data should be guided by rigour and procedures of the specific type of analysis. The study trails the qualitative research approach and deductive logic for data analyses due to the multiple cases that brought data from the different contexts of the cases (Gibbs 2007:4). Subsequently, it follows the use of thematic analysis to analyse data (Kawulich & Holland 2012:231). These authors further view thematic analysis as a general approach to analyse data that involve themes. The semi-structured interview data were aligned together with the data from the observation sheets and document analysis, categorised and coded to establish themes.

Consequently, the researcher compared and categorised responses and identified patterns of teachers' responses to each question with content data analysis. The researcher followed the approach where each respondent in the case was studied, analysed and reported on (Yin 2009). Based on the analysis of each case the researcher triangulated the data to answer the research questions and evaluate the realisation of the study objectives. The analysis and interpretation of the data were subjected to the interpretivist and postcolonial paradigms contexts (Chilisa & Kawulich 2012:54).

4.8 Strategies for trustworthiness of the study

Credibility and trustworthiness are the concepts that are used in qualitative research to describe the reliability and validity in relation to research instruments (Nieuwenhuis & Smit 2012:137). To ensure that the study is credible and trustworthy, this study engaged multiple data collection methods, i.e., semi-structured interviews (individual face-to-face), observation and document analysis (Nieuwenhuis 2007:86). The researcher also sought the supervisors' comments on the instruments used in this study. In addition, the interview guide was pre-tested (piloted) with three non-participating teachers in the actual data collection. The pilot study findings were not published as they were meant for the adjustment of the instruments.

The researcher observed the four standards of rigour in qualitative research to make sure that the process of the study and data collection and analysis is credible and trustworthy (White & Marsh 2006:38). These standards of rigour or standard of the quality of conclusion include credibility or internal validity, transferability or external validity, dependability or reliability and confirmability or objectivity (Miles & Huberman 1994: 277), of which each is briefly discussed in the subsequent subsections.

4.8.1 Credibility

Credibility is compared to internal validity as it refers to the situation where the phenomenon is clearly identified, and all research factors are reflected in the data collected (White & Marsh 2006:38). The researcher ensured that the process of data collection and analysis is credible and trustworthy through prolonged engagements, persistent observation, triangulation, peer debriefing/reflectivity and member checking (Mapotse 2012; Kawulich & Holland 2015). The researcher was as neutral as possible to avoid biasness by focusing on "the subjects and conditions of the inquiry" (Miles & Huberman 1994: 278). The researcher first piloted the data collection instruments to non-participants. The researcher heeded the inputs of the pilot participants by improving the instruments. Thereafter, the researcher briefed the participants about the field of research under study. The researcher did member checking after transcribing interview data, observation field notes and documents analysis results to ensure proper representation of data.

4.8.2 Transferability

Awuviry-Newton et. al. (2021) posit that transferability is about ensuring that there is an adequate description of the study sample and setting so that the study findings could be applicable to other contexts. Furthermore, it is very important to be clear about the theoretical lens towards the interpretation of data and should also have enough evidence to back up the claims to avoid making unsubstantiated (Bertram & Christiansen 2020) White and Marsh (2006:38) compare transferability with external validity, which refers to generalisability or "the applicability of findings from different contexts". This study provides detailed descriptions of the context to enable readers to make judgements of the findings obtained from the cases under study (Kawulich & Holland 2015:243).

In this study, transferability was enhanced by the way the participants were identified in terms of their demographic information (Campbell et.al. 2020). The researcher illustrated pertinent issues and factors when comparing the two contexts from the two districts (Gray 2009). The researcher also provided comprehensive descriptions through transcripts from audio tapes during interviews, document analysis and observations field notes as evidence for making judgements about the similarities of the two cases involved.

4.8.3 Dependability

Dependability is compared to reliability as it refers to the same results when using the same instruments (Cohen, Manion & Morrison 2007; Kawulich & Holland 2015:243). The current study employs an audit trail through the data, which enables readers to understand the context of the research that influences the conclusion as drawn from this study. The raw data through audio, the field notes obtained from interviews, and the document analysis and observations are made available for retrieval, viewing and verification to establish the trustworthiness of the study. Multiple data sources such as semi-structured interviews, document analysis and observations were used for triangulation purposes to establish the dependability of this study's findings.

4.8.4 Confirmability

Confirmability is compared to internal validity or objectivity, which refers to the bias-free procedures and interpretation of results (Botha, 2010; Ary et.al. 2010). Member checking applies to confirming the findings of the study to ensure that the findings are grounded in the data (Kawulich & Holland 2015:243). The research process was made transparent with enough details for the reader and participants to check if they would have reached similar conclusions (Bertram & Christiansen 2020). Participants were allowed to verify the accuracy of the verbatim transcripts extracted from interviews and comment on the field notes written during the data collection processes.

4.9 Ethics

According to Creswell (2008), ethical considerations, include issues such as informing participants of the purpose of the study, refraining from deceptive practices, sharing information with participants including one’s role as a researcher, being respectful of the research site, reciprocity, using ethical interview practices, maintaining confidentiality, and collaborating with participants. In this study, the researcher observed practices on ethical considerations, such as the privacy of participants, ensuring anonymity of participants, and confidentiality of the participants were observed. The semi- structured interviews were conducted after obtaining ethical clearance from the University of South Africa's College of Education (Research Ethics Committee) [Appendix 1], and after permission was granted from the Mpumalanga Department of Basic Education's research management office (Appendix 3).

The researcher wrote letters to seek permission from the Mpumalanga Department of Basic Education; from the principals of the targeted schools to conduct the research in their schools; designed letters of consent for the participants regarding their participation in the study; and permission to observe their classroom teaching. Given the classroom observations, consent from parents and assent from learners were sought, as the lessons were observed, learners' and teachers' faces are not shown to maintain anonymity. The researcher visited the schools prior to the data collection processes for briefing about the objectives of the study; to seek permission to analyse learners' written work and asks for the consent of participants to record the interview proceedings.

Power relations were not an issue, as the researcher was not working with the participants at the level of authority. However, the consent of the participants was sought even in the absence of power relations. The purpose of the research was shortly described in all the letters of permission to the authorities and participants for them to be aware of what the research aims to achieve. Participation was voluntary, as potential participants were informed of their right to withdraw from participating in the study at any time. Confidentiality and anonymity were preserved by protecting participants' privacy, their schools' names and anonymity to maintain trust in the research relationship.

The data collected from the participants was used for research purposes only, not for any other thing. To ensure the anonymity of participants, the interviews were recorded; however, transcripts had to be anonymous. The privacy of the participants was respected, and care was taken to prevent any possible harmful effects, such as transgressing of cultural values, of this study. The letters of permission contained a short description of the aim of the study and the following issues: participation in the research project was voluntary and participant information was kept confidential; participants' information was secured, and anonymity preserved; the participants could withdraw at any stage of the research project; and there were no incentives in monitory terms for participating in the research project (Appendices).

4.10 Conclusion

This chapter presented a detailed qualitative enquiry and outlined strategies used for case study design involving multiple cases. In the chapter, the research approach and paradigms with their philosophical assumptions were chosen, justified and discussed. The research design, sampling strategies, data collection methods - the semi-structured interviews; observations; and document analysis methods that were used to collect data were discussed. The data analysis strategies for the collected data were also discussed. The strategies for the trustworthiness of the study that involve credibility, transferability, dependability and confirmability were considered in this study to address the issues of reliability and validity of the current study findings of how Senior Phase Technology teachers integrate creativity and design activities of Systems and Control in the classroom during the teaching and learning process. The ethical issues were also outlined and discussed to protect the integrity of the participants and the institutions involved in the study.

The subsequent Chapters 5 and 6 delve much into data capturing and analysis. Data was captured and interpreted from semi-structured interview transcripts, document analysis schedules and observation schedules.

CHAPTER 5

DATA PRESENTATION AND ANALYSIS

5.1 Introduction

This chapter outlines the multiple case study data involving two districts in Mpumalanga Province to establish how Senior Phase Technology teachers integrate IKS in the creative design process activities when dealing with Systems and Control content in the classroom. The presentation of data from the semi-structured interviews comprise analysis for teachers, curriculum advisors and learners. The chapter begins with the presentation and analysis of the biographical information of the teacher participants as shown in Table 5.1 below. The presentation of the data and the findings and analysis are in three sections. Section 5.3 presents the narratives from the semi-structured interviews for teachers. Section 5.4 presents semi-structured interviews for curriculum advisors. Section 5.5 presents the semi-structured interviews for learners. Lastly, Section 5.6 presents the summary of the chapter.

5.2 Biographical information of the participants

This section covers the general profiling of participants and coding and teacher participant profiles.

5.2.1 General profiling of the study participants and coding

In this section, the presentation of data comprised participants from two districts coded as D1 and D2 embracing three categories of the data collected, i.e., teachers (both experienced and novices), curriculum advisors and learners as described in Table 5.1 below, which were also outlined in Chapter 4.

Table 5. 1: Participants' profiles per district

District 1 (D1)	District 2 (D2)
6 Teachers (3 experienced-E & 3 novices-N) - TA1-E; TA1-N; TA2-E; TA2-N; TA3-E; TA3-N; TA4-E; TA4-N	6 Teachers (3 experienced-E & 3 novices-N) -TB1-E; TB1-N; TB2-E; TB2-N; TB3-E; TB3-N; TB4-E; TB4-N
2 Learners-LA1 to LA2	2 Learner-LB1 to LB2
1 Curriculum advisor-CD1	1 Curriculum advisor-CD2

Twelve (12) teachers, four (4) learners and two (2) curriculum advisors participated in the semi-structured interviews. Teacher participants were categorised into two, novice and experienced, coded in this chapter as TA1-E; TA1-N; TA2-E; TA2-N; TA3-E; TA3-N; TA4-E; TA4-N, and TB1-E; TB1-N; TB2-E; TB2-N; TB3-E; TB3-N; TB4-E; TB4-N. In each district, there were three (3) novice teachers and three (3) experienced teachers. LB1 to LB2 and LA1 to LA2 were codes used for learners and CD1 and CD 2 codes were used for curriculum advisors respectively.

5.2.2 Teacher profile

In this section, pseudonyms are used to protect the confidentiality of participants. Table 5.2 below describes the participants' profiles for teachers. The categories of the participants' profiles broadly comprise age ranges, teaching experience, grades taught, school contexts and cultural background of school or individual.

Table 5. 2: Teacher profile

Participant	Age	Gender	Highest qualification	Experience teaching Technology	Grades taught	School context	Lab/workshop	Dominant culture
1	31-40	M	BEd Hons	5+ years	9	rural	No	Swati
2	41-50	F	ACE	5+ years	8&9	Rural	No	Swati
3	31-40	F	BEd	5+ years	8	Rural	No	Ndebele and Sepedi
4	31-40	F	BEd	5+ years	9	Rural	Yes	Ndebele
5	20-30	M	BEd	0-5 years	8&9	Rural	No	Ndebele and Sepedi
6	31-40	M	BEd	0-2 years	8	Semi-urban	No	Ndebele
7	41-50	M	ACE	5+ years	9	Semi-rural	No	Swati and Tsonga
8	31-40	M	BEd	5+ years	7&8	Rural	No	Pedi & Ndebele
9	31-40	M	BEd	0-2 years	7	Urban	No	Ndebele & Zulu
10	50+	M	BEd Hons	5+years	9	Rural	No	Swati
11	41-50	M	Masters	5+years	8&9	Rural	No	Swati and Tsonga
12	31-40	M	BEd	5+years	7	Rural	Yes	Swati

In Table 5.2, twelve (12) teacher participants consented to participate in the study and managed to complete the profiling information sheet. All the teacher participants in the study hail from the two districts, i.e., D1 and D2 in Mpumalanga Province. On the age of the teacher participants, one (1) participant's age ranged between 20-30 years and was relatively a newly appointee; seven (7) participants' ages ranged between 31-40; three (3) participants' ages ranged between 41-50 years; and finally, one (1) participant's age was more than 50 years. The profile on the age ranges shows that the majority of the participants were below the age of 40 whereas the remaining participants were older than 41 years, which gives the picture that the participants in the study were relatively younger. Nine (9) participants were males whilst 3 were females. Two (2) participants obtained an Advanced Certificate in Education (ACE) qualification in Technology Education; Seven

(7) participants had Technology Education at the Bachelor of Education (BEd) degree level; Two (2) participants had a Bachelor of Honours in Education (BEd Hons) degree in the subject, and one (1) participant obtained a Master of Education (MEd) degree in Technology Education.

The picture painted by the qualifications of the participants showed that they were well qualified to teach the Technology subject. Furthermore, when it comes to the participants' teaching experience, the majority (nine) had more than five (5) years of teaching the Technology subject in the Senior Phase; only four (4) had less than five (5) years of teaching the subject. The representation shows that most of the participants were well experienced to teach Technology in the Senior Phase; this is evidenced in four (4) participants, who had taught Technology in more than one grade (Table 5.1). In terms of the schools' contexts, eight (8) schools are in rural areas under the traditional leadership (Chieftaincy) whereas three (3) are in semi-rural either next to a township or town, and one (1) is in an urban area (Municipality). Only two (2) schools had Technology labs. One at D1 was a rural school with Grade 7 classrooms built and donated by local mining companies. The other one at D2 is a specialised school for Mathematics, Science and Technology identified and resourced by the Mpumalanga Department of Basic Education. The predominant cultures in the selected schools were Swati at D1 and Ndebele at D2 irrespective of the mixture in the three (3) schools which was either Pedi or Tsonga cultures.

5.3 Presentation of findings from the semi-structured interview data

Thematic analysis approach was used to analyse the data guided by the SLT model as discussed in detail in Chapter 2 and Chapter 4 respectively. Table 5.3 below outlines the themes generated from the data to lead the analysis in this study across the data sources.

Table 5. 3: Generated categories/themes

Categories/Themes for analysis
• Diverse perspectives on the concepts of IKS, creativity, and design process. • Designing and implementing teaching & learning processes/practices. • T&L strategies enabling the integration of IKS during instructional processes related to Systems and Control. • Opportunities to support meaningful learning to integrate IKS. • Reflections on IKS integration during teacher-learner classroom interaction • Challenges in formulating activities that support the integration of IKS. • The role of community IKS practitioners/experts in integrating IKS. • Effective teaching to enhance IKS integration for meaningful learning. • The interrelation of IKS and indigenous technologies. • The integration of IKS-oriented Systems and Control activities in Technology classrooms.

The sections that follow discuss data presentation and findings based on the identified themes and sub-categories.

5.3.1 Diverse perspectives on the concepts of IKS, creativity and design

This subsection outlines an analysis of the teacher participants' responses to the interview questions related to their understanding of the concepts of IKS, creativity and design. It also outlines the relationship that exists between the IKS and the Technology subject in the Systems and Control content. In this subsection, the findings are deliberated on in three folds, i.e., the general understanding of the concept of IKS, the understanding of IKS in the context of Technology subject of which some common and diverse views on both were ventilated and the understanding of the concepts of creativity and design process. The three folds were discussed in detail in the subsequent sub-sub-sections 5.3.1.1-5.3.1.3.

5.3.1.1 The general understanding of the concept of IKS

Concerning the general understanding of the concept of IKS, the findings revealed that among the participants, some understand IKS as associated with the way indigenous people used knowledge, culture, traditions, and systems to solve their day-to-day problems back then. This was echoed by TA1-E who said: *My understanding of the indigenous knowledge systems to me is when I am looking at the systems and the knowledge that was used back then how to do things*. Similarly, TA2-E stated: *IKS is likened to the olden times or practices back then there were things that were done in a particular way*. Furthermore, TA3-E viewed IKS as having s*omething to do with the traditional ways and the cultures that were used in the past before the new era came into place*. However, TB1-N understood IKS as *the way people used to live in the olden days.* There were participants such as TB4-N, who based the contextualisation of understanding the concept, IKS on the classroom situation where learners have the pre-classroom knowledge when this participant stated: *My understanding of indigenous knowledge is that it is the knowledge that our learners do have from their society.* TB4-N further emphasised that *IKS "is not the knowledge from the curriculum, but it is social knowledge according to my understanding"*. On the contrary, LB2 differed slightly from TB4-N when it comes to the curriculum when this participant indicated: *My understanding is that, like, any knowledge you learn from home will be useful in school or anywhere*. Even though the study's focus is on creative design processes in the Systems and Control content area, some of the participants based their understanding of the concept on 'Processing' as a theme in the Technology subject. For example, TA4-N argued that *people did practice technology a long time ago, but they didn't know that they were practicing this indigenous technology when dealing with processing.* Furthermore, TA4-N highlighted that *normally processing was done long before people used to process food, even clothing, they were doing technology but not knowing*.

However, when pursued further on the relevance of IKS in the current era, some participants highlighted that IKS is still relevant though it is difficult to integrate into class teaching due to a lack of specific guidelines. In support of this, TA1-E indicated: *If there were guidelines on the integration of local knowledge in the content that we are teaching, it was going to be simple to link the IKS but now it is difficult because you get the concept in that textbook talking about something that is not in the local area*. The same views were shared by CD2 saying: *I can only indicate that teachers do a little of integration of local* *knowledge because they just indicate the things that they were using in the past, though not necessarily relating that much to the content.* CD1 concurred with TA1-E, *my understanding regarding the indigenous knowledge is that teachers need to be orientated to the integration of IKS because it is one area that has been neglected when it comes to the implementation of CAPS.* In this instance, the findings revealed that the general understanding of IKS across the cases was that participants view IKS as the past knowledge or knowledge that was applied in the olden days. This view poses a challenge in the classroom due to a lack of integration guidelines, therefore, little is being done to aid the situation.

5.3.1.2 Understanding the relationship between IKS and the Technology subject

Regarding the understanding of IKS in the context of the Technology subject should be recollected from Chapter 3 in Table 3.1 in that the core content comprises Structures; Processing; Mechanical; and Electrical Systems and Control sections (Systems and Control block). However, the focus of this study is on the understanding of IKS in the context of the Systems and Control (Mechanical and Electrical) sections in creative design processes. As far as the participants are concerned, the findings revealed that in both novice and experience categories, participants shared different views depending on the circumstances they found themselves in, as in the community and/or school contexts. The findings highlighted a general understanding of the concept of IKS in the context of Technology, that it can enhance the learning of the content if only based on the contribution of the local community. That is, *indigenous knowledge systems can be seen as the knowledge that is already known including local knowledge from the learners linked to the content of the subject* (TB3-N). Similarly, the integration of IKS or local knowledge in the Technology subject can enhance learners' understanding of the concepts of design. Therefore, TB1-N argued that *to make education not strange to learners, we must make sure that the knowledge that relates to their norms must be integrated into the curriculum. Furthermore, TB1-N emphasised that integration of IKS into curriculum will make learners understand content easily than just giving them total new knowledge considering that learners are not clean slates, one needs to build on what learners have or know when you engage them in designing things.*

The findings further revealed that some participants viewed IKS as the knowledge that allows learners to understand the importance of culture and tradition in the teaching of Systems and Control sections in the Senior Phase. The notion asserted by TB2-E saying: *I understand that we must not do away with the traditional way of living. So, we must also teach our learners even though they live in the modern era; I think we need not forget where we come from.* This would mean culture and tradition play a big role in the teaching of Technology.

The findings further revealed that culture and tradition could assist in learning as indigenous communities do most of the things on a day-to-day basis. For example, when lifting objects and/or loading objects without being aware of the knowledge associated with Systems and Control content and IKS. This was in line with what TA3-E said: *The IKS in the context of technology is more about your learners drawn from different backgrounds, assisting on what could be presented in class.* The findings also revealed that the reality of where learners come from plays a very important role in their learning, hence, the type of learning should relate to learners' day-to-day experiences in the classroom since learners come from indigenous backgrounds. This finding is associated with TA1-E's assertion: *Local indigenous people, especially parents, do Technology where you find that there are motor mechanics doing their work under the trees.* TA1-E further elucidated that *indigenous people use pulleys not being aware that those pulleys are part of the Technology taught in our classrooms where learners do not align the pulleys used with the Technology subject.* Thus, it is very important that when teaching the topics of Systems and Control, teachers should consider aligning it with learners' day-to-day experiences and knowledge.

Society does impact teaching and learning, in that IKS is the knowledge that learners already know from their society which is not part of the curriculum knowledge but social knowledge. This was evident in TB4-E's assertion that *when teaching or learning takes place the knowledge that is based on the community should be included when giving examples that are associated with learners' indigenous knowledge so that they will understand the content much better*.

However, the DBE has since made IKS part of the Curriculum Assessment Policy Statement (CAPS) for Senior Phase Technology. Participants were asked to mention areas in the CAPS Technology that are associated with IKS. The findings revealed that in both categories and across the districts, some participants were able to locate IKS in the Specific Aim 3 of Technology, which covers technology, society and the environment. In support, TA1-N believes that *teachers should teach learners to create relations between what they learn in class and what they experience from their communities.* Furthermore, TA1-N pointed out that learners tend to separate what is happening in their environment/society from what is happening in class, which refers to technology, society and the environment. In addition, TB2-E identified *the areas that mention IKS in Technology as Specific Aim 3 of the CAPS Technology which covers at relate aspects of the environment such as biases, impact, and indigenous technology*. Such were rarely correctly identified by most participants. Similarly, TA4-E articulated: *I think it is in Specific Aim 3 where it talks about community knowledge. That is, the teaching of technology should enable learners to integrate classroom content with community knowledge which refers to technology society and environment.*

On the contrary, even if some participants had a clue about the areas in CAPS that cover the aspects of IKS, there was a misunderstanding noticed in others. This was confirmed by TA1-E who stated that *CAPS is about the knowledge associated with the process related to the impact on the environment but not exactly indigenous knowledge systems.* It shows that the participant lacked a clear understanding of the very 'Specific Aim 3'. However, the findings revealed that most participants had a problem identifying these areas associated with IKS in CAPS even after probing.

Other misunderstandings prevailed during the interviews when participants TA3-E, TB3-E, TB2-N and TA2-N associated the 'Specific Aim 3' with the Technology theme of Processing instead of Systems and Control. This was confirmed in the following verbatim statement: *I think processing can be processing food and materials. In both food and material processing cases, I believe that the issue of IKS plays an important role* (TA3-E). In addition, TA3-E stated that the *CAPS Technology document is about processing,* *where the learners are taught how to preserve, for example, preservation of food, preservation of metals, is on because obviously, in the olden days, there were no refrigerators to preserve that where the IKS comes in.* The three participants, TB3-E, TB2-N and TA2-N showed levels of misunderstanding by misinterpreting Systems and Control. To them, 'Specific Aim 3' refers to 'Processing'. They were expected to base their understanding on the Systems and Control topics. Instead, they focussed on 'Processing'. The misunderstanding reached a level where a participant gave the names of villages around as well as comparing the design of towers and bridges in rural and township areas. This happened despite questions being redirected during the interviews such as TB2-N when said: *In the rural design bridges and roads are not used the same in the rural as in other areas, where bridges made from stepping stones to cross the river, unlike in the townships where bridges are made of modern materials*. However, TA2-N thought that *it is easy to link IKS in the CAPS when teaching the topic levers in Mechanical Systems and Control,* the view that resonates well with the aim of the study.

5.3.1.3 Understanding of the concepts of creativity; design process; Systems and Control in relation to IKS

Creativity and design concepts are key to the Technology subject. The two concepts are important in problem-solving processes. Concerning the two concepts, the findings revealed that the seven of the participants (both experienced and novice), i.e., TA1-E, TB1-N, TA2-E, TA3-E, TA3-N, TB3-N, and TB3-E from the two districts were able to relate the two concepts creativity and design as intertwined and inseparable in the Technology subject when dealing with design processes. Participants shared their different understandings. TA1E described the design process as one of the basic elements which enable creativity through the aspects of drawing, *I think the design process is one of the basic elements that enable creativity because when you're dealing with the design process there is an aspect, we'll talk about design that brings in the issue of drawings.* Furthermore, TB1-N posited that one needs to be creative when wanting to design something, *I think you can't design something that you haven't thought of, you have to be creative first. If you're going to design, you must get it right, because whatever thing that you're going to design, you must be able to be creative to create it*.

Similarly, there was an expressed belief that prioritises thinking of something was first followed by designing it, as TA3-N said, *I think you can't design something that you haven't thought of. You have to be creative first. So, you going to take something into the design because whatever thing that you're going to design, you must be able to create it. So, I think it does correlate*. At the same time, TA2-E considered: *You cannot design something if you are not creative as you should come up with new things in your design*. Creativity was thus viewed as crucial to the innovative ways of problem solving, as TA3-E stated: *Creativity is very much crucial, in solving a problem for one to be able to be innovative. In fact, let me speak of innovation, let me not touch invention, for one to be innovative must be creative to solve a problem*.

TB3-N and TB3-E viewed knowledge as a trigger to creativity in one's mind, as TB3-N indicated: *technology doesn't stand on its own, you need to use the knowledge which it is the knowledge that you have acquired before that knowledge triggers the creativity in your mind or it is developed the creativity skills in your mind*. TB3-E further indicated that *creativity must be as to how the creative design process is going to be, for example, the patterns that are going to be used have to do with creativity and the design has to do with how you going to design.* TB3-E concluded that *creativity is also included in the design process as well as the final product, I think you need both to get the final product.*

Considering the integration of aspects of IKS into the teaching of the creative design processes in Systems and Control, the findings revealed across districts and categories that TA1-E, TA2-E, TB2-E, and TB3-E indicated that they never considered the integration of IKS in Systems and Control. However, some participants said they managed to consider integrating IKS into Systems and Control topics. TA1-E, when asked whether at some stage he thought about integrating the local knowledge/IKS, he said: As *I have explained before that when you look at the concept, the illustrations that are in the textbooks, and then at the focus on what is supposed to be assessed there is no space to integrate IKS*. Furthermore, TB2-E claimed it was for the first time to come across the talk about the integration of IKS in Systems and Control topics, as he indicated: *I can say, no, I never thought of integrating IKS, I didn't even know about this IKS, for the first time* *today to hear about IKS*. Similarly, TB3-E said: *I never thought of integrating IKS in the creative design process when dealing with Systems and Control.* TA2-E also indicated that she had not thought of *integrating IKS in the creative design process when dealing with Systems and Control*. The findings revealed that only the experienced category in both districts D1 and D2 showed that they never integrated IKS in creative design processes when teaching the topics of Systems and Control. Nothing came out of novice categories in this case.

On the other hand, TA2-E, TB2-N, TB3-N indicated that they managed to integrate IKS as TB2-N said: *It took place in Grade 7 because it is Grade 7, whereby where I was teaching the levers in the past, there were no wheels, but they were using a rod and a stone. If you are lifting up something that is heavy, you can find out that you can use the rod to push that stone*. Furthermore, TA2-E said: *It is important to integrate indigenous knowledge so that the learners, would not forget that we should carry on with our traditional way of doing things in the cultures that we use the species in that area. If it is a rural area, for example, if they use those tools, they should not do away with their tools at the expense of new innovations that come with technology*. Additionally, TB3-N stated that she *relates well to the integration of IKS when dealing with creativity and design processes in Systems and Control because some of the things that we learn about in Systems and Control they use them at home, especially wheelbarrow they use scissors, they use chisels to separate the log wood, they use wheelbarrows when they want to carry the load, they use ropes when they want to tie something or even to hang clothes*. Surprisingly, there were three participants TB2-N and TB3-N from D2 and one participant TA2-E from D1, who showed that they did attempt to integrate IKS in creative design processes when dealing with Systems and Control topics and it came out successfully though in an informal way.

Regarding Systems and Control as a content, the findings revealed that almost most participants except TB1-N, understood Systems and Control as the content that embraces electrical and mechanical Systems and Control topics. The content components comprised mechanisms, pneumatic and hydraulic systems, levers, gears, pulleys, and as well as electrical and electronic systems. To select a few who showed their understanding of the concept, TA1-E thought that w*hen we speak of systems, we talk about different elements that are working together to perform a specific function*. Similarly, TB1-E confirmed that he is *more familiar with Systems and Control because he has been teaching Technology for a long time and now, he thinks it is mostly, divided into two, Electrical Systems and Control, and Mechanical Systems and Control*. At the same time, TA2-N indicated that *in the Mechanical system is where one can differentiate between hydraulics and pneumatics*. On the contrary, TB1-N was not familiar with Systems and Control because the participant was still new to teaching the Technology subject and was not experienced in teaching the subject, *To me, Systems and Control topics are not much familiar because I'm new to the subject.*

Considering the actualisation of the creativity and design processes in the teaching of Systems and Control, the study findings revealed that participants came up with several ways in which they made sure that creativity and design processes are actualised in their teaching of the same. In line with that, TB1-N suggested that he *tried to use local examples based on the things around the society to make it easy for them to understand.* On the other hand, TB3-E suggested that *creativity, in the Systems and Control content, can be actualised when trying to design a system that can be used to lift the load easily.* TB3-E further indicated that creativity has to do with *how you make that system look better*, whereas TA1-N highlighted that when learners are out to design any product that will use pneumatics or hydraulics, *creativity is needed to design any object that they think of that will use pneumatics and or hydraulics systems*.

Similarly, TB2-N viewed *technology as a subject requiring practical work, which needs one to make sure that you start with the design process and make sure that learners understand the design process and all the steps from investigation design, whereby they need to write a design brief on everything*. However, TA3-E highlighted that *creativity and design processes are mostly actualised as it affords one the opportunity to deal with Systems and Control content even though my experience is not that much through interacting with other educators, who just give the learners an opportunity to and do projects aligned to Systems and Control*.

Teachers showed diverse views on the relationship between the integration of IKS and the Technology subject content, especially in creative design process activities when teaching the Systems and Control content. Some teachers never integrated IKS while others did. However, a cause for concern is that the findings showed that some experienced teachers from D1 and D2 indicated that they never integrated IKS whereas novice teachers who were mainly from D2 indicated that they attempted to integrate IKS into their teaching.

5.3.2 Designing and implementing teaching and learning processes/practices

This subsection of the findings is about the fundamental aspects that indicated the way participants design and implement T & L processes or practices. These include engaging IKS or local knowledge when designing, developing, and planning activities in Systems and Control; creation of a space where learners explain their understanding of IKS in their teaching; and the support that teacher participants give learners to master the creative design processes and activities in Systems and Control.

In the case of engaging IKS when designing and developing planning for activities in Systems and Control, the findings revealed that most participants indicated that they did engage the aspects of IKS, however, the annual teaching plan (ATP) as they are expected to follow it as prescribed becomes a constraint for the participants to integrate IKS in their activities. The participants indicated that even in these circumstances, they did allow the learners to mention examples based on their local knowledge, especially in the teaching of pulleys, *especially now, that the annual ATP changed the way we used to teach before, I can still relate pulleys with attaching a rope on the grooved wheel or pole to pick up an object or bucket of water from the ground or the well as a way of using IKS so that they can gain the knowledge and understanding of the concept of pulleys* (TB1-E). Similarly, TB3-E gave a clear practical example in line with TB1-E when he indicated that *Systems and Control topics like, pulley systems were used by local indigenous people before to fetch water from wells.* TB1-E further indicated that to promote local knowledge, learners could be engaged in activities that would assist them to understand how local indigenous people used pulleys back then. Hence, TB1-E felt that the pulley systems could be used to develop activities that are IKS oriented.

On the other hand, TA1-E and TA2-N revealed that they used scenarios to factor in the aspects of IKS or local knowledge. TA1-E said, *I structure the scenario in a way that describes the weaknesses in their school, just to bring it down local so that they can be able to familiarise themselves with what is happening in their locality*. Similarly, TA2-N indicated: *I give learners a scenario as from the scenario, learners are expected to write the design process from a scenario under the design processes, which requires you to have a design brief, identification of the problem, and then the solution based on specifications, these steps are where a learner can use his/her local knowledge to tell us how was the problem identified in the scenario is solved.* Scenarios play a pivotal role in introducing learners to real-life problem and developing problem-solving skills when doing design activities. As participants suggested, scenarios could do this in Systems and Control regarding creative design activities that would engage learners to solve real-life problems in their community or society. For instance, *we normally talk about the examples that are in our surroundings, I think it is part of that integration* (TB4-E). Hence, TB4-E suggested that the use of local knowledge would assist learners to understand the content much better and it would make sense for them to do well in the design process activities that involve Systems and Control activities. A similar sentiment was shared by TB1-N, *we just ask learners about the examples from their locality when we're teaching to make sure that you allow them to participate.* TB1-N illustrated further that learners should be encouraged to mention their own examples existent in their locality, such as the types of gears or systems they know, and thereafter, they could be allowed to choose the ones they prefer to design. The illustration resonates well will the aim of the study on the integration of creative design process activities when dealing with the Systems and Control section of Technology subject.

On the creation of a space where learners explain their understanding of IKS in their teaching, it was revealed that both novice and experienced participants across the two districts affirmed that they created space for learners to express their understanding of the concepts in Systems and Control in the language they are familiar with or comfortable using. TA2-N revealed that when learners were given a design project to complete, they were allowed to use their local language. TA2-N further exemplified that when learners were required to design a machine that uses hydraulic systems, they were also allowed to discuss in their home language to come up with a solution to make the machine.

However, the use of local or home language does not always mean the understanding of IKS. As a result, IKS can be useful for contextualising the subject content, as most of the content is Western-oriented. TA3-E stated thus: *I do create space in my teaching for learners to describe their understanding of concepts based on their local language, as a teacher I think that is very important to have the understanding trying to help the learner to understand the concepts in context.* To reinforce the understanding of the context, learners found themselves in their learning, as TB3-E added: *I introduce the new topic to the learners and ask them if they can relate, to what is happening in their communities*. Furthermore, the indigenous farming communities and homes are the creation of good space for learning. TA2-E confirmed this by stating that *it is important to create space in a classroom, I normally asked them how their parents use tools to do farming, not only in farming but even the tools they use in their kitchen as well.* TA2-E further gave an illustration about girls, who in most cases use kitchen utensils such as eggbeaters at their homes as there are gears integrated. Hence, in consideration of these findings, activities must be designed to facilitate learners' understanding of the context related to their indigenous homes and communities even if the content is Western-inclined. However, effort must be made to integrate indigenous content as well.

Furthermore, the participants were also asked about whether they do a glossary of terms to enhance learners' understanding of the concepts in line with IKS. Some of the responses that came out revealed that most of the participants never thought about that before, however, it is something that they would like to do. At times, even if the participants did not complete the glossary of terms, they indicated that they explained the concepts in the local language that learners understood. TA3-N indicated: *Learners are able to say that in their language like what they call a fulcrum in their language and a wheel in their language in siSwati, the wheel (livili)*.

It is very important for teachers to develop or plan activities that will support learners to master the creative design process activities in Systems and Control topics. Participants shared their individual views concerning this aspect. The findings revealed that to support the learners to be confident or master the activities, one would prefer more examples of the designed structures at their homes that involve Systems and Control such as gates, as TA1-E said: *I prefer more examples, to contextualise we looked at the gate structures. I asked learners to get pictures of different gates structures in their locality and allow them to compare their gates to determine the mechanism that were used to move the gate.* The participant's focus was on the way the mechanisms used to control the gate structure movement during the opening and closing as it relates to the Systems and Control. The issue of giving learners examples was further highlighted by TA2-N: *The things that I do to make sure that learners have these activities in every lesson before we can do anything with learners is when I give them the examples that they know as a support, in doing so they would master that activity before you put the new concept. Like, I start by asking them where they saw these things and they will respond then we'll link with the new concept then they will be able to master that*. On the other hand, TB1-E preferred learners to do their work in the classroom than at home in order to give support where it is needed, more so on the use of some tools, *before maybe we are having a class, we know that whenever learners try to design something, they must do the design in the classroom as they are not allowed to do the design at home, this is done so as to allow them to do their work in class so that whenever they are trying to cut something they will be supported because I'm always with them in a classroom than at home*.

TB3-E and TA4-E also indicated that they used videos to support learners to master the activities. TB3-E said: *I always support them by allowing them to explore the internet. I also, play videos in class to support their understanding*. Similarly, TA4-E said: *I'm using videos at the beginning so that it helps them to think in context on other aspects of the content as they observe something on the screen, the videos contribute towards making a difference from what they know about other aspects of the content in their society.* Contrary to this, TB2-E was honest to indicate that the integration of local knowledge during teaching was never done as he focused on a textbook that had activities that did not promote local knowledge. This participant said, *"I've never done that because in technology we are just using a textbook and all that, so the textbook doesn't include their* *local knowledge"*. One of the outstanding examples is when TA2-N illustrated how he linked the electric and pneumatic Systems and Control with local knowledge in the blowing of a traditional horn *(shaya uphondo* – well known as traditional *vuvuzela*). TA2-N likened the connection of a buzzer as it is used in electrical systems to give a sound. Whenever one uses the air to blow it produces the sound that is part of a pneumatic system. TA2-N indicated: *The blowing of a traditional horn is a compression of air in a space to create a sound like on the other side of the buzzer in an electrical system. The process is the same but at the end of the day, all these give us sound.* TA2-N further highlighted that the horn and buzzer *give us a sound but in a different process or context so now they use the traditional horn when calling for gatherings (imbizos).*

5.3.3 Teaching and learning strategies enabling the IKS integration

This subsection outlines the findings in terms of the strategies used to enable the integration of IKS during the teaching and learning processes. The subsection delves more into the findings involving the teaching strategies used to engage learners towards the realisation of local knowledge or IKS during the lesson on the creative design process activities in the Systems and Control topics. The findings were based on the following: Things being done to ensure the strategies applied in their teaching were rooted in the learners' local knowledge; assistance to learners to engage freely with IKS aspects when expressing their opinions; ways to encourage learners to interpret information about IKS; IKS-oriented creative design activities in Systems and Control; and the role of indigenous experts in teaching creative design activities in Systems and Control.

On the teaching strategies used to engage learners towards the realisation of local knowledge or IKS during the lesson, the findings revealed that across the districts and in both the experienced and novice categories, the common thread was that some participants viewed discussion, question-and-answer as well as the use of pictures as teaching strategies. Only in a few cases participants mentioned the use of language and leaner-centredness as the strategies that they manage to engage learners towards the realisation of IKS during the lesson.

Regarding the discussion strategy, TB1-E said: *I think the discussion is the most of thing we do. The way we group them whenever they are to do mini-PAT, discussion in groups is the most that we're used to doing*. TA2-N concurred: *The teaching strategies, can be a discussion, because of a question-and-answer method, this discussion is facilitated by a teacher and individual learner or learner to a learner or the whole class to avoid chaos, the teacher to a learner gives a learner time to express what they know then from there escalate to a full discussion in class*. In the event where there were different groupings in one class TA3-E indicated that *in the event where you have cases of two culturally different learners in one class, you let them explain or discuss to each other the way they do things in their culture in relation to the topic in discussion. You will find that in the end, you get similar feedback or outcome, I think this strategy works very well*. However, TB1-E indicated that *every culture has its own discipline, now whenever we are in class, especially when we're discussing, I make sure that learners listen to one another*. Similarly, during the discussions to ensure the rooting of IKS, TB3-E said that *one of the ways of making sure is to use the language that learners understand and that learners can take work and engage with the community back at home*. This was confirmed by TA1-E when he said that what learners know is very much important to what learners are to learn. TA1-E further illustrated: *If you create a situation or if you design activities that resonate with what learners know and learn there should be harmonised to sure that whatever is learned is deeply rooted in their local knowledge.* On the promotion of group discussions, TB1-N indicated: *It gives learners in a group an opportunity to learn and produce a clear description of IKS through interaction.*

From a unique angle that also involves the community. TA1-N further indicated that *discussion normally takes place based on what is happening locally in Systems and Control topics, although sometimes the electrical systems topics are a bit difficult when compared with mechanical systems where most of the things are done or used in their homes.* This is an indication that local people do apply the Systems and Control in creative ways on a day-to-day basis so engaging learners in such discussion could help to reflect on such practices in their local community.

TB1-N, TB2-E and TA3-N highlighted the use of question-and-answer as their strategy to engage learners towards the realisation of IKS during the lesson. It is for this reason that TB1-N indicated: *I use a question base strategy in class where I ask them about what they know about the topic, for example, a headgear at the same time I would not mind the language used as it helps the lesson to develop from everything they say in relation to their local knowledge*. Furthermore, TB2-E said: *I asked them questions in relation to the topic, if they don't understand it, I used to tell them to ask if they don't understand.* In addition, TA3-N further indicated: *During the lesson, I give them examples of what they live daily. I engage learners in question and answer. I start with teaching them by asking a question on the topic in relation to their day-to-day experiences*.

Regarding the pictures, TA1-E, TA2-E and TB3-N indicated that they brought images, videos and teaching aids to class to engage learners towards the realisation of IKS or local knowledge during the lesson on Systems and Control. This finding was confirmed during classroom observation lessons where teacher participants also brought in some charts, pneumatic and hydraulics kits and in some cases hand drills. However, none of the pictures and/or kits were aligned with IKS. TA1-E indicated: *I normally use pictures and videos just to show them how this used to be done a long time ago compared to now*. Similarly, TA2-E said: *One the strategy I use, I bring teaching aids such as the gears, the pulleys, and the eggbeater and operate them in front of the learners as part of the practical.* TA2- E highlighted the importance of using teaching aids as very important to learners because they learn what is taught in context not only relying on the textbook and the classwork books. However, TA2-E said nothing about IKS. Regarding the promotion of the use of pictures, TB3-N said: *I use pictures sometimes I use charts to support them for them to clearly understand the content even now I was cutting the pictures I'm going to give them to study the pictures, so these pictures contain elements of indigenous knowledge systems*. Furthermore, TB3-N indicated: *After giving them the pictures, I want them to explain what they got at home and tell the class what they got at home they answer the questions themselves after that then I give them corrections*.

Another strategy mentioned is learner-centredness. TB4-E said: *The teaching strategy I normally use is a learner-centred one but as a teacher, I give direction during the lesson, so, I start by engaging learners trying to find out what they know about the content, like about the local knowledge to encourage them to feel free so that they could share their views of what they know and understand with the class*.

Participants were asked about what they would do to make sure that the strategies applied in their teaching are rooted in the learners' local knowledge/IKS. The findings showed that participants' experiences differed due to the context they found themselves in. Some found it difficult to root learners' understanding of Systems and Control concepts on IKS. TA1-E shared *that it is quite difficult to do, it is quite difficult considering the Western concept that we have these days because when I'm teaching I try to make sure that they bring something that is common to the learner, something that learners are aware of and know, so if you want to bring that old concept or knowledge it is quite difficult because they can relate to looking at their generation it becomes difficult for them so it is not something that we use as a strategy to make sure that they accommodate learners' who are slow in understanding some concepts*. As much as there were indications of success in some participants, there were still some who were honest to indicate that they did not do anything to make sure that the strategies they applied in their teaching of Systems and Control were rooted in the IK or local knowledge, as TB2-E indicates: *I have never done anything because I just follow the ATP whatever it is*. Also, TA3-N said: *I never did it.*

On the issue of learners engaging freely with IKS when expressing their ideas, the findings revealed that some participants relied more on promoting the use of their mother tongue when dealing with design and making projects that involve Systems and Control, such as TB1-E who said: *In getting them through they are allowed to talk their own language. if they are talking or discussing in their own language the brighter ones can calculate what is saying, so they are free to talk even if we have an idea, we are not going to keep it to ourselves so that the only ones got ideas from the other ones or the ones that are going to work with the design that their making*. Also, TB4-E indicated: *As our surrounding is dominated by Ndebele and Sepedi-speaking learners we encourage them* *to code switch using their language or their mother tongue so that they will be able to express themselves or bring in that because some of the things they know are having specific names or African names and meanings. So, by encouraging them to be free we encourage them to express themselves using their mother tongue.* In the other context, TA2-E said: *I don't restrict them to the language of teaching which is English. I would allow them to also use their vernacular language which isiSwati in that way they feel free because they are not afraid to say something even may be in presenting if there's a presentation to be made, then I help them at the end to know the concept in English. I sometimes group them when given a task I do not individualise the work, say maybe in a group of five or 10 let us do this so that they will help one another*.

The use of language came into the picture where TB3-E shared the importance of the use of the local language in their teaching, "*I know, there are simpler and there are terms/concepts that cannot be broken down in accordance with their languages, but whenever I can code-switch, I code-switch to a different language that they understand"*. When asked whether he once thought of compiling a glossary of terms in this regard, he said that he *never thought about it*. On the other hand, TB1-N suggested that he made sure that they dealt with the understanding of the terminology from the learners' context before applying it in class, *I make sure that I do not leave them with the terms they don't know in my examples. I must always relate to their indigenous knowledge and allow them to voice out their understanding about the outside of the scope.* Furthermore, TA3-E said: *It could be by allowing learners to describe activities themselves but using the language that they understand or sharing ideas amongst themselves using the language also that they understand themselves*.

Participants indicated that they gave learners practical examples of how some of the Systems and Control systems work using mechanical systems. TB2-N illustrated: *For pneumatics, I've made an example of the garage where there are mechanics and then I told them that when they are working with a car is so big since we have started from the syringes there is a master and the slave for the car, they use these cylinders that are found in the garage to lift up the car so that the mechanic can work with that car easily*. TB3-E indicated that he linked the activities with the learners' culture to enhance their understanding, *I think with me, it is easy because I relate that to their culture because their culture is my culture. So, with me, I think it is easy for them as they are Ndebeles, I am also a Ndebele.*TA3-N indicated that when learners do a project, he encouraged them to engage freely: *I do everything with them if there's a project, I do with them class I am helping them do it but also do allow them sometimes to discuss these things (yes) in the language that they understand.* However, some participants said they did not do anything to engage learners to freely express themselves using IKS, such as TB3-N who said: *I have not done it*.

On the aspect of encouraging learners to interpret information about IKS when teaching creative design activities in Systems and Control, the findings revealed that participants had different views. TB1-E said: *I allow them to express themselves in their own mother tongue and the way they understand it based on their own background*. TA2-E said that he advised learners to create their own activities in the form of a questionnaire at home in order to exchange with other learners in the class, which were being moderated before they were exchanged: *I advise them to again create their own activities (questionnaires) so that when they come with them in class, they exchange them I would group them in pairs. They will exchange them with their friends where they answer their friend's questionnaires and answer their friends' questionnaires by so doing, they will be integrating the knowledge that they have*. On the other hand, TB1-N allowed learners to discuss how the Systems and Control in design activities help them in society: *What I do as a teacher is that I let them discuss or tell me, how this system design helps them in society. I asked them to have those discussions whenever we discuss, the usage or the importance of these systems in their society, also in their cultures, if they remain*, *and promote the use of the language and the use of the language so that we can progress.* Furthermore, TA3-E indicated: *Be as local as possible, in a sense that I do not want a learner to be carried away to say I want to bring maybe something that or to show that I can bring that something that everyone does it doesn't know, for instance, one can speak of IKS looking at South Africa as a whole, to say you've got your Xhosas you've got your Zulus and what not, but in most cases, I do not want to go far. I normally prefer to say locally, and why diverse communities let us deal with things.* However, TA4-E said little was done to this aspect of allowing learners to interpret the information about IKS: *But we do it a little, so we don't stress on that one.* At some stage during the process of T&L Systems and Control topics, one would opt to engage local experts or elders in indigenous knowledge to come and assist in contextualising the learning process. However, the findings revealed that none of the participants invited the elders or experts to IKS, however, there were general views that the participation of elders and/or indigenous experts in their classes would assist them, participants and learners, in understanding some of the concepts they use in Systems and Control in design activities which would enhance successful learning in context. A response from TB2-E was: *No, I have not done that*.

5.3.4 Opportunities to support meaningful learning to integrate IKS

The findings in this subsection focus on the opportunities that IKS presents for the teaching of the Systems and Control topics or content. It is expected of the teacher and education officials to make sure that the T & L environment is conducive to meaningful learning opportunities being created to inspire confidence in learners. The opportunities created can be utilised to support meaningful learning in context through the integration of IKS. Opportunities can be created for learners to be able to contribute local knowledge when learning design activities in Systems and Control. Furthermore, opportunities can be created to help learners to master the learning activities based on the local knowledge content and for learners' reflection on IKS-oriented activities.

On the issue of the opportunities that IKS presents for the teaching of the Systems and Control topics or content, the findings revealed that participants from different categories and across the two districts had different views.

The findings further revealed that some participants applied several different approaches to create opportunities to enable learners to bring in local knowledge. Three propositions were made, which are the use of existing artifacts in their homes or community, the design of scenarios related to their community, and leading learners through questions that allow them to relate with what is in their homes or community. On the use of the existing artifacts in their homes or community, TB1-E said: *I think before we start the lesson the questions that we pick must have prior knowledge and more specifically teaching technology* *becomes more difficult if teaching from paper so you must at least have some objects or talk about the objects that are there at home, how do they use them in order to have to understand better*. For the question of creating scenarios for learners, TB3-N said: *I think to manage this one I always create the scenarios that would help learners to be more practical in what they are used to doing at their home and using the knowledge from the community*. In leading the learners through questions that allow relating with what is happening in their homes or community, TA2-E said: *I can design questions to ask them about this indigenous knowledge in their local vicinity*. As to how learners can be assisted to express themselves in these three prepositions, TA1-N suggested: *We normally discuss in class, then, you know, once you take a topic that they are familiar with that is like things that are happening in their area, they just crop up, they'll group discussions are formed, then you see them coming even if maybe the topic maybe where you are to move to another topic*.

Regarding the opportunities that are created to help learners to master the learning activities based on the local knowledge content, the findings revealed that the support that one can put to assist learners to master the activities in Systems and Control is to allow learners to design based on what they have seen and experienced, as TB1-N said: *You allow them to design what they've seen, you don't give them activities that they have going to do something that they have never seen before*. The other one is the promotion of a learner-centred approach, as TB3-N said: *For the learners to feel free to learn based on their context or local knowledge and to be able to articulate these things, I think the learner-centred approach is the best one on this one to ask from the learners*. Also, for the use of teaching material like videos to enhance learners' understanding based on their local knowledge or IKS, TA4-E said: *I'm using the videos at the beginning so that it makes them happy to think about other things because since they see something on the screen, they become happy this is different from what they know about other things and it brings a bit of happiness*. The findings further suggest that the support put in place to allow learners to produce a clear description of IKS is through promoting group discussions, encouraging the use of language, and promoting the use of pictures and charts as well as understanding the mechanisms used to lift loads the indigenous way.

The other way of creating opportunities for learners to support meaningful learning is by allowing them to express themselves through reflection on IKS-oriented activities. The integration of IKS can provide that opportunity, as TB4-E said: *I think the opportunity that it provides and I mean IKS provide or presents bring something which as teachers, we're free to elaborate and explain then learners will do something which is new, but it is related to technology, and to their culture and cultural way of doing things*. The findings showed some participants claimed to allow learners to reflect on the IKS during learning, whereas others do it on rare occasions, and others still, do not do it at all. TB1-N said: *So, we asked them the questions if it is to say, what if there wasn't this? What will be your alternative? Yes, they are nowadays this whatever, what can you do to develop it too, so maybe a maybe if they design a car? How could you make it technologically wiser? Maybe now, they've got cameras, the new cars have got cameras, they've got this and that, then we allow them to think or reflect around that thing to think about the new shape*. However, a different take from TB3-N indicated that *you will never do that you just use the syllabus to make sure that the content is taught and for them to pass*.

On the use of a questionnaire, TA2-E said: *I can design a questionnaire to ask them about this indigenous knowledge in their local vicinity. So, ask them, what have you learned? What are the tools that we use from our forefathers? and so on and so on, they will give you the answers*. On the other hand, TA3-E indicated that: *It is very much effective, like now, for instance, I've given them a task to go and do their own research, about pneumatics and how a hydraulic jack operates.* TA3-E further said*: I randomly, pick one or a volunteer to explain what he/she has done and found out about hydraulic Jack operation and share the experiences when undertaking the research*.

5.3.5 **Reflections on IKS integration during teacher-learner classroom interaction**

Reflections on one's learning could be used as proof of whether learning has taken place successfully or not. The previous subsection looked at the challenges that teachers face and how they are addressed toward the integration of IKS-oriented activities in the creative design of Systems and Control. In this subsection, the focus is on the findings of whether opportunities are created for learners to be encouraged to use local knowledge to reflect on the activities. The findings showed that some participants do create time for reflections, though TA3-E indicated that he gave them the freedom to do so informally by telling stories, *I give them freedom the flexibility. I give them the freedom to express themselves yes, yes, they do reflect by telling their stories, and at the end of the day or during that reflection. I do not want it to be as formal because it can somehow hinder so to provoke everyone in the situation*. On the other hand, TA1-N created time for reflection but under difficult time constraints, *yes, although the time factor doesn't allow us, we normally do it because after they've maybe designed and maybe created or made that object, we normally tell those who have done well to stand up and show off their product in front of all learners*.

On the contrary, the findings revealed that some participants did not create such time because there was no provision in the syllabus and time created for such an exercise to happen in class, as indicated by TB1-N: *Time is not created*. Similarly, TB4-E said: *we normally truly speaking don't afford them a chance to reflect, as you know that in quite several activities on ATP, they are directly looking at our work as scheduled and stuff like that on reflection, I can lie*. However, TB1-E highlighted that encouraging learners to reflect would make them excel in their work, *I think doing reflection will do much better and reflection will encourage them. And at a later stage, they will also excel*.

5.3.6 Challenges towards formulating activities that support the integration of IKS

This subsection focuses on the challenges that teachers faced in the formulation of activities that support the integration of IKS as well as how the participants overcame such challenges. The findings revealed that when coming to formulating activities that support the integration of IKS, the participants across the two districts and categories faced challenges ranging from teaching in a multicultural classroom to a language where one has to strike a balance between cultures, as TB1-E said: *So even if they are two now the way Pedis are raised, is not the same as the way the Ndebeles are raised. So, some will say we say the same thing we say but we have to consolidate in a classroom that this is done like this when we are looking at this, but at the end of the day, we get the same outcome*.

Regarding the language used, TB3-N said: *Yeah, one challenge is the language which leads me to use formal language, I use street language*, the textbook materials, TA1-E said: *Integrating IKS into creative design activities in Systems and Control particularly* *when you look at the materials that we have, it is quite difficult it is a challenge because of the concept that they used in the illustration they used in the materials that we use these days*. In terms of the provision of the materials as in resources, TB1-N said: *One of the things may be its materials and maybe we need to cut some cardboard designing something to do, we don't have technology labs. In our community, our school, we don't have a technology lab where we go into design things and use them because, some of the things, we need are tools*.

Regarding the kinds of activities teachers gave in class and the influence of the present modern society, TA2-E said: *The challenge that we have is that these learners we have nowadays, are more modern learners, even if they live here, but the reality of their homes, the lifestyle has changed*. *This means that the knowledge it is trying to supersede its own local knowledge*. For the generation gap that exists within communities where the knowledge is not the same, TB4-E said: *Yeah, I think the challenge is that as you know, we're with a generation gap some of the learners, you'll find that that knowledge that we're seeking a no common knowledge, they will say at home*.

On how participants addressed the challenges, the findings revealed that they highlighted the use of diversity in their class, as TB1-E said: *Usually, we come up with a solution that at the end of the day, what is needed is the outcomes or the outcome that we're needing*. Also, some used their home language or local language to explain some of the concepts, as TA1-E said: *This one; I know I normally change the concept and address them in my home language. If it is an activity, try to put it in a local context.* TA1-N, TB1-N, TA2-E, TA2-N and TB3-E engaged learners in a variety of activities such as taking an excursion or tour, doing projects, giving feedback on their learning, and encouraging the use of local language when learning. At some stage, the participants do some demonstration or model the lessons to enhance learners' understanding, as TB4-E said: *Normally we demonstrate, they are good at following someone when someone approaches or something that they're good at imitating. Maybe it is a project that they were able to design that project and do it they are able to follow that learner or copy what others did*. However, some participants said they never did anything about addressing the challenges, like TA4-E who said: S*o far, I have done nothing*.

5.3.7 The role of community IKS practitioners/experts in integrating IKS

The subsection shares findings on the role indigenous knowledge holders can play in sharing knowledge. Indigenous knowledge holders or experts are seen in communities as the crop of experts that could play a role in assisting schools to preserve knowledge through collaboration. The findings in this regard revealed that participants across the two districts and categories agreed that the indigenous knowledge experts could play a very important role in assisting the integration of IKS into Technology subject areas or content. The move was seen as the one that would advance the sharing of knowledge and experience amongst the experts, teacher participants, and learners which was related by TB1-E, TA1-E, TB1-N, TA2-N, TB2-E, TB2-N and TA4-E. For example, TB1-E stated: *I think the expert now can explain these things better than me because they got the experience of what they're talking about. Unlike I'm talking about what I heard. So, obviously, if we go to the class now and I explain something, then the expert comes to explain how in the olden days they used to do. So, learners will understand better because you were there than the one, like I cannot say, I'm almost like them.* In addition, TA2-N said: *I think it will help a lot because the experts will elaborate on the indigenous or the IKS and then relate to the new concept that they are learning in school. I think inviting that expert, would be easy because they expect will explain the IKS to the learners in the language that they will understand*. However, the findings revealed that as much as participants unanimously agreed with the role that the indigenous knowledge holders or expect could play in T & L, there were some participants such as TA3-E and TB3-E, who indicated that they never invited them, but it is something they would consider doing in the future.

5.3.8 Effective teaching to enhance IKS integration for meaningful learning

In every teaching and learning environment, effective teaching can be realised if the correct frame or structure is in place. In this subsection, participants shared their thoughts about how a framework or structure could enhance the IKS integration for meaningful T&L. The findings revealed that all 12 participants agreed that there should be a framework that will guide them to integrate IKS into their T&L activities. They further suggested the aspects or elements that could constitute the structure or framework.

TA1-E, TB3-N and TB3-E felt that the curriculum textbooks should be transformed to accommodate local knowledge by linking the concepts that would involve local people to craft meaning in order to produce a glossary of terms. TA1-E indicated: *It is supposed to have a link between the concept that are used in the textbook and the concept that we use in a local area because when you check the practice, it is the same, but the manner in which it was conceptualised, is not the same.* TA1-E further said*: it becomes difficult for learners to draw the line unless you are at the level where you can understand, for example, when talking about a system, we used swings that were made from the experiences of our forebears' knowledge which was useful long time ago, it is simple. It is the same knowledge that is explained in the classroom*. Similarly, TB3-N said: *I think number one, it has to do with simple content terms or concepts explanation some sort of glossary; number two it is to seek the information from the experts and the knowledge holders and say, note that down or record the interviews with them.*

The findings further suggested that the elements should feature IKS, or local knowledge based on the tools that are used at home, as TB1-N said: *The element where you are featuring the knowledge at home and the current curriculum. So, make sure that there is no gap yes, between the indigenous knowledge and the current curriculum*, and TA4-E said: *To understand what you are thinking, we need to put a framework that will link local knowledge based on the tools that they use at home and how they use them. So, in that case, we'll be able to assist teachers to be able to integrate such things into their learning*.

5.4 Curriculum advisors' views on the integration of IKS in Technology Education

The analysis of the views of the curriculum advisors is based on key issues outlined in Subsections 5.4.1 to 5.4.10 below.

5.4.1 Curriculum advisors' profile

Table 5.4: Curriculum advisors' profile

Curriculum advisor	District	Age	Phase or Band	Experience as curriculum advisor	Cultural background
CD2	D2	41-50	GET Technology Senior Phase	5 +years	Ndebele
CD1	D1	50 +	GET Technology Senior Phase	5+ years	Swati

Table 5.4 above outlines the profile of the participant curriculum advisors representing each district in the study. The two participated in the interview after the researcher had district meetings about the study. The curriculum advisors' ages ranged between 41-50 and 50+ years. Gender had no bearing on the choice of participants in this category. The curriculum advisors were responsible for the GET Technology in the Senior Phase and had more than five (5) years in curriculum advisory services. Both participants had the Nguni backgrounds (Ndebele and Swati). The choice of the two curriculum advisors granted the researcher an insight into how Senior Phase Technology teachers integrated IKS in the creative design process activities when dealing with Systems and Control content in the classroom. The subsections that follow present the narration and analysis of the interviews that took place in the two districts involving teachers, curriculum advisors, and learners' participants.

5.4.2 Views on teacher support for the integration of IKS

This subsection presents an analysis of how curriculum advisors in the two districts supported teachers with the integration of IKS for effective teaching of the Technology subject in their classrooms. Furthermore, the subsection focuses on whether the IKS perspectives are considered during the Technology teacher empowerment sessions conducted by curriculum advisors.

Regarding the consideration and integration of IKS perspectives during workshops and teacher empowerment sessions, the curriculum advisors averred that the IKS aspects were not prioritised on the list of activities implemented during the advisory sessions. For example, CD1 highlighted that they did not consider and include any IKS-related concepts in the teacher empowerment sessions they conducted. Similarly, CD2 confirmed this matter by saying *we are not giving them any knowledge regarding this area*. However, the views shared were that it sometimes depends on the term and the content featured in it, in line with what CD2 said: *It all depends on the content, they are doing some of the content, and they don't necessarily touch the indigenous, but others do at their space. So, it depends on the content for that term.* This finding attests to the fact that teachers were left on their own to decide on the issues of IKS integration or not. On the support, the curriculum advisors left it to teachers to interpret the CAPS concerning IKS in Technology which is normally during lesson development and class teaching. The findings revealed that there was no provision in their scheduled plan for the year to integrate IKS. Instead, the only support put in place was to encourage teachers to follow the ATP-prescribed content. This treatment of IKS makes it to only “beautify” the CAPS; there is no concerted commitment to integrate it practically.

The above sentiments were shared by both CD1 and CD2, as CD1 said: *In terms of helping teachers, the approach that we take is that of ensuring that teachers are developing their lessons by paying attention to the annual teaching plan. So, in other words, this annual teaching plan that then becomes our framework is like our driver. And then when looking at it, the ATP, this indigenous knowledge system, as an area that will be integrated into the teaching of the subject is not included in the ATP.* Besides the shared sentiments above, CD2 gave a clue of some integration done but not on the formal plan, when she said: *There is some prescribed content that CAPS is requiring and then we work according to the content that is required by CAPS depending on which term or depending on which grade. And then if there is a relation to IKS and then we do relate the content to the skills that were there in the past.* The views of the curriculum advisors point at the prescribed content from the ATP that lacks indigenous knowledge concepts. This regulates how teachers are being advised, leading to the non-alignment of the content with IKS.

5.4.2 Views on familiarity with indigenous technologies and IKS

This subsection presents the findings based on the participants' familiarity with the indigenous technologies associated with the Systems and Control topics in creative designs as well as the examples that participants give when teaching creative design processes. The findings revealed that there was an agreement between CD1 and CD2 when it comes to familiarity with IKS amongst the teachers, such that CD1 said: *Teachers are familiar with the indigenous knowledge system, especially when given examples. This is one area, that can be related to indigenous knowledge systems when dealing with the Systems and Control. If you don't give them examples, and share or relate that to the subject, then it is like they are not going to be interested in indigenous knowledge systems*.

In addition, CD2 gave some percentage estimations of the teachers who were familiar with indigenous technologies related to Systems and Control content associating the familiarity with historical connotation, highlighting that *about 50% are familiar with IKS systems relevant to their teaching context*. CD2 echoed that *the machines that they are using, are related to what we normally used in the past.* CD2's emphasis was that the familiarity with the indigenous systems for both curriculum advisors and teachers is historical but not documented on the formal ATP and frameworks applied in teaching strategies.

The findings in this aspect are an indication that the presence of indigenous knowledge dominance among the teachers, learners, and curriculum advisors is evident but the education system does not cater for such in practical terms even though it encourages the integration of IKS in CAPS. At this stage, it seems as if CAPS components that promote IKS are sidelined in favour of the expedience of content teaching in the form of ATP. The ATP could be seen as a framework that prescribes the content taught at a particular time focusing only on the subject content excluding other essential factors such as the influence of teachers' and learners' indigenous background at the expense of other knowledge that is involved around where learners and teachers come from.

The findings revealed some of the examples that participants gave regarding to the types of indigenous technologies when teaching Systems and Control in the creative design process, for example, CD1 said: *No, this area is not addressed at all, it is not addressed, the reason for not addressing this one is that the teachers are not taking the integrative approach. In terms of planning, their lesson ensures that as they are handling Systems and Control, they need to bring in examples from their local area, so that they can make it simple for the learners to understand*. As a result of the fact that the area of IKS was not addressed, teachers were not encouraged to integrate it, just as CD2 said: *In terms of our training, we don't encourage them as I indicated earlier that we stick to the ATP*. On the contrary, CD1 mentioned that the area of IKS was not addressed. CD2 highlighted very important aspects of the way she used the design processes to expose some Systems and Control during practical assessment tasks: *The usage of the design process is helping because the teachers are supposed to build for an example this term they deal with the machines such as the usage of gears, the usage of pulleys in systems and then such knowledge and skills were used in the past*. This was the opportunity to encourage the integration of IKS even if it was not part of ATP.

The findings further revealed that curriculum advisors had no control over the development of the ATP to factor in the integration of IKS during training for teachers. Instead, it emerged that the ATP was developed by the National Department of Basic Education and factored down into implementation. The only time curriculum advisors and teachers are involved is when it is implemented in the classroom in the top-down approach, as CD1 indicated: *The ATP is not developed by us, it is developed by the National Department. You get them from the national department and filter them down to provinces, districts, and schools.*

5.4.3 Skills for Integration of IKS

The findings on the integration of IKS in Systems and Control revealed that the integration of IKS remains a grey area in the teaching of Technology. Furthermore, according to CD1, the integration of IKS or local knowledge never forms part of ATP. Several contributing factors could be the time allocated to the subject per term, lack of proper teacher training, and IKS not being considered completely within the circle of support services. According to CD1, *in terms of local knowledge, this area of IKS is not well addressed. It is still a grey area we continue with ATP; these others are just falling on the periphery.* CD1 further highlighted the reason for continuing with ATP without considering the integration of IKS as *"the amount of time that is allocated to the subject encourages them to stick to the ATP because, in a week, teachers have got only two hours for the subject.* CD1 suggested that could be the reason t*eachers try that by the end of the term, they've addressed all the content areas as indicated in the ATP*.

However, CD2, on the other hand, gave some clue on how the content of Systems and Control can be handled which is important to what the study focused on when she said: *Learners, especially those that are in rural areas, when they fetch water, they normally maybe go to the well or a stream. Then they use the ropes with the bucket so that links them to the pulleys and systems. Again, in terms of some who are maybe having farms at their homes when farming, there are machines that they use to irrigate their crops. These link to the Systems and Control because there are a lot of moving and turning things there.*

Specific Aim 3 of the CAPS involves the aspects of indigenous technology. CD1 and CD2 highlighted that to actualise Specific Aim 3, teachers are supposed to consider the integration of IKS and link it to the society or learners' environment. In addition, CD1 and CD2 stated that integration of IKS can be introduced when teachers work on projects that follow the design process, and in assessment tasks. Furthermore, the curriculum advisors highlighted that all teaching scenarios related to IKS should factor in local cultural knowledge by considering the values and attitudes of the cultural group at the exposure of the teachers or schools. In emphasis, CD2 argued that *mostly, existing problems in society link directly to environmental issues.* Environmental issues were defined by CD2 as the practices observed from surrounding people. Furthermore, CD2 motivated as follows: … *whatever content or project we are doing, we make sure that people benefit and we make sure that we take into consideration the values and attitudes of the people who will benefit from that particular design and content.*

On the contrary, the actualisation of Specific Aim 3 was supposed to align with the state of the ATP. The ATP design scenarios are prescriptive and the outcome of the process to be followed is defined which makes it not flexible to consider the local knowledge such that the whole exercise defeats the promotion of creativity and application of local knowledge /IKS in the process. In the same token, CD1 gave an illustration indicating that, *the manner in which these scenarios are written, they don't demand that the learners become creative. For example, where the learners are supposed to design and make a rescue system from the resources using examples of rescue systems those are already given. In other words, when learners are given such projects, learners need to use their creativity so that they come up with their models in terms of solving the problem.* Furthermore, CD1 highlighted that *you don't have to think and produce your very own which means there's no innovation, no creativity that is being and how are these mini-PATs designed because seemingly that's where things like IKS could be happening.* CD1's view brought curiosity as to whether the type of practical tasks that learners are engaged with in class are pitched to the level where they could be creative with the integration of IKS to achieve a level of innovation.

Furthermore, one can argue that the contention by CD1 in this regard is concerning, more especially at the point where the transformation of the education systems is supposed to be core toward promoting IKS in the school curriculum. The mini-PATs as prescribed in the ATP were supposed to be drivers of curriculum transformation in Technology Education through the integration of IKS in the formulation of the design scenarios activities. In other words, fulfilling the requirements of integrating IKS/local knowledge in learners' work or mini-PAT design scenarios requires proper guidance from the subject specialists. However, the subject specialist guidance, much as it is important, seems to be a huge hurdle to jump since the ATPs are prescribed for them with no flexibility to manoeuvre as indicated earlier.

In guiding teachers to integrate IKS/local knowledge to impact teaching, the findings exposited that the promotion of creativity in design processes and the local knowledge/IKS are limited in terms of ensuring the impact in the teaching of Systems and Control content. However, teachers are encouraged that whatever they know as part of IKS, they need to make sure that they implement and put it into practice irrespective of the prescribed work, in line with CD2 as said: *It is very important that learners understand, why they do technology subject. To do technology, they need to understand that they are doing that to solve everyday life problems that they come across. So, whatever teachers know, as part of indigenous knowledge, they need to make sure that they implement it and put it into practice.*

Guiding teachers on the content and strategies to promote the integration of IKS, the study's findings exposited that the area of integration needs to be improved and that teachers need to build on what learners know to ensure that local knowledge/IKS is catered for in creative design processes. This was echoed by CD2 when she said: *They need to make research on people who are around them, and then make sure that they understand what the needs of the pupil are, they're making sure that they understand how they help people, and then they make sure that they built on one what people know. So that people at least, won't see this subject as a strange subject*. However, CD1 still contended that the inflexibility of ATP is not advancing the integration of local knowledge and undermines the promotion of creativity in design as solutions are pre-determined, *integration, which means it took away also the creativity part in the design where learners would come up with their solutions. So, it means the solution is already there for them just to put the parts together, to see that something happens, they just join the dots.*

The curriculum advisors were further engaged to determine how they ensure that IKS is catered for during training and support (classroom visits). The findings in D1 revealed that local knowledge is not taken care of during their training and support, which to me as a researcher is a gap to be looked into, as CD1 said: *When training teachers this area of integration of local knowledge aspects is not entertained since is one of the areas that need to be explored.* On the contrary, in D2, the findings revealed that before the teachers' workshop, CD2 started with teachers' general challenges relating to the content for the term which excluded the integration of IKS in order to address them in a planned workshop for teachers, as CD2 said: *I normally do the workshop but before I plan my workshop, I check what are the challenges for the teachers so that I know what I'm going to deliver to the target group.*

The findings regarding this issue still showed that the curriculum advisors in the two districts use different approaches towards the support of teachers to integrate IKS in creative design processes activities in Systems and Control. The difference in approach comes against the backdrop that the districts follow the same programme after receiving the provincial training, as CD1 said: *In other cases, we sit as a team in terms of grades, and then we develop the material. So, in those teams, we look at what is the principal objective for you to get a common approach on how to interpret this document for teachers or for you to seek to come up with some new items to include in the material. The issue of coming up with something new is limited. This means the primary objective is to get a common approach to how you're going to train the teachers. So, in other words, we want to ensure that the officials who are training in Nkangala, are training the same thing as we are training at D1 or D2. We are taking a common approach. This means you make it universal for the province so that when the teacher maybe attends in D2 from D1, should get the same thing or content as when they are in Ehlanzeni.*

The findings showed that participants saw the importance of integrating IKS in their training materials which would assist teachers to develop a skill to integrate IKS when planning for class activities. This could assist not in the Systems and Control content area only, but also in other content areas in Technology Education. CD1 said: *There are so many opportunities where we can introduce the indigenous knowledge systems in ensuring that especially when developing the material for the training of teachers, that is one area where we can integrate it though we develop the materials at a very minimal level as it is the duty of the provincial coordinators. The provincial coordinators are the people who are tasked to develop the material and they train us on the material which in most of the material, once has been developed, we go through it to check some of the things and then we go and train teachers.* This assertion opens an opportunity to engage with the policymakers to influence the need for and importance of IKS-oriented materials to foster the transformation of the Technology Education curriculum.

5.4.4 Existing collaboration with indigenous experts

The collaboration with indigenous experts was looked at in three ways. Firstly, the findings looked at the strategies that CD1 and CD2 used to guide teachers in making sure that they engage indigenous experts or elders for the integration of IKS in creative design processes in Systems and Control content to develop activities that are informed by local contexts. The findings exposed the importance to engage with elders or indigenous experts for assistance on the integration of IKS with subject content during T & L. However, the participants conceded that there were no strategies put in place at this instant. Consequently, teachers need to understand that solutions can be obtained where indigenous resources are available from respective cultural or traditional exposure that can be utilised.

Secondly, the findings looked at the way CD1 and CD2 engaged IKS during planning or developing training activities for teachers towards creative design processes in Systems and Control. The findings revealed that there was minimal understanding from some of the participants about planning. in that, when planning to teach you should make sure that you align with Specific Aim 3, the idea came from B, CD2 said: *when you plan to teach, or plan your lessons you need to make sure that you collaborate with Specific Aim 3 because it deals with the impact on the environment based on the products that people are doing.* In A, nothing came up as there was no such engagement of local knowledge even though CD1 acknowledged the three aspects of Specific Aim 3 as impact, indigenous technology, and biases. He indicated that the three aspects are factored as separate entities, as he said: *This is an area where we need to develop because once we have developed from this area, then we will ensure that we include other areas as indicated in the policy, the area that deals with the impact of technology, the biases because now is like these three areas, are no longer entertained. Even if the three areas are entertained, they are entertained as part of separate entities from the main content which means the realisation of the three specific aims is not done in an integrated manner.*

Thirdly, the findings also focused on clarifying whether the activities planned to promote the use of local knowledge in understanding what is being taught. The findings revealed that the participants showed different approaches to this one, with CD1 believing that the three aspects of impact, biases, and indigenous technology could be factored in phases, design phase, and content phase separately in planning the activities. He said: *The three aspects could just be done as separate entities. For example, deal with design process steps first before the content. Furthermore, when you come to deal with the content, is then that you give activities to apply those steps in line with the three aspects of Specific Aim 3.* In addition, CD1 illustrated that *the correct approach to integrating Specific Aim 3 would be, to deal with each Technology theme at a time, for example, when you deal with structures integrate the content on structures with the local knowledge system, then do the same with the mechanical and electrical system as well as with processing theme.* The suggestion by CD1 was partly reinforced by CD2 when she said: *Whatever content that you teach, you need to make sure that you know your target group, you know, who must benefit, and then you know, why must benefit. So, for each piece of content you make, make sure that you know why you're doing that.*

The findings on the three ways toward collaboration with experts gave a gleam of hope that if proper operation with guidelines that have interest in transforming the curriculum is in place, the integration of IKS could formally be part of everyday teaching. That would benefit both teachers and the society in educating learners towards decolonising the Technology Education curriculum for sustainable education.

5.4.5 Creation of an interactive environment to engage in IKS concepts

The findings in this section focus on the space created for teachers and learners to describe or explain their understanding of the concepts. This involves the development of activities that promote the integration of IKS, and the support given to teachers to reflect on learners' activities based on the local knowledge context. It is of essence that Technology Education teachers are well capacitated to describe or explain the concepts they teach considering learners or society and develop the activities that promote the local knowledge that would promote the integration of IKs in their teaching.

The curriculum advisors are better placed to make sure that space is created to ensure that integration of IKS happens in their local schools. The findings in this aspect revealed that as always, CD1 maintained the space in the explanation of concepts based on local knowledge is not promoted in D1. On the contrary, CD2 maintained that they consider allowing teachers a platform to share experiences from home during training which assists in aligning the training to suit their teaching contexts in D2. CD2 said: *We do this as we do training, we normally give them platforms to share their experiences from their homes or locality on how the different types of machines that were there in the past and then making sure that they are able to integrate and include them in their lesson planning*.

On the issue of the development of materials that promote the integration of IKS, the findings revealed that CD1 and CD2 agreed on the importance of producing the training materials that integrate the IKS into their activities towards capacitating teachers in which they also suggested that such activities could be included in projects that require design processes, as outlined respectively. CD1 stated in this regard: *In terms of the development of the workshop materials, we ensure that the materials include the integration of IKS on the package that we develop to able teachers to integrate IKS with confidence in their classes*. Similarly, CD2 suggested: *When they plan or when they are doing their project, they follow or use the design process that is, having the five aspects and then those aspects as you follow the investigation, finding out about the IKS knowledge, and then the design process coming up with the drawings, the designs for that particular product that they're supposed to do.*

One can still conclude that based on CD1's and CD2's shared views, there was an indication that the two districts had changed perspectives and realised a need to enhance their teacher training sessions by integrating IKS in their training materials at the circuit/district level and during interactions in workshops. Regardless of the obligations to follow the ATP exactly as designed at the departmental level, the curriculum advisors expressed a perspective that there was a need to include and support teachers based on the integration of IKS.

On the support for teachers to reflect on the activities based on learners' local knowledge/IKS context and to bring clear description of IKS elements in their teaching, the findings revealed that there was not much done except encouraging teachers to read more about IKS in various sources. There was as a result no clarity from the curriculum advisors on what to do to be able to reflect on the activities. However, on the description of IKS elements, the findings revealed that the area was neglected as CD1 said: *Teachers require training on the integration of IKS because IKS is one area that is neglected and teachers lose interest but if teachers can be trained they will start to be aware of it in their teaching*. In D2, the findings showed that CD2 embarked on site visits to establish what teachers were doing to assist them, sometimes even giving lessons to demonstrate, *apart from conducting workshops, giving them the knowledge that is needed. I also embark on on-site visits to make sure that I see and then I understand what they are doing. I even assist them in terms of presenting lessons to their learners.*

5.4.6 Opportunities for reflecting on IKS and engagement of teachers

The findings on the opportunities for reflecting on IKS and engagements of teachers were focused on the teachers' reflections on the IKS aspects in Systems and Control and the engagement to the point of their capacitation to integrate IKS when developing the activities in Systems and Control. On the creation of opportunities for reflection on the IKS activities, the findings revealed that reflections were not prioritised due to time allocation, as CD1 said: *That area of reflection is also lacking, we don't do reflections due to time factor.* However, sometimes teachers were given a platform to share their frustrations related to the implementation of the ATP. The curriculum advisors also shared the strategies on how they deal with the teachers' frustrations though not related to IKS, *as I indicated earlier, we give them platforms to share their frustrations and then share some strategies on how to address their frustrations* (CD2). It was also revealed that there was no time even to reflect on the previous term because one hour was allocated to teacher training per term, CD2 would just brief the teachers on what is expected of them for the term, hence, there was no time to reflect on the IKS aspects.

Concerning capacitating teachers to integrate IKS when developing activities in Systems and Control, the findings showed that during workshops, curriculum advisors embarked on practical activities outlined in the mini-PATs. Teachers were assisted on how to handle these mini-PATs in class where Systems and Control is being addressed and, but there was not much about IKS. As CD2 indicated: *Most of the time, we embark on practical activities in our workshops where we address the content and then we are doing some practical activities to assist teachers to gain an understanding towards benefiting their learners, as they do the practical activities in Systems and Control.* Hence, the time to capacitate them on infusing the IKS aspects is not always provided.

5.4.7 Teaching approaches and strategies used to integrate IKS

Teaching approaches play a very important role in teaching Technology more so the content on Systems and Control. Teaching approaches enhance the teaching strategies applied during the T & L processes. The findings revealed that due to COVID-19, the teaching approaches changed tremendously to the extent that teachers resorted to demonstrations due to the distance created by the lockdown. The groupings in class were restricted in that most of the teaching was done through a teacher-centred approach, as CD1 said: *The issue of the indigenous knowledge systems in terms of the teaching approaches. The grouping of learners was restricted since the COVID-19 period. This means teachers were expected to do demonstrations on their teaching of practicals to avoid contact.* The lockdown caused the whole teaching methodology of the subject to be compromised.

The findings further revealed that participants turned to apply a hands-on approach where teachers integrated real objects such as the Technology kit on Systems and Control such as gears, pulleys, electrical circuits. The curriculum advisors also encouraged teachers to work in their groups and form small clusters in the circuit to cover the integration of IKS, as CD1 said: *The strategies that we normally apply would include the hands-on approach, in other words, teachers were required to bring in real objects such as kits to class.* Furthermore, CD1 indicated that *by letting teachers bring their kits during training we did to make sure that when talking about the meshing of gears, learners should be able to observe when the teacher does a demonstration*. The approach defined here took place in one of the Grade 8 classes I visited to observe lesson presentations. On the question of grouping and clusters, CD2 said: *I normally encourage teachers to work in groups and then they form small clusters. So that they can help each other because we find that maybe they don't master the same concepts in the entire system and control. So, whoever is mastering a certain concept and then they come together in the cluster and then they share*.

The points raised by CD2 show how they created a community of practice to promote Ubuntu/Botho. CD2 said: *On top of that, as they are implementing their strategies, I make sure that I do monitor that implementation and then in case there are still gaps and then we meet to address those gaps*. However, the findings in this section do not show how IKS is integrated, but only revealed that the approaches they used were not rooted in IKS but in the ATP context. The curriculum advisors monitor the implementation and close the gaps that might exist. However, the findings suggested that teachers were encouraged to integrate IKS in Systems and Control and research IKS, as CD2 said: *I motivate them to research more information about IKS to cascade the information to their learners.*

In the process the findings revealed that there was an attempt to create the glossary of terms or concepts in isiNdebele but to a certain extent, *we need to understand that indigenous languages are part of our knowledge systems. In terms of the glossary terms, one never thought of advising teachers to do the collection of the concepts, in Ndebele language. What we do is to collect some words and associate them with pictures, of either levers or gears. Also, I have pictures of people working to observe how the mechanisms work* (CD2). This only happened in D2, not in D1. CD1 indicated that they had never spent time on IKS as that was spent on the implementation of the ATP as prescribed.

The next subsection focuses on the findings of the classroom experiences and the mechanisms used to engage reflection on the learners' written work.

5.4.8 Classroom experiences, a mechanism used and reflection on written work

One of the delegated responsibilities of curriculum advisors is classroom visits to support teachers on curriculum and policy-related matters. The findings in this subsection are based on the classroom experiences of how teachers and learners received the integration of IKS in Systems and Control, the mechanisms put in place to ensure assistance given to the learners toward the realisation of the importance of the integration of IKS, learners' written work in terms of what it reflected about IKS, and the advice normally given to teachers toward showing an appreciation of IKS integration.

On the classroom experiences, the findings revealed that D1 facilitated the development of lesson study in which teachers from the circuit would be gathered in one venue, and identified a school after planning the common lesson where they would demonstrate how it should be taught. In the end, all teachers would teach the lesson in their respective schools. It was suggested that the same could be done to integrate the local knowledge, as CD1 narrated: *The lesson study, encourages team teaching what we do, we look for a school, we then identify the teacher to be ready to present the modelled lesson on a chosen topic for a particular date. Then we organise local teachers in that cluster to develop a lesson as a team. Thereafter we give the chosen teacher a chance to demonstrate how is he or she going to teach it the following day in class.*

The lesson study gave a chance for a community of practice where both novice and experienced teachers were put together to plan a lesson for which the same could be done to integrate IKS into the Systems and Control activities. *When it comes to the local knowledge/IKS, we needed to use the very same approach, because normally teachers do not have the same understanding to assist teachers to be able to operate at the very same level, regardless of age, and experience, promotion of a principle of Ubuntu creates a community of practice based on lesson studies* (CD1). CD1 suggested that the move to a lesson study assisted teachers to learn from each other and to be effective in their classrooms.

CD2 indicated that her support was well received as something familiar was being done to increase the learners' interest to know more of what was being taught. CD2 said: *Learners seemed to be happy, because I think we know that if one is doing something that looks familiar, one becomes interested and want to know more.* On the issue of mechanisms put in place to ensure that learners were assisted to realise the importance of the IKS integration into their learning of Systems and Control, the findings revealed that in D1, whilst there was a mechanism put in place to ensure that the correct content was taught as per prescribed work in ATP, there were no mechanisms put in place for IKS integration as was the trend throughout. CD1 indicated: *In terms of mechanisms, regarding the indigenous knowledge system, we have none, but we do have mechanisms for ensuring that the correct content for that given term is being done.* The findings also revealed that in D2, teachers were encouraged to use their budgets to organise tours for learners to learn about IKS concepts to enhance their understanding of the subject matter as well as participate in expo competitions. However, the focus was not on integrating IKS. CD2 suggested that teachers were encouraged to take learners on tours to visit farms, power stations, etc., to make sure that learners experienced the content they learned in class such as the Systems and Control in practice. The reason cited by CD2 was that the move to encourage teachers to take learners on a tour was that a subject like Technology, *if you don't make it practical and if you don't make it to be interesting learners, surely, we cannot get good results*.

The findings showed that CD1 and CD2 did check the learners' work for the ATP coverage. CD1 indicated: *Yes, we do check learners' work as we visit schools because in checking the learners' work, we normally want to check their curriculum content coverage. So, we use the learners' books because the ATP indicates the content areas that should be covered in a given week. So, as we visit the school, we make sure.* However, the findings further revealed that participants did not find it easy to get information on content that promoted IKS. Furthermore, participants indicated that they were able to observe learners doing some activities in class that reflected that learners have some understanding and interest in IKS though it was not an official focus point. CD2 said: *As I indicated it is not easy to get that in every content. So, for the content that is related to IKS, we could see learners doing some activities showing that they do have some interest and then they do understand the IKS*. In this case, there should be reflections on the advice that was normally given to learners to appreciate the integration of IKS in their learning.

The findings revealed that participants did reflections with teachers based on the work done for the term after moderation was concluded. However, it was left to the learners to use Google search to know more about IKS, as CD1 said: *In terms of doing reflections, with the teachers like you said, normally, you moderate what they have done this term, it is one process of reflection. Yeah, which at the end you give feedback to teachers. I indicated that when doing integration, we needed to integrate regarding this area of the indigenous knowledge system, the biases, and the impact. On top of that, there is one critical area also, the critical thinking skills. Without the learners critically thinking about the material they do, engaging learners is not going to help them to be creative though at the end they need to ask critical questions, and they also need to critically think about any other material that they are given (sic). So that they could be able to critically develop and be creative in terms of developing new products.* It can be noticed in this section that the participants were not clear about the aspects of reflections. The next subsection presents the findings on the engagement, challenges, and support mechanisms in place to assist teachers toward the integration of IKS into Systems and Control.

5.4.9 Engage, challenges, and support mechanisms

On the aspect of assisting teachers to engage freely with IKS, the findings revealed that districts approached the issue differently. CD1 indicated that teachers are not assisted when it comes to the integration of IKS in Systems and Control besides the ATP-related content, *in terms of teaching Systems and Control, we are not assisting teachers to engage freely with knowledge systems. so, they will have to stick to what is there in ATP and the textbook that they have. In other words, we are textbook driven, yeah you understand that these textbooks when they were developed, were not given the mandate to address this area, should the developers be given the mandate to address the IKS? I'm thinking that all our textbooks were going to be guiding teachers to address the issue of the knowledge system in terms of them unpacking their content, you understand*. CD2, however, acknowledged the formation of a collaborative cluster group to facilitate assistance where it is required even if CA is not present in person.

Regarding the challenges faced by teachers toward the integration of IKS, the findings revealed that CD2 did not believe that there was any challenge since the aspects of IKS were not addressed in D1. However, the findings revealed that teachers, especially the newly qualified ones in the field were not that interested in IKS as things looked more modern in the teaching fraternity, hence, there was a means in place to ensure that teachers understood the role of IKS as it is part of the policy, as CD2 said: *What I have noticed the new graduate teachers are not very interested in the IKS because they want things that look more modern. We need to assist them to be able to identify the content in line with IKS because they do know indigenous knowledge, they just think maybe it is something that is outside their scope.*

CD2's views are not different when contrasted with the findings from some of the teacher participants who viewed IKS as a type of knowledge that belong to the olden times. As far as the challenges that are encountered in integrating IKS, the findings showed that the integration of IKS had not been attempted. CD2 further committed that one should make sure that teachers are zoned together to be able to attend to their challenges, as CD1 said: *I don't think we could have some challenges since it is not attempted in the district though we are aware that some individual teachers in their spaces are doing it.*

The findings revealed that teachers were encouraged to address the challenges of integrating local knowledge/IKS with the curriculum advisors even if it is not part of ATP. The curriculum advisors talk with the teachers about the challenges for assistance, as CD1 said: *Okay, so that will be the way to address the challenge is just to encourage teachers, even if it is not part of ATP, but they must be able to give local examples of exactly where these things are applicable.* Furthermore, CD2 indicated: *We like to speak about the challenges, and then we try and assist each other. And then again, the intervention that one is doing, like in terms of the workshop, because what I normally do for the workshop, before I plan my workshop, I check what is the challenge for the teachers so that I know what I'm going to deliver to the target group*.

5.4.10 Framework

On the frame to guide teachers towards achieving the integration of IKS, the findings revealed that curriculum advisors agreed that they cannot do the integration of IKS without a proper framework in place, so the frame could be highly appreciated by teachers, sentiments shared from both districts. The findings further revealed a piecemeal technique where one deals with section-by-section of Technology content to show how IKS could be integrated starting with Systems and Control.

5.5 Learner interview analysis

This section covers the learner interview data presentation and analysis. The findings are presented from Subsections 5.5.1 to 5.5.10 below.

5.5.1 Learner Profile

Table 5.5: Learner profile

Learner	District	Age	Gender	Grade	Cultural background
LB1	D2	14-16	M	9	Ndebele
LB2	D2	14-16	F	9	Zulu
LA3	D1	14-16	M	9	Swati
LA4	D1	14-16	F	9	Swati

Table 5.5 above outlines the profile of the participating learners. Each district, i.e., Nkangala and Ehlanzeni had two (2) learners who were interviewed. The learners volunteered to participate in an interview after the teachers made a call. The learners were coded as LB1 and LB2 for D2 and LA3 and LA4 for D1 to protect their identity. The learners' ages ranged from 14-16, with two (2) females and two (2) males all in Grade 9. The dominant cultures of the learner participants was Ndebele (LB1), Swati (LB3 & LB4) and Zulu (LB2). Learners were allowed to use their local languages in answering some of the interview questions as some struggled with the use of English.

5.5.2 General understanding of IKS in the Technology subject

Understanding the subject matter and the other knowledge associated with it is important in the T & L situation. Learners strive all the time to understand what they learn. The findings revealed that learners had a different understanding of IKS in that LB1's understanding was confined to the technology that has to do with day-to-day activities. *Technology is something that we also use at home it happens in our local area. So, technology is something that has to do with our day-to-day activities.* LB2 viewed technology as the knowledge learned from home, *my understanding is that, like, any knowledge you learn from home will be useful in school or anywhere*. LA2, though expressed in Siswati, confined IKS to the way of life in their local community as well as how they live with other people, *my understanding about homegrown knowledge (kutsi tinto tasemakhaya, siphila njani yabona) is how we live with others in the community and local (kutsi siphila njani nebanftu), how we live with others, and you see there's nothing much*.

The findings brought an understanding that learners did not have a clear description or understanding of IKS, local knowledge or home-grown knowledge. Furthermore, based on their understanding of IKS in the subject of Technology, the findings showed that some learners had a narrow understanding of the concept about the subject. LB1 indicated that local knowledge is the knowledge used in Technology that they can express their opinions, *um, our local knowledge is also used in technology subject we are allowed to experience and express our opinions.* LA2 expressed her understanding of IKS in Technology as the technology tools used at home like electricity, washing and cleaning machines, *it means the way of life as locals having electricity and other things (kutsi nje ngemphakatsi siphila njani kufana negezi tinto) like Technology every stuff. Unganikenta mibono letikhona emphakatsini Tinfto teTechnology ekhaya/ like, for example, the technologies available at home) kufakamshini wekuwasha/like washing machine, mshini wekuklina/cleaning machine, magedlela/kettles* (mixture of Siswati). This shows that the comprehension of IKS amongst the participating learners is lacking in the main.

5.5.3 Integration of IKS during learning

On the integration of IKS during learning Systems and Control, the findings revealed that learners were allowed to share their ideas about the things that are happening in their locality in relation to IKS. However, more concrete practical examples were required from learners in order to comprehend the integration of IKS in their learning. LB2 said: *I think they should give more practical examples for learners to actually understand the* *stuff better, okay. Based also on the learner's understanding, exactly. Most* learners *don't get it until they see it visually on paper*. This finding could be a sign that the teachers and curriculum advisors did not do or encourage the integration of IKS/local knowledge except by giving examples of the things that happen in the society on a day-to-day basis that are not indigenous, as confirmed by LB1 who said: *Last term we were using cross bracings and we are allowed to share our ideas and sometimes it is something that you can also do at home as I said it happens in our locality, so, we are actually allowed to share our ideas.* However, integration of IKS into their learning was supposed to emanate from the understanding of Specific Aim 3 which gives allegiance to indigenous technology as one aspect that teachers were supposed to consider or take advantage of integrating IKS into the learning activities that they engage learners. Based on the findings in this section, a question could be asked as to whether learners are familiar with Specific Aim 3 or not.

5.5.4 Familiarisation with CAPS, Technology and IKS

The subsection comprises the familiarity with Specific Aim 3, and the realisation of IKS during learning.

On the question of familiarity with the Specific Aim 3, the findings revealed that LA2 and LB1 indicated their awareness of Specific Aim 3. LA2 said: *Yes, I am familiar with specific aim number 3, sike sakufundza eklasini (we once learned about it in class).* To the contrary, LB2 indicated that he was not familiar with this aim, *no, I'm not familiar. I am not familiar with that completely.* Based on the findings in this subsection, there was a lot to be done to make sure that Specific Aim 3 was enforced, however, the fact that teachers are required to work within the prescribed content of Systems and Control as in ATP might make it difficult to execute, if it is not prescribed.

Even though much of Specific Aim 3 was not entertained, the findings on the realisation of IKS during learning showed that there were some indications from learners that some aspects of IKS or local knowledge were being realised during their learning. This was confirmed by LA2 and LB2 as they indicated respectively. LA2 said: *Yes, the teacher uses indigenous examples when teaching*. This was confirmed during lesson observations.

Furthermore, LB2 said: *It reminds me that during the start of the session, say explain that in the olden times, people used wells to get their water. That's when I realised that it connects indigenous and modern connects because we used to do that in the past, they used to have a curved wheel in the middle and a rope that went down with a bucket tied on it, which is when they then collected the water and pulled it using their effort. That's what we learned in technology, that is how people had water.* The views expressed by the two learners indicate that teachers try to integrate some of the local knowledge even outside Specific Aim 3.

5.5.4 Integration of indigenous technologies

The subsection comprises indigenous technologies from the learners' environments, and IKS integration during learning is discussed respectively below.

The findings on the identification of indigenous technologies from learners' environment revealed that learners were able to come up with some examples of technologies in their locality or home, such as some of the technologies were identified, such as *Tigwcebe/cooking spoon, tintsambo/ropes, nje ngekusila/grinding stone. Kukhombisa kutsi nje kulendzawo lesikuya kute tinfto teTechnology letinyeti kusho kutsi kufuna sisebentise tinfo tasemakahaya nase mafamu/it shows that in the place that I come from there are no technology tools we have to use local tools even in the farms. Emafamu kute gezi kulamanye makhaya iTechnology iyaswela so basentisa tinto takudzala nje ngetigcwebe, mlilo nalokunye/there is no electricity in some of the families in the rural areas they turn to use things of the old. Lokunyeti kungaba ma/most are pulleys, levers/ kuhlangene futsi kuyahluka ngaletinfto lotisebentisako/combined and differs from the things you can use at the time* (LA2). In addition, LB2 said: *At home, we have a generator, it is pretty big. You can't lift it on your own. So usually, my dad ties a rope on it and uses the same kind of knowledge we learn today to pull it and place it. When asked why he uses a rope to lift the generator he said it would be too heavy to lift off his own strength soon be strong enough. So, he uses a rope to pull the generator from the van down into the ground.* All that the learners indicated in these findings confirm and suggest that Systems and Control can still be taught from a context of local knowledge/IKS.

The technologies identified in the preceding paragraph could make the integration of IKS much easier during the T & L process. The findings revealed that learners articulated well how some of the technologies were applied during their learning in class. However, they were dissatisfied with the shortage of practical examples. LA2 *said: Kungaba kahle ngobe tintfo kusebentisa tintfo tasemakhaya kwenta umsebenti ube lula nekuvisisa lakhuluma ngako/It can be very good and can make our lives much easier as we use indigenous knowledge even to understand better what we learn about.* On the contrary, LB2 said: *I don't think so. We don't have actual practical examples. We just have words. Okay, we basically don't have that much knowledge. The teacher is telling exactly what is in the textbook than related to day-to-day*.

5.5.5 IKS's impact, experiences, and applications

This subsection covers the impact of IKS on learning, and activities linked to the learners' daily experiences or socio-cultural context.

On the impact that IKS/local knowledge has on the learning process. The findings revealed that learners acknowledged that the impact of IKS in their learning allowed them to be exposed to what they learn in class at home even before they come to school. LB1 said: *Like as we learn about/lezinto siyazibona/Some of these things we can see them as we learn, so rather than making an image in your mind, you can see some of these things around you*. Furthermore, LB2 expressed: *Well, usually I learn stuff before I come to school.*

The findings also revealed that learners had different views on the issues of linking design activities in Systems and Control to day-to-day experiences. Learners such as LB1 indicated that the activities on Mechanical and Electrical Systems and Control do link with day-to-day experiences in her school context. LB2 disputed the fact that there was no link to day-to-day experience in their case whether at school or home. LB1: *Yes, we are used to the activities on mechanical and electrical linked to the day-to-day experiences. As I said, an example of the electric fence yes surrounds our homes you know. Whereas on the contrary,* LB2 said: I *don't usually do these kinds of things at home*.

5.5.6 Interaction with other learners

The findings further showed the way learners are allowed to interact with fellow learners on the application of IKS /local knowledge during their learning where they agreed to share ideas, even using the home language to promote IKS, as LB1 said: *We talk about we share our ideas together yes and so far, I have not done anything in groups we do it individually but we are allowed to share our ideas together. So normally what do you use to share these ideas language wise language which language? isiZulu sir okay it is how we can talk to each other in a friendly manner. We use isiZulu because the majority of the learners talk isiZulu since most of us are from here. And the language that is used is Zulu, so we use the language to share ideas as we learn*. Furthermore, on the same note, LB2 shared his classroom experience regarding the issue of sharing ideas when he said: *Usually when they don't understand something one of my friends usually teaches as it turns since the teacher was too busy to explain to me so like today in mechanical advantage the punk ropes Mr (teacher) said that we should check the direction of the rope I didn't hear that part, but my friend actually explained it to me that we should look at the direction of the rope to actually count how many ropes are used in the mechanical advantage. So, that made you understand made me which language you use. He used all kinds of speaking to me and individually speak and mix of English and local knowledge.*

The findings in this subsection are an indication that should the integration of IKS be taken into consideration during T & L, it can make a big impact as the learners will gain an understanding of the Systems and Control in their context which will, in turn, inform a wide range of sharing ideas to promote creativity when dealing with design projects in a Senior Phase Technology classroom.

5.5.7 Approaches used in learning IKS-oriented activities

The learner participants related the approaches the teachers used to integrate IKS /local knowledge during their teaching. The findings revealed that learners agreed that the teachers gave verbal examples to the class. LB2 said: *Well, our teacher usually gives us practical examples using unpractical verbal examples, today he told us that wells remember about wells and how they used to use them to get water. So, our teacher uses it very well to make us understand better since he can actually use it visually, he has to* *do it verbally.* This is one piece of evidence that some teachers do factor in some practical examples in the teaching of Systems and Control from indigenous contexts, despite what the curriculum advisors said regarding the lack of integration of IKS during the teaching and learning process. Furthermore, LA2 confirmed what LB2 said by stating (translated from isiSiswati): *Uyasikhipha ngaphandle asikhombise mibono taletinfto lafundzisa nganto, uyasikhomba konke njenge takhiwa tesikolo uyasikhomba kutsi loku kunjani/He takes us sometimes outside of the class to show us some of the things e.g., the school buildings and other tools. This means that the teacher does a lot of demonstrations. Yes, kutsi sivisise kahle/He sometimes does some lesson demonstrations for us to have a clear understanding of what we are learning about*.

The findings further revealed that learner participants LA2, LB1, and LB2 found the teacher approaches to be helping them to learn IKS-oriented activities in Systems and Control when they dealt with creative design projects. This was echoed by what LA2 said: (translated from isiSwati): *Ngibona kukahle kutsi asebentisa lwati lamsemphakatsini ngobe kwenta umsebenti wethu ube lula lokusikhomba nekutsi sikwati nekutsi uma sihamba sikone kubona kutsi naku lokubesifundza ngako natsi siyabona kutsi ngiko bekakhuluma ngako/I think is good or acceptable for the teacher to use the local knowledge because it makes cause it makes our work much easier this also shows us that when we move around we can see that some of the things we were taught or learned about in class, sititjwayele nasemakhaya nasemphakatsi/we normally use these things at home and in our community.* Furthermore, LB2 added that the teaching methods could be applauded, as he said: *I find his teaching methods quite enjoyable. He has a little comedy in it creating little fear those are the teachers I kind of like.*

5.5.8 Type of activities when engaging with IKS during the learning process

The findings revealed that learners were engaged in activities that promoted local knowledge. This was echoed by LA2, LB1 and LB2. In the case of LA2, it was indicated that the teacher gave them practical examples of things common in their homes and society, as she said (isiSwati translated to English): *Tishela ngaso sonke sikhatsi uma angena eklasini ubeka mibono ngetinfto tonke tasemakhaya/The teacher gives practical examples of the things we are used to at home most of the time when he teaches us.*

Sibonelo, ubuya netinfto tasekhaya lakhe asikhombe njengema drill, netintsambo, tisimbi netinfto natsi lesingavisisa ngato/For an example such as drills, ropes and things that can make us understand the content.

In addition, LB1 indicated that their teacher created an environment for them to share and discuss the content during learn for better understanding, *yes, encourage discussion with fellow learners, he lets us share ideas so that we can also understand better.* On the contrary, much as the participating learners were happy about the way they were taught, LB2 felt that as much as they were being encouraged, they had not promoted IKS/local knowledge, as he said: *Sometimes we are encouraged even though we have actually never done it (IKS/local knowledge) because some learners might have, so it is easy for them to understand better.*

5.5.9 Local knowledge usage in class with other learners

The findings in this regard differ from one learner participant to another even though there were some similarities in some other cases such as LA2 and LB1 in terms of the level of encouragement where LB1 said that the teacher encouraged them during discussion sessions to share their understanding in their own language. On the other hand, LA2 said the opportunity was being created to allow learners to express themselves to apply local knowledge. However, LB2 felt that they were not given an opportunity to share their local knowledge during their learning.

In line with the findings are the extracts from the interview, where LB1 said: *He lets us share ideas. So that we can also understand better yes*. Furthermore, LA2 emphasised that their teacher granted them the opportunity to express themselves to a greater extent, as she said (siSwati translated to English): *Yebo uyasikhutsanta kutsi sisebentise ngoba netinfto teftu nje ngobe kusinika mandla kutsi sitisebentise kakhulu nektsi singayenta njani lento kutsi ibe lula kutsi uyisebentise/The teacher encourages us to use our local knowledge which in turn gives us courage to understand what to go about the answer. Yebo, uyasivumela ngobe uyasiphakamisa kutsi siye ebhodini siyochaza ngetibonelo tetinfto/He allows us an opportunity to explain our examples on the board.* The learner participants' assertions in this regard could be an indication that some teachers, though not formally prescribed in the ATP, do their best to make sure that IKS/local knowledge is promoted for learners' better learning and understanding in context.

5.5.10 Opportunities created to integrate IKS

This subsection covers the categories, the opportunities given to learners to express their local knowledge, and reflection on learning in class.

The findings in addition revealed that opportunities can be made available for the use of learners' local knowledge during the learning of creative design processes in Systems and Control. However, learners expressed that such opportunities were not available as the teacher focused on finishing the syllabus as prescribed in ATP. The learner participants indicated that if the opportunity could be created for integrating IKS, they could still make use of it. LA2 said in line with the findings (isiZulu translated to English): *Yena uyasho kutsi sebentisa lulwimi lokhululekile kulo, kuyasho njenge sitori uma nje ubeka lakufunako nje kuphela/The teacher allows us to use the language that we understand better to explain some of the things which are our local language during learning.* LB1 also indicated: *When the teacher asks questions, we are allowed to raise our hands, even if it is something that is maybe our knowledge from outside during the project. Last term, we did the projects, and as I said, yes, we were allowed to.* On the contrary, LB2 said: *There are no opportunities created, however, if they arose, I would make use of them. Sometimes, I usually ask my mother who is actually really helpful.*

Reflection on learning is a very important matter toward knowing how successful or not successful T & L was as it took place more so in this case, allowing learners to use local knowledge/IKS in class in collaboration with their peers. The findings revealed that to some learners (LA2 & LB2), teachers sometimes allowed them to do reflections in the meetings where they had discussions, whereas to some learners' (LA1 & LB1) reflection, using IKS/local knowledge was an experience of free expression toward sharing ideas. This was echoed by LA2 who said: *Siyahlangana bese siyachazelana, sibhale sonke/Yes, we do meet and have a discussion where we explain to each other what we are learning. In a situation wherein others know, and others don't. Siyasintana/We help each other in our discussion*. Similarly, LB1 further said: *The experience of learning is an amazing* *experience because we are free, we are allowed to express ourselves. So, if it is actually something related to today's topic, we are allowed to discuss it, and you are allowed to share your ideas. So, you are free. We don't give something to you. They'll tell you if it is wrong or right.* LB2 expressed how local knowledge helped him when studying as he said: *Local learning local knowledge helped me. Usually, when studying some other stuff like a home language, I am unusually taught the stuff by my grandmother. Yeah. So basically, her knowledge helps me to get better in school.*

5.6 Conclusion

The chapter delved into the presentation of data and findings in line with the aim of the study which was to establish how Senior Phase Technology teachers integrate IKS into the creative design process activities when teaching Systems and Control content/topics in the classroom. The chapter reported on the semi-structured interview data that involved teachers, curriculum advisors, and learners. For these three groups of participants, the interview data findings were ventilated through the themes identified in Table 5.1. The participants generally regarded the concept of IKS as knowledge used in the olden days, a view that poses a challenge about downplaying IKS as it limits the view of its existence currently. Furthermore, the CAPS lacks sufficient guidelines about the integration of IKS in Technology.

However, there was a consensus across the districts and participants about the general understanding of the concept of IKS in the context of the Technology subject that it can enhance the learning of the content if it is only based on the contribution of the local community. This came as participants believed that culture and tradition could assist the local people to learn that the indigenous communities do most of the things on a day-to-day basis such as lifting objects and/or loading objects without being aware of the knowledge associated with Systems and Control content and IKS. Regarding their understanding of the Technology subject in relation to IKS, participants across districts and categories were able to relate to the concepts of creativity, design processes and Systems and Control content, but some participants had difficulty relating these concepts with IKS, except in the case of other content areas such as processing.

Concerning creativity, the participants indicated that the type of mini-PAT where design activities are entertained does not promote creativity on the side of the learners as they are required to follow the instructions and respond as expected. On the design processes, an idea came out from the curriculum advisors that as teachers work on projects which follow design processes in nature as they deal with the PAT, the scenarios were supposed to consider the integration or link to the society or environment where learners belong. As far as the Systems and Control content was concerned, teachers considered integrating IKS into the Systems and Control topics in their teaching.

As much as CAPS is a policy that pronounces the importance of integrating IKS, there were mixed views on the interpretation and alignment of the content with IKS as required by the same policy. The actualisation of the Specific Outcome 3 was supposed to align with the state of the ATP and which is not currently. Some participants acknowledged that they were familiar with the requirements of CAPS with respect to IKS, whereas others had misunderstandings about CAPS requirements. On the designing, developing, and planning; and training on activities in Systems and Control topics, some participants indicated that they engaged in IKS whilst some indicated that they did not engage with the aspects of IKS. The reason for not engaging IKS was the ATP, which does not give them space to do so as they were expected to follow the prescribed work required to be completed per term. IKS in this regard was seen as an add-on.

However, some participants indicated that even in the circumstances they do allow the learners to mention examples from their local knowledge to enhance their understanding. Hence, both novice and experienced participants across districts affirmed that they do create space for learners to express their understanding of the concepts in Systems and Control in the language learners are comfortable or familiar with despite the ATP requirements. The participants cited examples of such activities and illustrations they embark on during the teaching of the content. The data also exposed the teaching strategies used to engage learners toward the realisation of local knowledge or IKS during the lesson. The participants across the districts and in both the experienced and novice categories viewed discussion, question and answer as well as the use of pictures as teaching strategies. However, not all the teaching strategies discussed support the integration of IKS. Participants apply different approaches to create opportunities to enable learners to bring in local knowledge for meaningful learning. Thus, three prepositions were made. The prepositions made were, the use of existing objects in their homes or community; engaging indigenous experts in teaching and learning; developing scenarios in line with learners' local knowledge; and leading learners through questions that relate to their local knowledge.

On the reflection of learning in relation to IKS in Systems and Control, the findings revealed that participants had diverse views on the reflection of learning. Some participants indicated that they do create time for reflections on learning and some do not create time for reflections. Participants who created time for reflection were able to give learners the freedom to reflect by allowing learners to narrate their experiences with the integration of IKS informally. Participants who did not create time to reflect on the integration of IKS cited that there was neither provision on the ATP nor time created for such an exercise to happen in class. The challenges that participants experienced in integrating IKS when formulating the activities range from teaching in a multicultural classroom where there is a need to strike a balance between cultures, integrating IKS in the activities, and the time factor.

The challenges prompted the need for the role of IKS experts in the integration of IKS. The findings revealed that participants across districts and categories agreed on a role that indigenous knowledge experts could play in helping towards the integration of IKS into Systems and Control content. The move was seen as the one that would advance the sharing of knowledge and experience amongst the experts, teacher participants, and learners.

Finally, the findings in this study have shown that there were gaps in the coverage of the Technology subject content in relation to the integration of IKS across districts, participants (teachers, curriculum advisors and learners), as well as experienced and novice categories across the board. However, to close the gaps that exist in handling the subject content, more so in Systems and Control, there arose a need for a guiding framework which is presented in Chapter 6. The findings of the lesson observations, document analysis and the synthesis for Chapter 6 are treated together with the discussion of findings in Chapter 6.

CHAPTER 6

DATA ANALYSIS AND DISCUSSION OF FINDINGS

6.1 Introduction

This chapter is an extension of Chapter 5, focusing on the findings from document analysis, observations and the synthesis. This chapter further reflects on the study findings presented in both Chapters 5 and 6 on how Senior Phase Technology teachers integrate IKS in the creative design process activities when dealing with Systems and Control content in the classroom. The discussion themes were based on the theory and the literature to culminate into a framework that can assist teachers during the teaching and learning of the subject. The issues emerging from the findings are appropriate for the development of a framework for the integration of IKS in Systems and Control topics. This is the contribution of the study.

6.2 Document analysis

This section deals with document analysis from eight (8) different documents, i.e., the annual teaching plan (ATP), three lesson plans, the teacher's book, the learners' books (textbooks, workbooks), teacher's guide-formal assessment task and learners' assessment task(mini-PAT). The analysis is aligned to the four main domains or areas namely, cognition, learner, teacher, and situation. Each domain or area further comprises its own categories (Table 6.1) used to define the analysis of each source document. In each category, a criterion was developed for the four levels for identification of the integration of IKS in the source document (Appendix 11). The domains and their categories in this section were developed in line with the study's aim and objectives.

Table 6.1: Document analysis' domains and categories

Domain/Area	Category
Cognition	• Information, concepts, principles • Cognitive processes • Approach to the nature of problem-solving approach (the design process) • Relations to everyday life experiences • Subject content sequencing and complexity in relation to problem solving (design process)
Learner	• Learning context • Opportunities for learner development • Planned focus of tuition • Learning structure
Teacher	• Curriculum design • Teacher autonomy • Role in teaching • Consideration of needs
Situation	• Environment/context • Interaction between socio-cultural context and the curriculum

The analysis covered the domains with specific categories in each instant of the source document analysed.

6.2.1 Annual Teaching Plan Data

The ATPs for the Senior Phase classes exhibited the integration of IKS mostly in the themes of Structures and Processing but little in the Systems and Control topics as required by the CAPS document. The ATPs used in this study were sourced from the curriculum advisory services in Mpumalanga Province. In this section, the researcher analysed Terms 1 to 3 of the ATP Grade 9. The reason to focus on Grade 9 ATP was that the six participants who volunteered to be observed in class were Grade 9 teachers. In Table 6.2 below, for example, Term 1 Grade 9, the ATP presents the information on the creative design processes that emphasises combining investigative skills, design skills and making skills that to a certain extent resonate with the socio-cultural context of the teacher and the learner as highlighted in Weeks 7 to 10. The ATP addresses some aspects of problem-solving in a creative way based on authentic contexts rooted in real situations such as costing the materials. It also addresses creative design processes knowledge in an integrated manner within the subject content (Mechanical Systems and Control) which may include indigenous context at the level of formal or informal assessment.

Table 6.2: ATP Term 1 Grade 9

TERM 1 47 days	Week 7	Week 8	Week 9	Week 10
CAPS Topics	**Investigation skills Design skills**		**Making skills Costing**	
Topics / Concepts, Skills and Values	**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. • **Sketch initial ideas:** each learner generates two possible ideas. • **Evaluate and adap**t: teams evaluate individual ideas and develop a final idea. • **Design brief:** learners write a design brief with specifications for the final idea. • **Flow chart:** each 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	
Requisite pre-knowledge	Investigation skills; Design Skills		Graphic Communication	
Resources (other than textbook) **to enhance learning**	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource YouTube videos, etc.		DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource YouTube videos, etc.	
Assessment – **Informal Assessment**; Remediation			Informal	
Assessment – **SBA (Formal)**	**Formal Assessment: PAT 1**			

Term 1, ATP is designed for teachers to engage learners on aspects of the investigation by first exposing them to the concepts such as sketching initial ideas, evaluating and adapting, and designing the brief and flow chart using examples that they will understand better before learners are introduced to scenarios. Furthermore, in Table 6.3 below Term 2, the emphasis was on the investigation skills in Mechanical Systems and Control where the learners investigate the hydraulic systems and pneumatic systems in Weeks 1 and 2. In Weeks 3 and 4, learners were to do action research on the use of wheels and pulleys movements to advance mechanical advantage (MA=1). Furthermore, learners were to research several mechanical control systems as indicated in Weeks 3 and 4. Even if there is no mention of IKS or link to it, the ATP contains the concepts in Mechanical Systems and Control that teachers' teaching strategies could offer teaching alternatives or gives room for the sociocultural context. As a result, the content has the potential to include types of knowledge such as local knowledge/IKS

Table 6.3: ATP Term 2 Grade 9 Week 1-4

GRADE 9 TERM 2

TERM 2 **49 days**	**Week 1**	**Week 2**	**Week 3**	**Week 4**
CAPS Topics	**Mechanical Systems and Control** **Investigation skills**		**Mechanical Systems and Control** **Investigation skills**	
Topics / Concepts, Skills and Values	• Revise: syringe mechanics using two equal sized syringes linked by a tube. • Force transfer between the syringes filled with: ○ Compressed air – pneumatic system. ○ Water – hydraulic system. • Action research: learners experiment / teacher demonstrates with two different sizes of syringes linked by a tub and filled with hydraulic fluid (water). Learners experience force transfer with either force multiplication or force division • Gases (like air) are compressible. Liquids (like water, oils) are incompressible. Pascal's principle – pressure exerted on one part of a hydraulic system will be transferred equally, without any loss, in all directions to other parts of the system. • Note that equal volumes of liquid are moved through the systems, and this results in different extensions (amount of movement) where syringes (cylinders) are of different sizes, so less distance/more force (MA > 1); and more distance /less force (MA < 1).(why is this part left out?) • The hydraulic press (including simple calculations). • The hydraulic jack. • Investigation: Design considerations ~ fit-for-purpose: ■ Evaluate the design of the hydraulic jack in terms of: • Who is it for? What is it for? Will it do the job? What should it be made of? What should it cost? Is it cost-effective? Does it look good (aesthetics)? Is it safe/easy to use for the end user (ergonomics)? • Draw a systems diagram that describes how a hydraulic jack function.		• Action research: practical investigations: • Use a single wheel fixed pulley to change the direction of pull (MA = 1). • Use a single wheel moveable pulley to change the direction of pull (MA > 0). • Use a pulley block system (block and tackle) to determine the relationship between loadbearing ropes on moveable pulley wheels and M.A (force multiplication). • Investigate: learners find out about the following mechanical control systems: ○ Ratchet and pawl. ○ Disc brake. ○ Bicycle brake. ○ Cleat.	
Requisite pre-knowledge	Mechanical systems and control		Mechanical Systems and Control	
Resources to enhance learning	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.		Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.	
Informal Assessment	Informal Assessment		Informal Assessment	

On the other hand, the integration of IKS/local knowledge could also be realised in Weeks 5 to 8 as shown in Table 6.4 below.

In Table 6.4, Weeks 5 and 6 dealt with the Mechanical Systems and Control, Investigation skills and Evaluation skills on the types of gears. Similarly, weeks 7 & 8 are planned to deal with the Mechanical Systems and Control based on investigation skills and design skills. The focus is on graphic communication skills involving artistic drawing for a single vanishing point. However, there was no indication of IKS in the whole content outline. It is an indication that there is an opportunity that teachers could make use of to explore examples that are IKS oriented.

Table 6.4: ATP Term 2 Week 5-8

SBA (Formal)		

TERM 2 49 days	**Week 5**	**Week 6**	**Week 7**	**Week 8**
CAPS Topics	**Mechanical systems and control Investigation skills and Evaluation skills**		**Mechanical systems and control Investigation skills Design and Making**	
Topics / Concepts, Skills and Values	• Lead learners as they **revise** the interactions of the following: • Spur gears of equal size counter-rotating. • Spur gears of unequal size counter-rotating – note velocity/force relationships. • Spur gears using an idler to synchronise rotation. • Lead learners as they find out about the interactions of the following: ○ Bevel gears of equal size – axis of rotation 90o. ○ Bevel gears of unequal size – axis of rotation 90◦ – note velocity/force relationships. ○ Rack-and-pinion gear system as found on automatic gates and steering racks. • Worm gear system for large reduction in speed and increase in force.		• **Artistic Drawing**: single vanishing point perspective. ■ Learners draw a 3D wooden object using single VP perspective. They enhance the drawing • showing the texture of the wood grain, colour and shadows. • Learners use single VP perspective to draw an inside view of the classroom.	
Requisite pre-knowledge	Mechanical systems and control		**Mechanical systems and control Graphic Communication Skills**	
Resources (other than textbook) **to enhance learning**	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.		DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.	
Assessment — **Informal Assessment:** Remediation	Informal		Informal	

Furthermore, the ATP in Table 6.5 below focuses on Electric and Electronic Systems and Control investigation skills. In Weeks 1 and 2, the ATP presents information on the revision of components and simple circuits in Electrical Systems and Control. Also, Weeks 3 and 4 present investigation skills through calculations and controlled systems. The findings showed that the ATP emphasises the combination of concepts and general principles of Electrical and Electronic Systems towards the investigation skills that resonate with the socio-cultural context of the teachers and learners to a certain extent. Furthermore, on the investigation skills, the findings revealed that the ATP provides a variety of opportunities for learners to engage in problem-solving approach-design processes in Electrical Systems and Control that promote creative thinking skills. Hence, there are opportunities for learner cognitive development and the use of design process skills through the diversification and complexity of the tasks in Electrical Systems and Control that integrate IKS.

Table 6.5: ATP Term 3 Grade 9

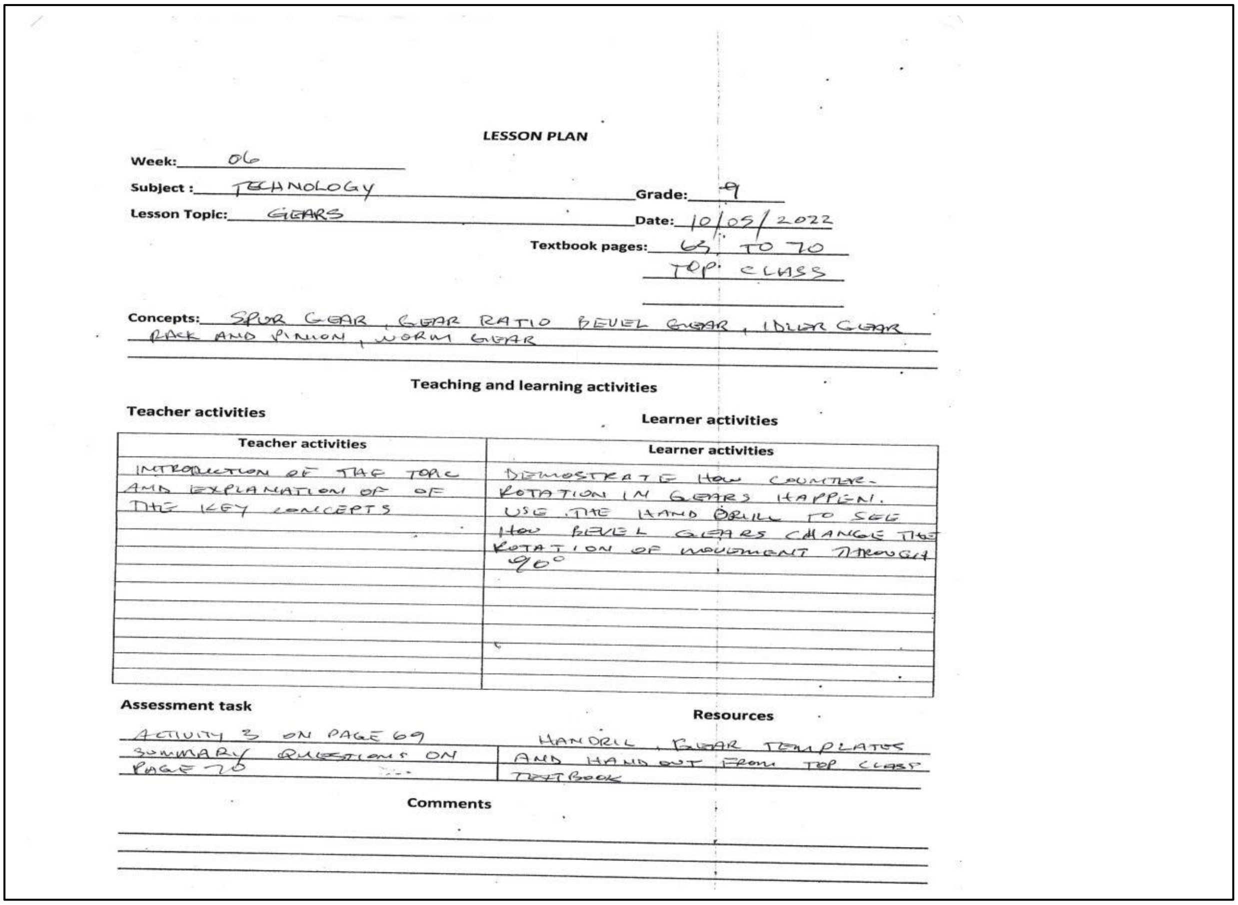
TERM 3 48 days	**Week 1**	**Week 2**	**Week 3**	**Week 4**
CAPS Topics	**Electrical Systems & Control Investigation skills**		**Electronic Systems & Control Investigation skills**	
Topics / Concepts, Skills and Values	• **Revise 1 – component symbols:** - Cells in series and parallel. - Lamps in series and parallel. - Switches in series (AND logic) and parallel (OR logic). - Current in the circuit – conventional current flows from positive to negative. • **Revise 2 – simple circuits:** - One cell, switch, two lamps in series. - Two cells in series, switch, two lamps in series. • **Ohm's law quantitatively**: *as voltage increases, current increases if resistance is constant*. Action research: testing Ohm's Law practically – measure the voltage (potential difference) and the current strength in each of the following circuits: One cell connected to a 20W resistor – note the voltmeter and ammeter readings. • Two cells connected to the 20W resistor – note the voltmeter and ammeter readings. • Three cells connected to the 20W resistor – note the voltmeter and ammeter readings • Plot the readings on a graph and determine the relationship between potential difference and • current strength while keeping the resistance constant.		Calculate Values **Note**: **R** - *represents the resistance of a resistor in ohms* .... [Ω]. **V** - *represents the potential difference in volts* [V]. **I** - *represents the current strength in amperes* . [A]. Switches: Manual switches controlled by the user, e.g., Push SPST, SPDT, DPDT Diodes and LED (Light Emitting Diode): A diode is a component that allows current to flow in one direction only. A LED allows current to flow in one direction only and also gives off light and is often used as an indicator that a circuit is 'ON'. Resistor colour codes: • Low value resistors often have their resistance value printed on them in numbers. • Higher value resistors are coded using coloured bands. The first three bands give the value of the resistor in ohms. The fourth band is an accuracy rating as a percentage.	
Requisite pre-knowledge	• simple circuit components, component symbols: simple circuits: input devices, control devices and output devices • Ohm's law qualitatively • Alternating current		Resistors as output devices	
Resources (other than textbook) **to enhance learning**	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	Informal		Informal	

The problem-solving approach in this case should be based on authentic contexts rooted in real situations to enable the integration of IKS. However, the content in ATP allows learners to investigate the systems approach to input, process, and output of a system using switches, resistors, light-emitting diodes (LED), etc. The possible challenges could be addressed and reflected in the consideration of the opinions and attitudes of teachers. Consideration of teachers' opinions and attitudes could help to address the ideological concerns and socio-cultural needs to accommodate local knowledge/IKS in ATPs in the Technology curriculum.

6.2.2 Lesson plans

In this subsection, three lesson plans in Figures 6.1, 6.2 and 6.3 were analysed. The three lessons' scope addresses the Mechanical and Electrical Systems and Control content or topics. Two of the lessons were supplied by the Department of Basic Education (Figures 6.2 and 6.3) and one lesson plan was supplied by the teacher for analysis.

In Figure 6.1, a Grade 9 lesson focused on gears. The lesson was planned from the *Top-class* textbook. The lesson plan presented below outlines the topic, concepts, teaching, and learning activities, assessment task, and resources.



LESSON PLAN

Week: 06

Subject : TECHNOLOGY Grade: 9

Lesson Topic: GEARS Date: 10/05/2022

Textbook pages: 65 TO 70

TOP CLASS

Concepts: SPUR GEAR, GEAR RATIO BEVEL GEAR, IDLER GEAR RACK AND PINION, WORM GEAR

Teaching and learning activities

Teacher activities

Learner activities

Teacher activities	Learner activities
INTRODUCTION OF THE TOPIC AND EXPLANATION OF OF THE KEY CONCEPTS	DEMOSTRATE HOW COUNTER-ROTATION IN GEARS HAPPEN. USE THE HAND DRILL TO SEE HOW BEVEL GEARS CHANGE THE ROTATION OF MOVEMENT THROUGH 90°

Assessment task

ACTIVITY 3 ON PAGE 69
SUMMARY QUESTIONS ON PAGE 70

Resources

HANDRILL, GEAR TEMPLATES AND HAND OUT FROM TOP CLASS TEXTBOOK

Comments

Figure 6.1: Grade 9 Lesson Plan 1

The lesson plan presents less information and less emphasis on the combination of concepts, and general principles that resonate with the socio-cultural context of the teacher and learner. The teaching and learning activities promote learner involvement in active learning that links concepts to concrete understanding and assists a learner to acquire knowledge. However, the lesson plan does not address the individual needs and shared interests of learners based on their local knowledge (IK) and socio-cultural context. The lesson plan should have taken into consideration the selection of the subject matter tasks, and the setting of context to address the anticipated roles during teaching and learning in the classroom to accommodate local knowledge. The accommodation of local knowledge in the lesson could play a central role for the teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IK and support in guiding learners in independent learning. The lesson in its format does not integrate IKS.

In Figures 6.2 and 6.3, the two lesson plans were supplied by the Department of Basic

Education for Term 2 and Weeks 1-4 covering investigation skills and Mechanical Systems and Control. The lessons present content, concepts and skills, teacher and learner activities, type of assessment, and resources.

The lesson in Figure 6.2 addresses the hydraulic press including simple calculations in which the teacher should explain how the hydraulic press works and further explain the force transfer in terms of force and area. The teacher should illustrate the relationships between pressure, force and area. On the other hand, learners are expected to evaluate the design of a hydraulic jack taking into account design considerations-fit for purpose. Also, learners should draw and explain the systems diagram which describes the way the hydraulic jack works. However, no matter how the content is based on authentic contexts that are rooted in real situations and address knowledge in an integrated manner within the subject content, it does not integrate IKS or local knowledge.

LESSON PLAN: technology Grade 9				
Name of School:		Term: 2		Week 1 & 2 continuation
Name of Teacher(s):			Date	
Focus	Investigation Skills			
CLASSROOM ACTIVITIES (generic planning)				
Periods	1	2	3	4
Content, concepts and skills	Hydraulic Press including simple calculations		**Investigation:** Design considerations ~ fit-for-purpose: Evaluate the design of the hydraulic jack in terms of: Who is it for? What is it for? Will it do the job? What should it be made of? What should it cost? Is it cost-effective? Does it look good (aesthetics)? Is it safe/easy to use for the end user (ergonomics)?	Draw systems diagram which describes the way a Hydraulic jack works
Teacher's Activities	• Explain how the Hydraulic press works • Explain Force transfer in terms of Force and Area • Introduce the formula for pressure, force and area • Show simple Calculations for Pressure, Force and Area and SI units		• Illustrate how a Hydraulic jack operates • Provide a worksheet for learners to record the design considerations	• Explain a system diagram in relation to input-process-output
Learners' Activities	• Participates • Complete tasks • Make notes • Active involvement		• Make notes • Complete the worksheet	• Describe how a hydraulic jack works using a system diagram.
Type of Assessment	Informal		Informal	Informal
Resources	DBE Sasol Inzalo Workbook/Text book CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Text book CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Text book CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Text book CAPS Document Samples / Examples
IDENTIFIED LEARNERS' NEEDING SUPPORT:		**Name of learner(s)**		**Name of learner(s)**
Indicate the name(s) of learner(s) identified as having learning difficulties/not achieving or use the class list.		1. 2. 3. 4.	5. 6. 7. 8.	

1 of 2 | Page   Grade 9 DBE Technology Lesson Plans

Figure 6.2: Term 2 Lesson Plan A

Similarly, in Figure 6.3 the content coverage is more on action research where learners are expected to conduct practical investigations using a wheel-fixed pulley as outlined in the ATP. In this case, the teacher is expected to use models to demonstrate how the single wheel fixed pulley changes the direction of the pull and sketches to illustrate this. Learners were expected to complete systems diagrams for the ratchet and pawl, disc brake, bicycle brake, and cleat. However, as much as there were more opportunities to integrate IKS, it was not integrated into all the activities.

LESSON PLAN (Technology Grade 9)				
Name of School:		Term: 2		Week 3 & 4
Name of Teacher(s):			Date	
Focus	Investigation Skills, Mechanical systems and control			
CLASSROOM ACTIVITIES (Generic planning)				
Periods	1	2	3	4
Content, concepts and skills	**Action research: practical investigations** o **Use a single wheel fixed pulley** to change the direction of pull (MA=0) o **Use a single wheel moveable pulley** to change the direction of pull (MA>0)	**Use a pulley block system** (block and tackle) to determine the relationship between load-bearing ropes on moveable pulley wheels and M.A (Force multiplication)	**Investigate:** Learners find out about the following: o Ratchet and pawl o Disc brake	**Investigate:** Learners find out about the following: o Bicycle brake o Cleat
Teacher's Activities	• Uses models to demonstrate • Uses Sketches to illustrate	• Uses models to demonstrate • Uses Sketches to illustrate • Provide calculation worksheet for Force multiplication	• Practical demonstration of how the mechanisms work in: o Ratchet and pawl o Disc brake	• Practical demonstration of how the mechanisms work in: o Bicycle brake o Cleat
Learners' Activities	• Observes and makes notes. • Draw 2D sketches to explain the concepts of changing direction	• Observes and makes notes. • Complete the calculations on worksheet	• Completes the Systems Diagram for: o Ratchet and pawl o Disc brake • List examples of where mechanisms are used in modern technology	• Completes the Systems Diagram for: o Bicycle brake o Cleat
Type of Assessment	Informal	Informal	Informal	Informal
Resources	DBE Sasol Inzalo Workbook/Textbook CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Textbook CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Textbook CAPS Document Samples / Examples	DBE Sasol Inzalo Workbook/Textbook CAPS Document Samples / Examples

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Figure 6.3: Term 2 Lesson Plan B

The lesson plan in Figure 6.4 below focuses on Electrical Systems and Control. This lesson is based on Term 3, Grade 9 ATP. It is comprised of the focus area, objectives, classroom activities for the teacher and the learner, assessment, and references and support material. The lesson plan presents the information and emphasises combining concepts and general principles that resonate with the socio-cultural context of the teacher and learner. The lesson plan covers the revision of electrical systems and the introduction of Ohm's law. The lesson plan is more on practical and demonstration work. The lesson expects the teacher to supply learners with electric components or kits and learners to complete the action research tasks which require learners to connect the circuit diagram and measure the current and potential difference to determine the resistance of the circuit.

education
DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

LESSON PLAN

GRADE 9 TERM 3	
Lesson No. 1 Week: 1 (21/07-25/07) Duration: 2 Hours	
Focus area: Electrical Systems and Control	
Content, concepts and skills **Revision of – component symbols** **Revision of – simple circuits** **Ohm's law quantitatively**: as voltage increases, current increases if resistance is constant. **Action research:** Testing Ohm's Law practically.	
Objectives of the lesson: Revision of electrical systems and introduction of Ohm's Law	
CLASSROOM ACTIVITIES:	
Teachers Activities: 1. The teacher revises electrical components symbols. The revision includes: • Cells in series and parallel. • Lamps in series and parallel. • Switches in series (AND logic) and parallel (OR logic). • Current in the circuit – conventional current flows from positive to negative. 2. The teacher revises simple electrical circuits: • One cell, switch, two lamps in series. • Two cells in series, switch, two lamps in series 3. The teacher provides learners with equipment for testing Ohm's Law. 4. The teacher guides learners for the drawing of the V vs. I graph while keeping R constant.	**Resources:** Electrical components Kits Reference Textbooks Graph papers
Learners Activities: 1. Leaners complete informal (as below) activities on the revision of electrical systems. 2. Learners completes the **action research** **Action research:** Testing Ohm's Law practically measure the voltage (potential difference) and the current strength in each of the following circuits: • One cell connected to a 20W resistor. • Two cells connected to the 20W resistor. • Three cells connected to the 20W resistor 3. Learners plot the readings on a graph and determine the relationship between potential difference and current strength while keeping the resistance constant.	**Resources :** Textbook Electrical components kits Stationary: basic mathematical set with pencil, eraser, ruler and graph papers.
ASSESSMENT:	
Enabling tasks	

Figure 6.4: Grade 9 Lesson Plan, Term 3

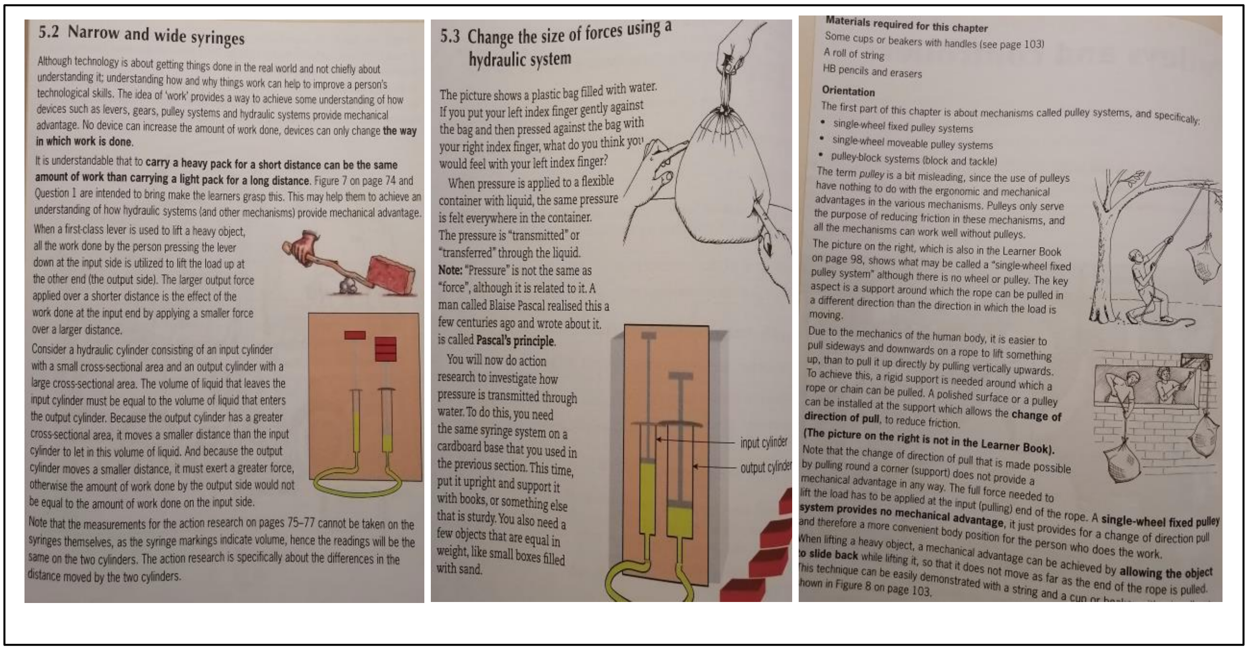
Macmillan Solutions For All pg. 124, 127, 132, 136 Platinum pg. 114, 116, 120
Further references and support material Activities from the Technology workshop material
Notes Do not spend more than the time allocated for the **revision,** more time will be needed for the **practical**. If learners are struggling, rather engage them with many home activities that can be looked into at the beginning of each lesson. The action research practical can be done after school to allow learners to achieve good results. To draw the graph: • Give the graph a **title** that explains what the practical was about. • **Label the axes** with the physical quantity and the unit it was measured with. • Choose an appropriate **scale** that will result in a clear graph • **Plot the points accurately** and clearly. • Draw an **appropriate best fit line**. The points you get from a practical are not perfect, follow the line that best describes the relationship between the two quantities. • A straight line should be drawn with a **ruler**, not freehand. Any points that are well away from the line are called anomalies. They are probably due to experimental error. Extended opportunities for learners who are ahead: • Investigate Ohmic and non-ohmic conductors • Calculate the resistance of the resistor from the graph that was obtained from the practical

Figure 6.5: Grade 9 Lesson Plan Term 3 (continuation of 6.4)

In conclusion, the four lesson plans are supposed to clearly emphasise the context that shows the influence of local knowledge (IK) on the development of the subject knowledge. However, there is no integration of IKS in the lesson plans to cover both the teacher and learner activities. The Department of Basic Education, both nationally and provincially presented the lesson plan content in Figures 6.4 and 6.5. As a result, despite the opportunities presented by the CAPS document, the teachers' scope is limited because the lesson plans do not reflect the integration of indigenous knowledge. However, as the ATP and CAPS documents have flexibility in terms of indigenous technology aspects, the lesson plans' content is open for the integration of IKS. The integration of IKS in the lesson plan should consider the selection of the subject matter tasks, the rationale regarding learners, the setting of context (accommodate local knowledge) and address the teacher’s anticipated role during teaching and learning in the classroom. This could happen provided the ATP is developed in a manner that integrates IKS.

6.2.3 Data from different textbooks

The Grade 9 teacher's guide, specifically *Sasol Inzalo* has made some references to indigenous ways of life in both Books 1 and 2.



5.2 Narrow and wide syringes

Although technology is about getting things done in the real world and not chiefly about understanding it; understanding how and why things work can help to improve a person's technological skills. The idea of 'work' provides a way to achieve some understanding of how devices such as levers, gears, pulley systems and hydraulic systems provide mechanical advantage. No device can increase the amount of work done, devices can only change **the way in which work is done**.

It is understandable that to **carry a heavy pack for a short distance can be the same amount of work than carrying a light pack for a long distance**. Figure 7 on page 74 and Question 1 are intended to bring make the learners grasp this. This may help them to achieve an understanding of how hydraulic systems (and other mechanisms) provide mechanical advantage.

When a first-class lever is used to lift a heavy object, all the work done by the person pressing the lever down at the input side is utilized to lift the load up at the other end (the output side). The larger output force applied over a shorter distance is the effect of the work done at the input end by applying a smaller force over a larger distance.

Consider a hydraulic cylinder consisting of an input cylinder with a small cross-sectional area and an output cylinder with a large cross-sectional area. The volume of liquid that leaves the input cylinder must be equal to the volume of liquid that enters the output cylinder. Because the output cylinder has a greater cross-sectional area, it moves a smaller distance than the input cylinder to let in this volume of liquid. And because the output cylinder moves a smaller distance, it must exert a greater force, otherwise the amount of work done by the output side would not be equal to the amount of work done on the input side.

Note that the measurements for the action research on pages 75–77 cannot be taken on the syringes themselves, as the syringe markings indicate volume, hence the readings will be the same on the two cylinders. The action research is specifically about the differences in the distance moved by the two cylinders.

5.3 Change the size of forces using a hydraulic system

The picture shows a plastic bag filled with water. If you put your left index finger gently against the bag and then pressed against the bag with your right index finger, what do you think you would feel with your left index finger?

When pressure is applied to a flexible container with liquid, the same pressure is felt everywhere in the container. The pressure is "transmitted" or "transferred" through the liquid.

Note: "Pressure" is not the same as "force", although it is related to it. A man called Blaise Pascal realised this a few centuries ago and wrote about it. is called **Pascal's principle**.

You will now do action research to investigate how pressure is transmitted through water. To do this, you need the same syringe system on a cardboard base that you used in the previous section. This time, put it upright and support it with books, or something else that is sturdy. You also need a few objects that are equal in weight, like small boxes filled with sand.

Materials required for this chapter

Some cups or beakers with handles (see page 103)

A roll of string

HB pencils and erasers

Orientation

The first part of this chapter is about mechanisms called pulley systems, and specifically:

- single-wheel fixed pulley systems
- single-wheel moveable pulley systems
- pulley-block systems (block and tackle)

The term *pulley* is a bit misleading, since the use of pulleys have nothing to do with the ergonomic and mechanical advantages in the various mechanisms. Pulleys only serve the purpose of reducing friction in these mechanisms, and all the mechanisms can work well without pulleys.

The picture on the right, which is also in the Learner Book on page 98, shows what may be called a "single-wheel fixed pulley system" although there is no wheel or pulley. The key aspect is a support around which the rope can be pulled in a different direction than the direction in which the load is moving.

Due to the mechanics of the human body, it is easier to pull sideways and downwards on a rope to lift something up, than to pull it up directly by pulling vertically upwards. To achieve this, a rigid support is needed around which a rope or chain can be pulled. A polished surface or a pulley can be installed at the support which allows the **change of direction of pull**, to reduce friction.

(The picture on the right is not in the Learner Book).

Note that the change of direction of pull that is made possible by pulling round a corner (support) does not provide a mechanical advantage in any way. The full force needed to lift the load has to be applied at the input (pulling) end of the rope. A **single-wheel fixed pulley system provides no mechanical advantage**, it just provides for a change of direction pull and therefore a more convenient body position for the person who does the work.

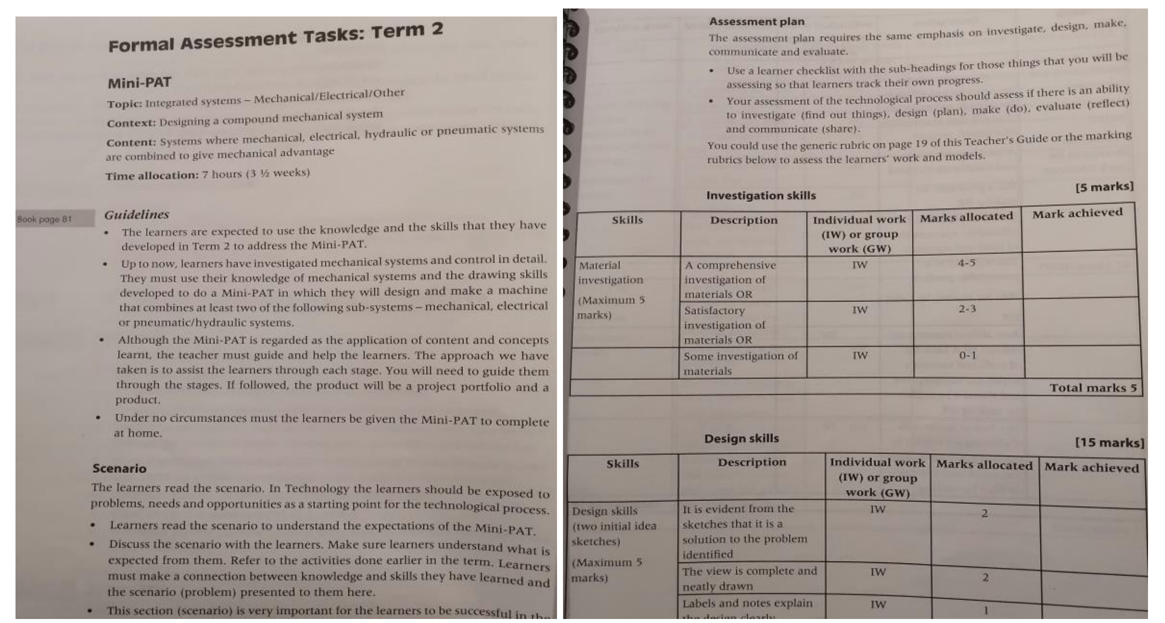
When lifting a heavy object, a mechanical advantage can be achieved by **allowing the object to slide back** while lifting it, so that it does not move as far as the end of the rope is pulled. This technique can be easily demonstrated with a string and a cup or beaker ... shown in Figure 8 on page 103.

Figure 6.6: Hydraulic and lever systems

The text in Figure 6.6 shows three different sets of pictures from the clips. The first clip shows the narrow and wide syringes, the second clip shows the size of forces using the hydraulic systems, and the third clip shows the importance of pulleys to move loads. In each clip, the authors of the textbooks managed to capture parallel pictures resembling both indigenous and conventional drawings in their illustrations of hydraulic systems. However, little is said about the pictures that resemble indigenous knowledge. The authors lost opportunities to integrate IKS into their explanation of the texts and missed acknowledging IKS as one of the principles undergirding CAPS. Hence, the textbooks would have played a central role to support the teachers in their subject matter knowledge and diversify it and their skills to cater for IKS and support and guide learners towards independent learning. Consequently, the idea of authors putting parallel pictures to the Systems and Control content is an indication that the Technology curriculum recognises the importance of integrating IKS across the content areas. However, some textbooks make it difficult for teachers to integrate the aspects of IKS as there are more references to Western knowledge which in turn make it impossible for them to integrate IKS into their planning and teaching.

6.2.4 Formal assessment tasks

The analysis of Figures 6.7 and 6.8 below delves into two mini-PAT. The two figures were extracted from two different textbooks. The researcher investigated the way the mini-PATs are structured in response to the integration of IKS.



Formal Assessment Tasks: Term 2

Mini-PAT

Topic: Integrated systems – Mechanical/Electrical/Other

Context: Designing a compound mechanical system

Content: Systems where mechanical, electrical, hydraulic or pneumatic systems are combined to give mechanical advantage

Time allocation: 7 hours (3 ½ weeks)

Book page 81

Guidelines

- The learners are expected to use the knowledge and the skills that they have developed in Term 2 to address the Mini-PAT.
- Up to now, learners have investigated mechanical systems and control in detail. They must use their knowledge of mechanical systems and the drawing skills developed to do a Mini-PAT in which they will design and make a machine that combines at least two of the following sub-systems – mechanical, electrical or pneumatic/hydraulic systems.
- Although the Mini-PAT is regarded as the application of content and concepts learnt, the teacher must guide and help the learners. The approach we have taken is to assist the learners through each stage. You will need to guide them through the stages. If followed, the product will be a project portfolio and a product.
- Under no circumstances must the learners be given the Mini-PAT to complete at home.

Scenario

The learners read the scenario. In Technology the learners should be exposed to problems, needs and opportunities as a starting point for the technological process.

- Learners read the scenario to understand the expectations of the Mini-PAT.
- Discuss the scenario with the learners. Make sure learners understand what is expected from them. Refer to the activities done earlier in the term. Learners must make a connection between knowledge and skills they have learned and the scenario (problem) presented to them here.
- This section (scenario) is very important for the learners to be successful in the

Assessment plan

The assessment plan requires the same emphasis on investigate, design, make, communicate and evaluate.

- Use a learner checklist with the sub-headings for those things that you will be assessing so that learners track their own progress.
- Your assessment of the technological process should assess if there is an ability to investigate (find out things), design (plan), make (do), evaluate (reflect) and communicate (share).

You could use the generic rubric on page 19 of this Teacher's Guide or the marking rubrics below to assess the learners' work and models.

Investigation skills [5 marks]

Skills	Description	Individual work (IW) or group work (GW)	Marks allocated	Mark achieved
Material investigation (Maximum 5 marks)	A comprehensive investigation of materials OR	IW	4-5	
	Satisfactory investigation of materials OR	IW	2-3	
	Some investigation of materials	IW	0-1	
				Total marks 5

Design skills [15 marks]

Skills	Description	Individual work (IW) or group work (GW)	Marks allocated	Mark achieved
Design skills (two initial idea sketches) (Maximum 5 marks)	It is evident from the sketches that it is a solution to the problem identified	IW	2	
	The view is complete and neatly drawn	IW	2	
	Labels and notes explain	IW	1	

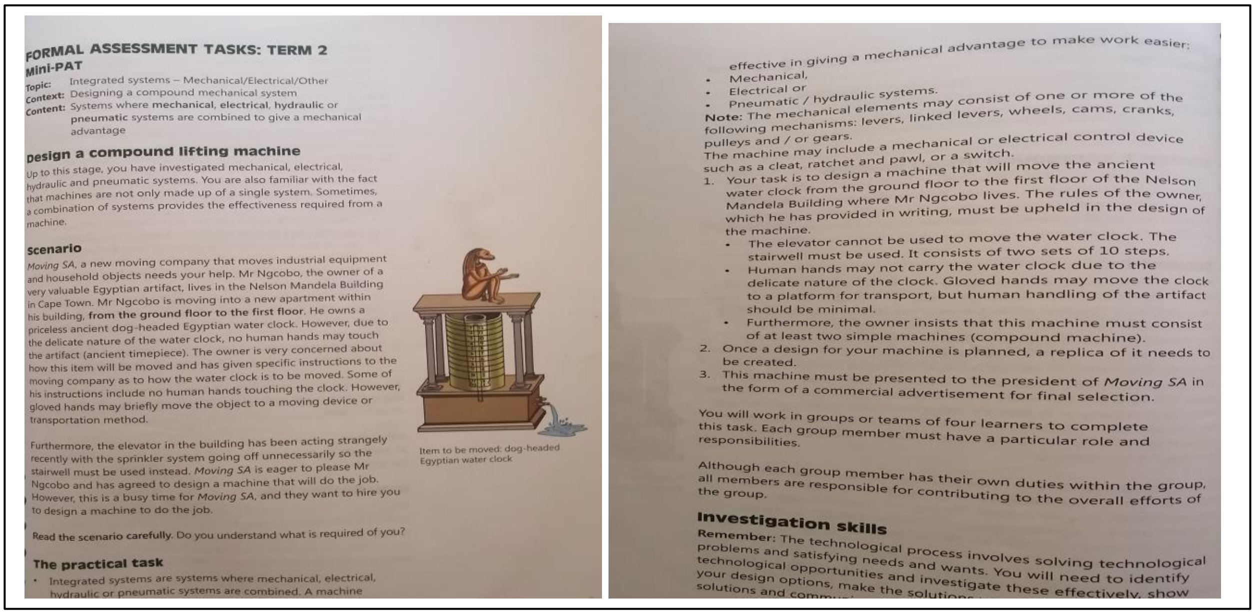
Figure 6.7: Formal assessment tasks (mini-PAT): Term 2, Teacher's guide

In Figure 6.7, the mini-PAT is structured to cover the topic, context, content, time allocation, guidelines, scenario, assessment plan investigation skills and design skills. The topic for this mini-Pat focuses on integrated systems – mechanical or other systems in the context of designing compound mechanical systems. The formal assessment task was the teacher's guide. The mini-PAT gives guidelines to the teacher on how he/she should support the learners. One of the guidelines among the four states as follows:

> *Although the mini-PAT is regarded as the application of content and concepts learnt, the teacher must guide and help the learners. The approach we have taken is to assist the learners through each stage. You will need to guide them through stages……*

This guideline allows the teacher to integrate IKS into the context that shows the influence of local knowledge on the development of the systems and control knowledge to learners. This can still be done when the teacher presents the scenario. The scenario can be presented in the context of local knowledge. As much as the IKS could be integrated into the mini-PAT, nothing is said about the IKS in Figure 6.6.

Figure 6.8 shows the learner's formal assessment task in which the scenario is included for them to design a compound lifting machine.



FORMAL ASSESSMENT TASKS: TERM 2

Mini-PAT

Topic: Integrated systems – Mechanical/Electrical/Other
Context: Designing a compound mechanical system
Content: Systems where **mechanical**, **electrical**, **hydraulic** or **pneumatic** systems are combined to give a mechanical advantage

Design a compound lifting machine

Up to this stage, you have investigated mechanical, electrical, hydraulic and pneumatic systems. You are also familiar with the fact that machines are not only made up of a single system. Sometimes, a combination of systems provides the effectiveness required from a machine.

Scenario

Moving SA, a new moving company that moves industrial equipment and household objects needs your help. Mr Ngcobo, the owner of a very valuable Egyptian artifact, lives in the Nelson Mandela Building in Cape Town. Mr Ngcobo is moving into a new apartment within his building, **from the ground floor to the first floor**. He owns a priceless ancient dog-headed Egyptian water clock. However, due to the delicate nature of the water clock, no human hands may touch the artifact (ancient timepiece). The owner is very concerned about how this item will be moved and has given specific instructions to the moving company as to how the water clock is to be moved. Some of his instructions include no human hands touching the clock. However, gloved hands may briefly move the object to a moving device or transportation method.

Item to be moved: dog-headed Egyptian water clock

Furthermore, the elevator in the building has been acting strangely recently with the sprinkler system going off unnecessarily so the stairwell must be used instead. *Moving SA* is eager to please Mr Ngcobo and has agreed to design a machine that will do the job. However, this is a busy time for *Moving SA*, and they want to hire you to design a machine to do the job.

Read the scenario carefully. Do you understand what is required of you?

The practical task

- Integrated systems are systems where mechanical, electrical, hydraulic or pneumatic systems are combined. A machine

effective in giving a mechanical advantage to make work easier:

- Mechanical,
- Electrical or
- Pneumatic / hydraulic systems.

Note: The mechanical elements may consist of one or more of the following mechanisms: levers, linked levers, wheels, cams, cranks, pulleys and / or gears.

The machine may include a mechanical or electrical control device such as a cleat, ratchet and pawl, or a switch.

1. Your task is to design a machine that will move the ancient water clock from the ground floor to the first floor of the Nelson Mandela Building where Mr Ngcobo lives. The rules of the owner, which he has provided in writing, must be upheld in the design of the machine.
   - The elevator cannot be used to move the water clock. The stairwell must be used. It consists of two sets of 10 steps.
   - Human hands may not carry the water clock due to the delicate nature of the clock. Gloved hands may move the clock to a platform for transport, but human handling of the artifact should be minimal.
   - Furthermore, the owner insists that this machine must consist of at least two simple machines (compound machine).
2. Once a design for your machine is planned, a replica of it needs to be created.
3. This machine must be presented to the president of *Moving SA* in the form of a commercial advertisement for final selection.

You will work in groups or teams of four learners to complete this task. Each group member must have a particular role and responsibilities.

Although each group member has their own duties within the group, all members are responsible for contributing to the overall efforts of the group.

Investigation skills

Remember: The technological process involves solving technological problems and satisfying needs and wants. You will need to identify technological opportunities and investigate these effectively, show your design options, make the

Figure 6.8: Formal assessment Tasks (mini-PAT) Term 2, Learner task

The formal assessment task considers the selection of the subject matter tasks, the rationale regarding learners, the setting of context an opportunity to integrate local knowledge. It also addresses the teacher's anticipated role during teaching and learning in the classroom. As much as the scenario addresses the socio-cultural context it does not address the integration of IKS. Hence, the mini-PAT could offer opportunities for learners' cognitive development and psychomotor skills (use of design process skills) through the diversification and complexity of the tasks that integrate IKS.

In all the documents analysed none was found directly promoting the integration of IKS. However, all four classified groupings have shown that there is room for the opportunity to use the available information to promote the integration of IKS. Furthermore, the findings suggest the rethinking on how ATPs are developed to integrate the IKS or local content in their design. The alignment of content to integrate IKS should be in line with CAPS. The integration of IKS in detail could be included in the ATP with a guiding framework as CAPS lacks detail.

6.3 Classroom observations

The qualitative data in this section is derived from classroom lesson observations from the six (6) teacher participants. The volunteering participants were assigned these pseudonyms: TA1-E, TA2-E, TA3-E, TB1-E, TB2-E, and TB3-E all from the experienced (E) category as there was none from the novice (N) category (Table 5.4). Teachers who participated in this study were observed while teaching Grade 9 in Senior Phase. The participants who were observed in their Technology classes were from the two districts, here named as Ehlanzeni and Nkangala in Mpumalanga Province. The analysis of classroom observations is advanced by focusing on participating teachers' lesson profiles, teaching materials and resources for creative indigenous design processes in Systems and Control, experiences in the teaching and learning environment, integration of IKS in lessons and classroom activities, use of subject matter knowledge to integrate IKS, teaching methods and approaches to promote the integration of IKS and reflections on IKS integration during teacher-learner classroom interaction.

6.3.1 Teachers' lesson profiles

Table 6.6 below outlines the information captured regarding the participants' lesson profiles. The duration of the lessons observed ranges from 39-45 minutes across the districts and schools. All the lessons observed took place in Grade 9 classes. The topics observed were more on Mechanical Systems and Control which comprise hydraulics, pneumatics, gears, mechanisms, mechanical advantage, and gear ratio.

Table 6.6: Participants' lesson profiles

Participant	District	Duration	Topic		No. of learners and sitting arrangement
TA1-E	D1	07:45-08:30	Hydraulic Jack		56 learners in pairs.
TA2-E	D1	12:10-12:50	Gears		45 learners in pairs
TA3-E	D1	13:15-13:50	Pneumatics and hydraulic systems		77 overcrowded class the movement was not easy.
TB1-E	D2	09:00-09:45	Pulleys and Mechanical Advantage		33 learners seated in pairs.
TB2-E	D2	13:30-14:10	Hydraulic systems		84 in a school hall (Platooning system due to covid)
TB3-E	D2	11:53-12:32	The Mechanical Advantage in pneumatic and hydraulic systems		40 learners in pairs

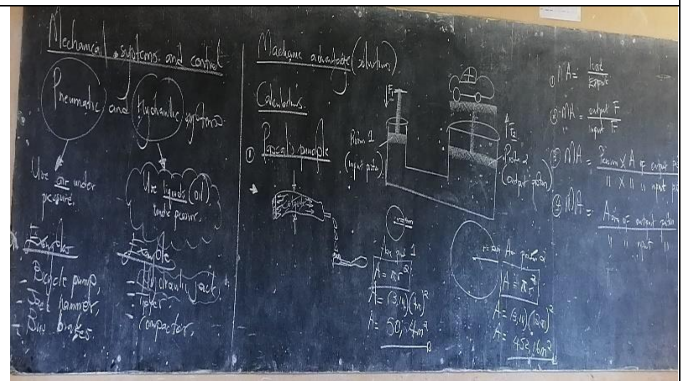
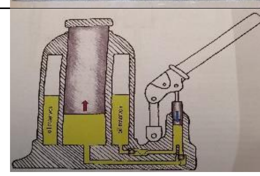
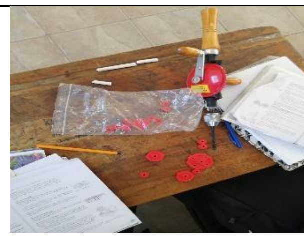
6.3.2 Teaching materials for indigenous design processes in Systems and Control

Teaching and learning resources remain essential in the Technology classroom context. The teacher-learner engagement with the resources for practical application is important in the case of Systems and Control. In addition, indigenous material should be accessible to enable the teaching of Systems and Control. Data reveals that the resources utilised to convey the knowledge of Systems and Control were partly aligned with the content but not with indigenous knowledge acquired during the lesson. The text material and dominant teacher explanation method show that the theoretical part of the Systems and

Control knowledge was prioritised. All six teachers made complete reference to the prescribed text material for the theoretical concepts of the content. Two teachers (TA3 and TB2) utilised tubes to demonstrate and led the learners to experiment. Hand drills and hydraulic jack chart were utilised at the same level to explain the hydraulic systems by TA1. Similarly, gears were also utilised by TA2 to demonstrate the concept of gear ratio. The teacher engaged the learners in experimentation with different types of gears including spur, bevel, idler, scar, rack and pinion. To demonstrate the theme of Systems and Control further, TA2 and TB2 utilised syringes. Teachers displayed their knowledge of the content of Systems and Control since five teachers (TA1, TA3, TB1, TB2, TB3) managed to combine the text and practical resources to demonstrate while they explained the terms and also engaged learners in the experimentation of the concept in System and Control. Table 6.7 below shows a combination of text and practical resources per individual teacher.

Table 6.7: Combination of diverse resources

Teacher	Combination of resources	Evidence
TB2-E	Text, syringes, tubes, and water	
TB1-E	Text material	

Teacher	Combination of resources	Evidence
TB3-E	Text material	
TA1-E	Text and a hydraulic jack chart	
TA2-E	Different kinds of gears (spur, bevel, idler, scar, rack & pinion, as well as a worm) and worked on gear ratio. Also 3 hand drills and textbook Shutter top class.	
TA3-E	Syringes, tubes, and text material.	

The combination of resources was focused on concepts related to the theoretical, visual imagery and conceptual knowledge of Systems and Control. Indigeneity, aligned with the nature of Systems and Control was none of the teachers' focus, but the teacher presentation did not show any evidence based on the material used to convey knowledge of Systems and Control as aligned with the indigenous design process. In terms of the utilisation of teaching and learning resources and materials, the conveying of content knowledge outweighs the integration of IKS into the theme of Senior Phase Systems and Control. Figure 6.8 displays the balance between the content part and indigenous knowledge evident in the teaching and learning of Systems and Control.

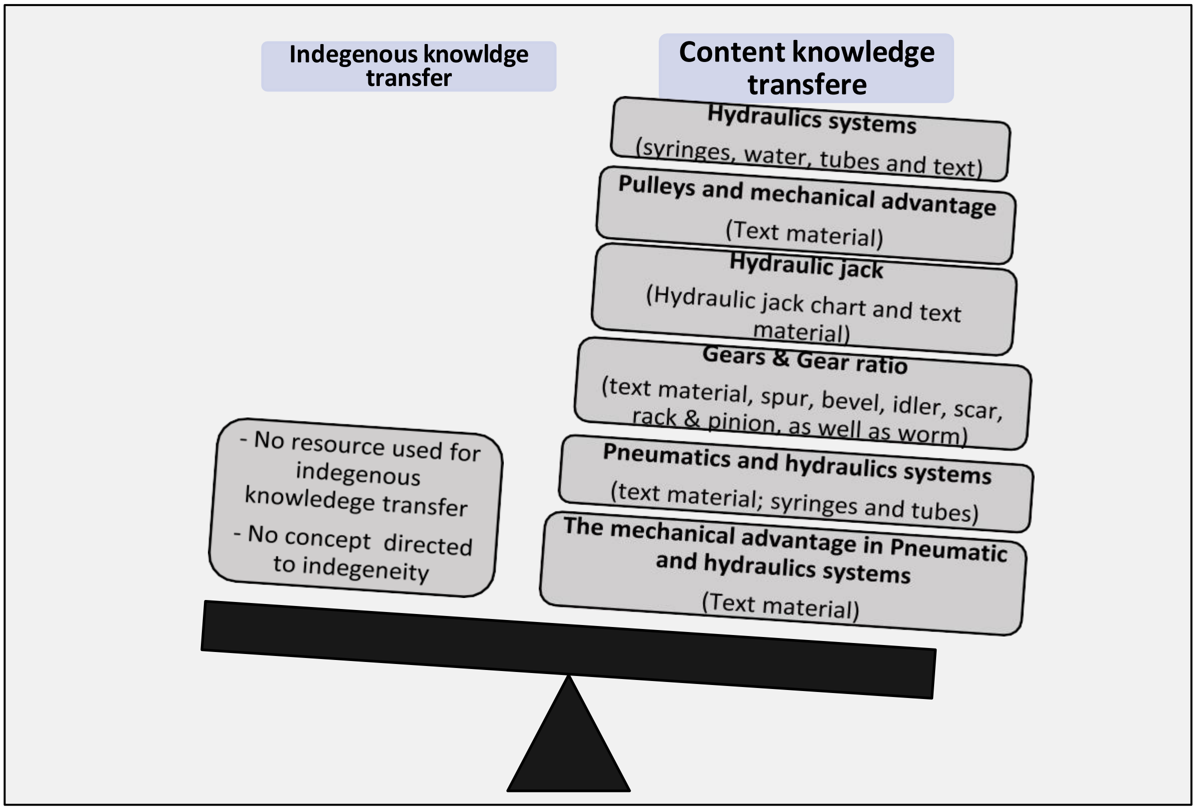


Figure 6.9: Utilisation of resources for content and indigenous knowledge

6.3.3 Experiences and teacher engagement in the Technology classroom

The participating teachers faced challenges including large numbers of learners in classes where deep consideration was needed to maintain discipline, manage practical sessions well and maintain teamwork effectively. The engagement was based on the teachers' demonstration and limited learner engagement. For example, teachers TB2, TA2 and TA3 demonstrated and performed experiments using relevant materials to advance learners' conceptual understanding (Table 6.3). However, the engagement was teacher-based without learners participating in experiments to explore and discover the content on their own. In addition, the demonstrations and experiments were content-based, focusing on the Systems and Control content. All activities were not informed by IKS. It is evident that the IKS content still needs to be considered in classroom engagement during the teaching and learning of Technology. The findings revealed that teachers still lack experience in integrating the IKS content into the teaching of Systems and Control and Technology in general.

6.3.4 Integration of IKS in lessons and classroom activities or tasks

The integration of IKS in lessons and the classroom is discussed based on how teachers apply their content knowledge to integrate IKS, and the teaching strategies that they employ to promote IKS.

All teachers have shown competency in the subject matter. Based on the fact that IKS is not included as per the ATP and lesson plans, its integration seemed to be a challenge. The possibilities for the recognition of IKS in communities and schools could be included as part of the lesson. This could help to use the learners' cultural background and experience to guide and provide more conceptual understanding and content knowledge. The rigid frame of the curriculum deprives teachers of expanding their knowledge to integrate IKS. Therefore, no reference was made to IKS in relation to the teachers' content knowledge of Systems and Control.

Prominent teaching methods encompassed explanation, demonstration, and only one teacher attempted a teamwork approach. The teacher-centred approach seemed to outweigh the learner-centred one. The teaching methods and approaches were not showing IKS content. Teachers' lesson plans were focused on critical content matters that addressed learners' conceptual development in Systems and Control. The IKS integration exclusion in the curriculum prohibited the teachers' creativity to apply the strategies and approaches that would engage learners based on their daily, societal and cultural experiences.

6.3.5 Reflections on IKS integration during teacher-learner classroom interaction

The current dispensation of teaching and learning in Technology excludes IKS, hence, it excludes indigenous technologies as well that exist in communities. Learners learn foreign technology with no reference to a n indigenous one as an alternative. Reference to indigenous technology is a means to increase learners' critical thinking and creativity in design processes. In addition, learning Technology needs to be focused on both assessment and grades including equipping learners with knowledge that can empower them to address the needs and wants in their immediate communities. The findings show that the teaching of Technology occurs through teacher-centredness with IKS excluded.

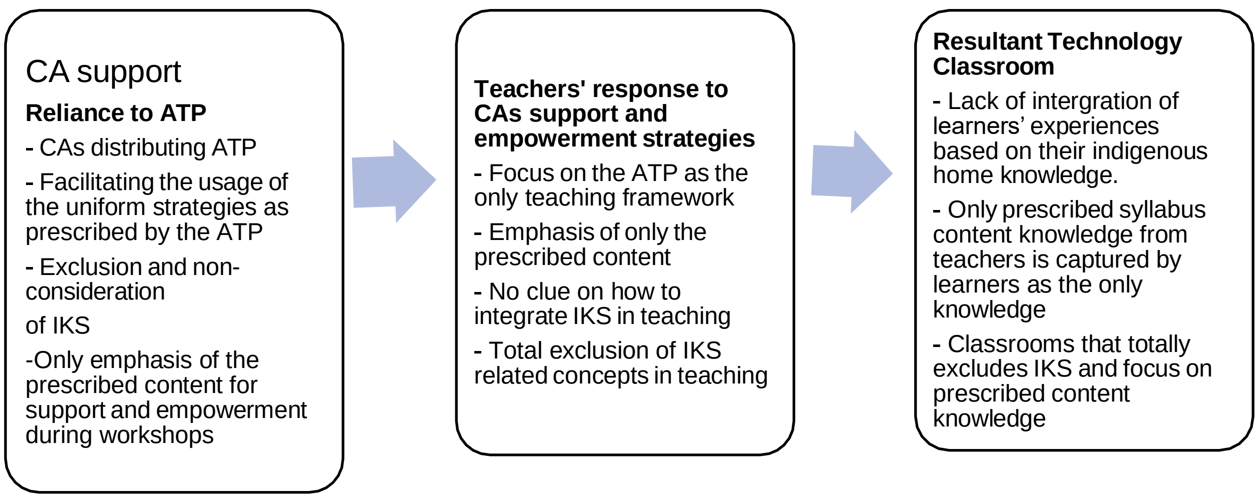


Figure 6.10: Visual model for curriculum advisors' support to Technology teachers

6.4 Synthesis

Chapter 5 presented a detailed analysis of the data that emanated from the semi-structured interviews for both the novices, experienced and curriculum advisors and two districts. Chapter 6 presented document analysis and lesson observations. These chapters outlined the biographical detail of the participants based on their contexts in the study. The analysis from the interviews, document analysis and observation are integrated in this chapter's section 6.5 for discussion of the findings.

6.5 Discussion of findings

The findings were based on the semi-structured interviews, document analysis and observation of data to establish how Senior Phase Technology teachers integrate IKS in the creative design process when teaching the Systems and Control topics. Data were collected from two districts with 18 participants in the study detailed in Chapter 5 Table 5.1. The shape of the discussion followed the six themes that are aligned with the objectives of the study. Those themes are Technology teacher's understanding of IKS, opportunities that the third IKS-inspired specific aim presents, Technology teachers' attempt to integrate IKS, learners' grasp of the integration of IKS, the kind of support subject specialists give to teachers and Technology classroom practice through the integration of IKS. The literature and the theory were engaged to confirm whether the study objectives are achieved or not.

6.5.1 Technology teachers' understanding of IKS

In this subsection, discussions focused on establishing the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs as contained in the third specific aim of CAPS. Technology teachers' understanding of IKS could be a prospect for teaching and learning in the context of the subject in the Senior Phase classroom. The discussion in this subsection pays attention to major findings on the general understanding of the IKS, IKS in relation to Technology subject, and understanding of IKS in relation to concepts of creativity, design process, Systems and Control. On the general understanding of IKS, the findings revealed that across the districts and categories of teachers (novice and experienced) and learners, IKS is viewed as the past knowledge or knowledge that was applied only in the olden days, a view that poses a challenge about downplaying IKS which limits the view of its existence currently. Hence, the different understanding of IKS can necessitate a different explanation of the IKS concept itself from different people including the Technology classroom. The findings are confirmed by the literature which suggests that IKS concepts are understood in various contexts and historical cultural backgrounds as traditional knowledge systems, local knowledge systems, endogenous knowledge systems, and classical knowledge systems (Odora-Hoppers 2021; Keane et al. 2023). Therefore, in line with these findings, the literature reviewed also confirms that IKS has situated knowledge that is rooted in social, cultural, and physical contexts (Herrera 2020; Kurt 2021). Thus, IKS emerges as a field of the indigenous way of knowing which has become important in the emerging global economy, also in the classroom (Ogunniyi 2007; Chilisa 2012; Gaotlhobogwe 2017).

Regarding the understanding of IKS in relation to Technology subject, the study's findings found that in both novices and experienced categories, participants share different views depending on the circumstances they found themselves in, i.e., community or school context. Furthermore, there is a consensus of ideas across the districts and across the categories that IKS can enhance the learning of the content if it is only based on the contribution of the local community. In this case, IKS was viewed as the knowledge that allows teachers to understand the importance of culture and tradition in the teaching of the Systems and Control sections in the Senior Phase. This came as participants believed that culture and tradition could assist the local people to develop an understanding or come to the realisation that the indigenous communities do most of the things on a day-to-day basis such as lifting objects and/or loading objects without being aware of the knowledge associated with Systems and Control content. These findings are confirmed by the literature reviewed that knowledge traditions are said to be grown and shaped by the needs and interests of the community members-bringing in the elements of values and attitudes (Nordlöf et al. 2021:1587).

Concerning concepts of creativity, design process, Systems and Control, the findings revealed that across districts and categories, participants were able to relate to the concepts of creativity, design processes and Systems and Control content. The results conformed with literature that these concepts constitute technological knowledge classified as procedural knowledge and conceptual knowledge (McCormick 2004; Pavlova 2005; Nordlöf et al. 2021). Accordingly, the literature further views knowledge as a complex body of several socially constructed ideas validated by the dominant intellectual persuasion, hence technological knowledge (Mitcham 1994; Ezeanya-Esiobu 2019). Procedural knowledge and conceptual knowledge are linked with design, problem solving, thinking, and systems concepts, which all constitute the body of knowledge in Technology Education (Pavlova 2005). Furthermore, the concepts of creativity and design were seen by participants as intertwined and inseparable when dealing with the design process. Design skills, thinking skills and systems concepts featured prominently in this study where the study wanted to establish how Senior Phase Technology teachers integrate IKS in the creative design process when teaching Systems and Control topics. In the literature reviewed, it is confirmed design is regarded as a social process that promotes an argumentation amongst the different perspectives and values towards finding a solution to the problem (Cramer-Petersen, Christensen & Ahmed-Kristensen 2019). The literature further pointed out that thinking skills comprise critical and creative thinking skills that involve the generation and evaluation of knowledge (Hamza & Hassan 2016:588).

Critical and creative thinking skills are an integral part of the design processes (Howard, Culley & Dekoninck 2008:160) of which creative thinking (creativity) featured prominently in the study. Similarly, the literature described creativity as an original cognitive ability and problem-solving process towards producing a product (Hamza & Hassan 2016). Therefore, the building of cognitive ability and problem-solving skills in the Technology subject could be realised through the design process at a metacognitive level (Cramer-Petersen, Christensen & Ahmed-Kristensen 2019). Consequently, IKS became an important resource to enrich creativity and innovation (Moalosi et al. 2017). Creativity contributes to cognitive analysis during the design-based learning process. Therefore, cognitive analysis in Technology plays a role in building creative knowledge through creative design activities of the core content of Systems and Control in the context of IKS (Masaka 2018). The Systems and Control content area is constituted of Mechanical, Electrical and Electronic Systems and Control. Hence, the literature confirms the importance of these concepts of creativity, design process and Systems and Control in the Technology subject. However, there were some difficulties in relating these concepts with IKS. The literature confirms the argument that the values and attitudes of society can have an impact on producing technological products (Dakers 2006). Hence, the literature exposed that a focus on IKS can necessitate archaeology and re-appropriation of knowledges that was not allowed to develop our human understanding (Odora-Hoppers 2021).

IKS is specialised knowledge (Gumbo 2015). Therefore, IKS can determine the authentic context in which Technology concepts such as creativity, design process and Systems and Control content could be taught (Gumbo 2018). The authentic context should be located within the classroom practice to the shaping of and constitute knowledge and know the social and cultural practices in which learners and teachers are at the centre (Lave & Wenger 1991; Mudau 2016). In this study, it is argued that community members define the values and attitudes in the knowledge and skills, thus creating a relationship between IKS and technological knowledge that could ease the teaching and learning process in the classroom.

In conclusion, the findings in this subsection were confirmed by the extensive literature reviewed suggesting that teachers across the districts, both novice and experienced, need to gain knowledge and understanding of IKS in relation to the technological knowledge to master the concepts based on the authentic contexts in order to diversify the learners' activities with different knowledge systems that exist to cater for the needs of learners they teach in their classrooms. Hence, there should there be a framework to guide the integration of IKS that would facilitate the process of understanding IKS in relation to Technology. This could create opportunities in the teaching and learning of Technology. The next subsection discusses the opportunities that the third IKS-inspired aim presents in Technology.

6.5.2 Opportunities that the third IKS-inspired specific aim presents

The subsection identifies and discusses the opportunities that the third IKS-inspired specific aim presents to the Senior Phase teachers regarding the teaching of the creative design process in the Systems and Control content. The findings revealed that in both categories and across the districts, some participants were able to locate aspects that relate to IKS in the Specific Aim 3 of Technology. Hence, Specific Aim 3 sets the context to create opportunities for IKS' recognition in the teaching and learning of Technology. The literature reviewed confirms that context is an important aspect of Technology (Gumbo 2019). On the contrary, the findings also revealed that some participants had some challenges in identifying the aspects associated with IKS in Curriculum Assessment Policy Statement (CAPS). This was evident as some misunderstandings were noticed about Specific Aim 3 across cases, which calls for the supporting guidelines or frame to be in place. CAPS is the official curriculum framework in the South African education systems. According to the Department of Basic Education [DBE] (2011), CAPS Technology curriculum contains three specific aims. Specific Aim 1 focuses on the strand design processes. Specific Aim 2 focuses on the strand knowledge and understanding. Specific Aim 3 focuses on the strands, technology, society and environment (TSE). In this study, the TSE strand in Specific Aim 3 is identified as the third IKS-inspired aim. It contains three aspects, namely, biases, impact and indigenous technology. The indigenous technology aspect presents opportunities to integrate IKS into the Technology curriculum content areas.

The findings were confirmed by the literature reviewed that the curriculum is designed to achieve the ultimate purpose of education as articulated in different educational policies (Tseane & Motebang 2023). Furthermore, the literature reviewed argued that most of the curriculum reforms in some of the developing societies in Africa are still Euro-Western oriented, disregarding the integration of IKS until the recent two decades (Smith 2008; Goatlhobogwe 2017; Moalosi et al. 2017; Yishak & Gumbo 2017). The findings also revealed that teachers were left alone to interpret the CAPS concerning IKS in Technology which is normally during lesson development and class teaching which is contrary to the literature. The literature, instead, argues that Technology is in a better space to transform towards re-aligning its relevancy based on the philosophical grounds that make it inclusive to meet the needs of society, especially the indigenous societies (Ndlovu & Gumbo 2018). Hence, an opportunity can be created to put up support structures such as the community of practice (CoP) where participants of different categories would have social collaborations. This is seen as a way of sharing ideas in the spirit of *Ubuntu/Botho* in meaning making to increase their knowledge about the dynamics of the subject based on their context (Gumbo 2020; Mhlauli et al. 2021). The literature further confirms that the idea of knowledge and meaning-making stems from the interaction and experiences associated with situated learning and the constructivist view (Lave & Wenger 1991).

The findings further revealed that some participants applied several different approaches to create opportunities to enable learners to bring in local knowledge using existing artifacts in their homes or community, design scenarios related to their community, and also leading learners through questions that allow them to relate with what is in their homes or societies. However, societies are dynamic, they impact teaching and learning in that IKS remains the knowledge that learners already know from their society which is not part of the curriculum knowledge but social knowledge. Hence, the reviewed literature confirmed that it would require the teacher to show expertise in the knowledge of the domain (concepts, facts and procedures), heuristic strategies (techniques and approaches for accomplishing tasks), and the control of learning strategies (De Bruin 2019).

Regarding the opportunities that are created to help learners to master the learning activities based on the local knowledge content, the findings revealed that the support that one can put to assist learners to master the activities in Systems and Control is to allow learners to design based on what they have seen and experienced. The findings further suggest that the support put in place to allow learners to produce a clear description of IKS is through promoting group discussions, encouraging the use of language, and promoting the use of pictures and charts as well as understanding the mechanisms used to lift loads the indigenous way. These findings were confirmed by the literature which argues that the basic underlying principle that all knowledge, including IKS and technological knowledge, is originally grounded in personal encounters with concrete situations (Korthagen 2010). The literature further confirmed that technological knowledge fits well in IKS which if integrated into creative design activities in Systems and Control, it could make learning more meaningful (Ndlovu & Gumbo 2018). Hence, the IKS-inspired Specific Aim 3 opens the opportunity to support teachers' planning for teaching in the context of their classes.

In the case of engaging IKS when designing and developing planning for activities in Systems and Control, the data revealed that teacher participants did engage with the aspects of IKS in their activities, however, the annual teaching plan (ATP) becomes a constraint as they are expected to do as prescribed. The view supported by the

Curriculum Advisor that ATP design scenarios are prescriptive and the outcome of the process to be followed is defined which made it not flexible to consider the local knowledge. The whole exercise defeats the promotion of creativity and application of local knowledge/IKS in the process. On the issue of the opportunities that IKS presents for the teaching of the Systems and Control topics or content, the data revealed that different categories across the two districts had different views. The views shared saw some participants apply several different approaches to creating opportunities to enable learners to bring in local knowledge. Hence, three propositions were suggested, i.e., the use of existing artifacts in their homes or community, the design of scenarios related to their communities, and leading learners through questions that allow them to relate to what is in their homes or communities. These propositions form part of the framework in 6.5.6. The next subsection turns to the teachers' attempt to integrate IKS.

6.5.3 Technology teachers' attempt to integrate IKS

This subsection focuses on the Senior Phase Technology teachers' attempt to integrate IKS in the creative design process when teaching Systems and Control. In this subsection, the teachers' practices and perspectives clarified how the Senior Phase Technology teachers integrate indigenous creative design processes in Systems and Control. The biographies of all the six teachers who participated in the study indicated that they all were qualified to teach Technology (Chapter 5, Table 5.1). From their biographical information, participants were marked as competent in teaching strategies and possessed the necessary content knowledge relating to Systems and Control. Their expertise matched the lesson profiles that indicated that the lessons were based on Systems and Control. The topics taught in the classroom related to the curriculum content for Systems and Control in general, and they were gears, hydraulic jack, pneumatics, pulleys and mechanical advantage.

The findings revealed that across the districts and in both the experienced and novice categories, the common thread was that some participants viewed discussion, question-and-answer as well as the use of pictures as teaching strategies. Only in a few cases where the use of language and learner-centeredness were mentioned as the strategies that are used to engage learners towards the realisation of IKS during the lesson.

The literature reviewed confirms that context is vital for understanding, learning and practice, as knowledge cannot be just acquired mechanically (Handley et al. 2006:643). In any teaching and learning environment, teaching and learning resources play an important role in teachers delivering the content and for the learners to advance their conceptual understanding. The findings showed that participants' experiences differed due to the context they found themselves in. Some found it difficult to ground learners' understanding of Systems and Control concepts on IKS. As much as there were indications of success in some participants, there were still some who were honest to indicate that they did not do anything to make sure that the strategies they applied in their teaching of Systems and Control were rooted in the IK or local knowledge. This is evident in the teachers' capabilities to utilise the teaching materials to deliver the content in diverse topics of the content area Systems and Control. Nonetheless, in terms of the utilisation of teaching and learning resources and materials, the conveying of Systems and Control content knowledge outweighs the integration of IKS into the Systems and Control contents. Figure 6.11 displays the balance between content delivery and the indigeneity evident in the teaching and learning of creative design processes in Systems and Control.

Technology teachers are competent in content delivery, looking at how they apply relevant teaching resources to diverse topics. However, there is no indication that teachers could find indigenous resources that will support them to integrate creative design processes in teaching the content in Systems and Control. The resources prescribed by the ATP are the only utilised resources in Technology classrooms. Moreover, in all the four groups of documents analysed, i.e., ATP Grade 9, lesson plans, teacher/learner books and formal assessment tasks (mini-PAT), none was found directly promoting the integration of IKS. For example, as the findings from document analysis in Figure 6.5, the authors of the textbooks managed to capture parallel pictures resembling both indigenous and conventional resources in their illustrations. However, little is said about the pictures that resembles the indigenous part. The authors lost opportunities to integrate IKS in their explanation of the texts. Hence, the textbooks would have played a central role to empower the teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IKS and be supportive in guiding learners towards independent learning. Consequently, the idea of authors putting parallel pictures in the Systems and Control content is an indication that the Technology curriculum recognises the importance of integrating IKS across the content areas.

Subsequently, all four classified groupings of the findings have shown that there is room to use the available information to promote the integration of IKS. Furthermore, the findings suggest the rethinking of how ATPs are developed so that they can integrate the IKS or local content. The alignment of content in integrating IKS should be in line with CAPS. The teachers could supplement the prescribed resources with the indigenous resources found in schools' specific geographical contexts to enable the utilisation of the learners' contexts for meaningful learning of Systems and Control. These findings are confirmed by the literature that highlights that IKS is difficult to locate since it is a challenge for most individuals to determine what constitutes IKS in terms of social, cultural and geographical contexts (Tharakan 2017). This refers to the challenge of teachers to integrate relevant indigenous resources to engage with learners' indigeneity. Teachers' and learners' societal orientations play a major role in the ability to identify what constitutes indigenous resources, for example, available and known resources in communities could support teachers' ability to engage learners in innovative projects that would support conceptual understanding in the classroom context.

The literature revealed that agreements in communities concerning socio-cultural contexts that define the community indigeneity are essential for the ease of integration at the community level (Tharakan 2017). This study argues that the socio-cultural contexts that schools are exposed to impact the rigid teacher identification of classroom resources to engage learners. For example, the ATP that prescribes what should happen in the classroom does not consider community indigenous systems; and includes industrial technical knowledge only. Therefore, this study avers that a model for integration of socio-cultural indigenous context is necessary to guide teachers to maintain a balance between utilisation of indigenous-based resources and industrial technical resources to further balance the technical content of Systems and Control with IKS. Figure 6.10 shows a model as a guide for the consideration of IKS-based resources. An intense understanding of socio-cultural indigenous knowledge is a means to effective integration of IKS in the subject matter knowledge and in the teaching strategies to promote indigenous technology design processes. This is confirmed by the reviewed literature that suggested some varying teaching strategies that could aid the integration of IKS such as integrated approaches, starting with the prior knowledge, engaging learners in problem-solving activities, allowing dialogue and arguments in the process that involves design and local knowledge (Ogunniyi & Ogawa 2008; Jacobs 2015; Ndlovu & Gumbo 2018).

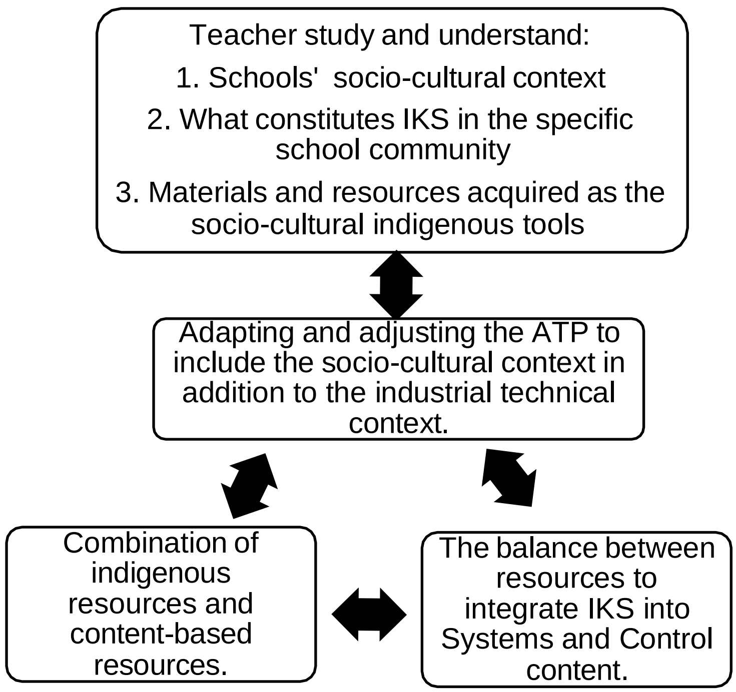


Figure 6. 11: A model as a guide for consideration of IKS-based resources

Therefore, the integration of IKS in teaching strategies calls for learner-centred teaching approaches over teacher-centred approaches. The next subsection delves into the learners' grasp of the integration of IKS.

6.5.4 Learners' grasp of the integration of IKS

This subsection establishes how Senior Phase learners receive the integration of IKS in the creative design process when learning Systems and Control. The findings revealed that the support that teachers can give to learners is to assist them to master the creative design process activities in Systems and Control through designs-based scenarios that are in line with their IKS/local knowledge that comprises things they have seen and experienced. Scenarios play a very important role in introducing learners to real-life problem and developing problem-solving skills when doing design activities. The literature confirms these findings by suggesting that quality learning can only occur if teachers instruct in ways that will enable and encourage learners to engage in the intellectual activities that promote quality learning (Killen 2015:64). Furthermore, the literature confirms that opportunities that are created to help learners to master the learning activities should be based on the local knowledge content as this help learners to consider ideas from multiple perspectives, solve complex problems, arrive at reasoned conclusions that use their own initiative to guide their exploration of local knowledge (Killen 2015).

The findings suggested that the use of IKS/local knowledge would assist learners to understand the content much better and it would make sense for them to do well in the design process activities that involve Systems and Control activities. The findings further suggest that teachers should encourage learners to mention their own examples that exist in their locality, for example, the types of gears or systems they know, in order to choose the one that they prefer to make a design. These findings were confirmed by the literature reviewed, suggesting that learners as novices need to gain skills, as established members of a community that are required to learn those skills, explicitly articulating them, not taking for granted their assumptions, and remembering important incidents to relate towards developing own praxis through dialogue and or interaction with fellow learners (Brooks et al. 2020). Hence, the learners as novices learn from more experienced or expert teachers. Therefore, the literature argues that while learners may be inexperienced in the work of CoP, they are not devoid of knowledge, skills or viewpoints, but also can serve to consolidate and reaffirm expert knowledge with learners' local knowledge. Subsequently, learning and knowledge transfer within a CoP should be seen as a mutual process, which challenges the notion that CoP learning occurs linearly and chronologically (Lave & Wenger 1991; Brooks et al. 2020). Consequently, the findings suggest that the support of learners through the promotion of group discussions, encouraging the use of local language, and the use of indigenous pictures and charts as well as understanding the mechanisms used to lift loads the indigenous way should be put in place to allow learners to produce a clear description of IKS.

On the creation of a space where learners explain their understanding of IKS in their learning, the findings revealed that both novice and experienced participants across the two districts affirmed that they created space for learners to express their understanding of the concepts in Systems and Control in the language they are familiar with or comfortable using. Hence, the study argues that it is within the integrated context where everyone learns, where knowledge and skills are shared, and where both novices and experts contribute to the learning process. The findings confirmed by the literature further suggest that during the learning process, learners are peripheral members of the grouping that yet require to learn and reflect on the required skills towards the integration of IKS/local knowledge as members, at the same time, playing an important role in their groups' work (Brooks et al. 2020). Therefore, learners should learn through collaboration, in groups, observing existing practices, supporting expert teachers, taking basic tasks and gradually assuming responsibility for their learning in creative design process activities in Systems and Control. It is further suggested that when learners are required to design a machine that uses hydraulic systems, they should also be allowed to discuss in their home language to come up with a solution to make the machine. However, the use of local or home language does not always mean the understanding of IKS. As a result, IKS can be useful in contextualising the subject content, as most of the content is Western-oriented.

However, considering the findings, activities must be designed to facilitate learners' understanding of the context related to their indigenous homes and communities even if the content is Western-inclined (Chilisa 2012; Ezeanya-Esiobu 2019). Efforts must be made to integrate indigenous content as well. There should be a glossary of indigenous terms in local languages to enhance learners' understanding of the concepts in line with

IKS. This comes against the backdrop that teachers and curriculum advisors maintained that they never thought about a glossary of indigenous terms before and there was no glossary of terms in any of the indigenous languages in both districts on the documents analysed. The aforesaid is confirmed by the literature which suggests that knowledge equities can also be supported by using indigenous words in dissemination, such as indigenous names for different mechanisms used in Systems and Control content (Mehltretter et al. 2023). However, it is something that they would like to do. At times, even if the participants did not complete the glossary of terms, they indicated that they explained the concepts in the local language that learners understood.

It is important for teachers to develop or plan activities that will support learners to master the creative design process activities in Systems and Control topics. Participants shared their individual views concerning this aspect. The findings revealed that to support the learners to be confident or master the activities, one would prefer more examples of the designed structures at their homes or community that involve Systems and Control such as gates, ramps, and lifting of heavy objects for meaningful learning. The other way of creating opportunities for learners to support meaningful learning is by allowing them to express themselves through reflection on IKS-oriented activities. Reflection is one of the processes in the teaching and learning domain (Tariq et al. 2021). This would contribute to learners' metacognition which is supported by self-reflection. These findings were confirmed by the literature reviewed that describes metacognition as thinking towards understanding an analysis of creative thinking processes using the appropriate skills and strategies to solve problems through designing (Antonietti, Confalonieri & Marchetti 2014).

The study data revealed that as much as time for reflections on learning was created, there were instances where teachers did not create such time because there was no provision of space in the ATP, and time was not created for such in some classrooms. The literature reviewed further confirmed the finding that reflective thinking comprises metacognition, reflective thought and narration that form competencies to face the demands of classroom realities around societies or environments influenced by both informal settings and formal contexts (Antonietti et al. 2014). Therefore, reflections on one's learning could be used as proof of whether learning has taken place successfully or not. Consequently, based on the discussions on the leaners' grasp of the integration of IKS in their learning, it can be confirmed that more still needs to be done to support teachers, whether in the form of the development of the text materials, lesson plans, or adjustment of ATP to suit the IKS. Also, the availability and use of resources that include indigenous and contemporary, as well as the development of the glossary of indigenous terms. This requires a framework that can guide participants across the sections in districts such as teachers, learners, and curriculum advisors as it will be applicable for use and implementation in their classrooms and when developing their training materials. The next sub-section deals with the kind of support subject specialists give to teachers.

6.5.5 Kind of support subject specialists give to teachers

The subsection discusses the kind of support subject specialists for Technology give to teachers towards the integration of IKS in creative design process activities in Systems and Control. In the South African context, one of the principles that ground the curriculum is the principle of valuing IKS (DBE 2011). This principle gives room for the integration of IKS in creative design processes activities in Systems and Control. This subsection of the chapter reports more on the challenges than opportunities. As the findings affirmed, the IKS aspects were not prioritised on the list of activities implemented during the advisory sessions such as workshops/cluster meetings. For example, the curriculum advisors confirmed that they did not consider integrating any IKS-related concepts in the teacher empowerment sessions that they conducted. The findings were confirmed by the literature that points out that taking the integration approach comes with its own prospects and challenges that need expertise and sound teaching approaches (Lee & Perret 2022). Furthermore, the literature confirmed that in terms of knowledge, skills, and teaching, teachers are expected to demonstrate expertise in the integration of IKS in their teaching practice context with the necessary support (Zweeris et al. 2023). Hence, during the workshop/training sessions curriculum advisors were expected to build the CoP, which literature defines as the complete community that is composed and dependent on the novice and experts, teachers and curriculum advisors in this instance (Brooks et al. 2020). In such sessions, teachers' empowerment to integrate IKS in creative design process activities in Systems and Control should take place. Nevertheless, the findings established that teachers were left on their own to decide on the issues of IKS integration. Furthermore, the findings revealed that there was no provision in their scheduled plan for the year to integrate IKS except encourage teachers to follow the ATP-prescribed content. This was evident in the document analysed for Grade 9 ATP. Hence, there was no concerted commitment to integrate it practically.

The findings further revealed that curriculum advisors had no control over the development of the ATP to factor in the integration of IKS during training for teachers. Instead, it emerged that the ATP was developed by the Department of Basic Education and factored down into implementation starting from the districts to schools. Consequently, this contributes to the difficulties that teachers experience when it comes to the formulation of activities that support the integration of IKS. Other challenges were that the participants across the two districts and categories faced challenges ranging from teaching in a multicultural classroom to language, where one need to strike a balance between cultures. This is because of the gap that exists within communities where the practices of cultures and languages are not the same, hence that would need indigenous experts. As much as participants unanimously agreed with the role that the indigenous knowledge holders or experts could play in teaching and learning some participants indicated that they never invited them, but it is something they would consider doing in the future. Indigenous knowledge holders or experts should be seen in communities as the crop of experts that could play a role in assisting schools to preserve knowledge through collaboration, a process that can be facilitated by teachers and curriculum advisors to build a community of support structure. Hence, the data confirmed that participants across the two districts and categories agreed that the indigenous knowledge experts could play a very important role in assisting the integration of IKS into Technology subject areas or content. The move was seen to advance the sharing of knowledge and experience amongst the experts, teachers and curriculum advisors.

A collaboration between curriculum advisors, teachers and indigenous experts would give a gleam of hope, provided a proper operation with a clear framework that contains the elements of transformation of the curriculum is in place. Hence, the integration of IKS could formally be part of everyday teaching that would benefit both teachers and the society in educating learners toward decolonising the Technology curriculum content by integrating IKS for sustainable education. In conclusion, a change in perspectives towards the realisation of the need to integrate IKS in teaching materials could lead to enhanced and transformed training/workshop sessions. The next sub-section deals with the technology classroom practice through the integration of IKS.

6.5.6 Technology classroom practice through the integration of IKS: 5Cs-IKS-1C

The subsection focuses the discussion on a framework that can guide Senior Phase Technology teachers towards the effective integration of IKS in the creative design process. This subsection is the culmination of the contribution of the study towards creating the teaching model of Technology Education classroom practice through the integration of IKS. The model in Figure 6.12 is categorised into four elements, i.e., 1) content knowledge and contexts, 2) curriculum support, curriculum materials and community of practice, 3) IKS integration, and 4) classroom practice, which culminate to 5Cs-IKS -1C. In Element 1, Technology teachers as experts are expected to be well grounded in the content knowledge domain with a clear understanding of the subject matter (concepts, facts, and procedures), and strategic knowledge that involves techniques and approaches as well as having the ability to control the various learning strategies that also involve integrating IK (Collins et al. 1991; Tariq et al. 2021). The context refers to the socio-cultural and physical contexts which can be defined in the local knowledge. The literature reveals that learning is the situated practice in which cognition and social interaction are connected (Lave and Wenger 19191). The literature further argues that context is vital for understanding, learning and practice of knowledge (Handley et al. 2006: 643). Hence, the content knowledge and skills of the creative design process in Systems and Control content should be organised in an authentic context where it is defined by socio-cultural and physical contexts, i.e., learners' indigenous background and classroom environment. Furthermore, learning that is embedded in the social, cultural and physical contexts is more effective than non-situational learning (Arnseth 2008; Pengiran & Besar 2018; Cakmakci et al. 2020).

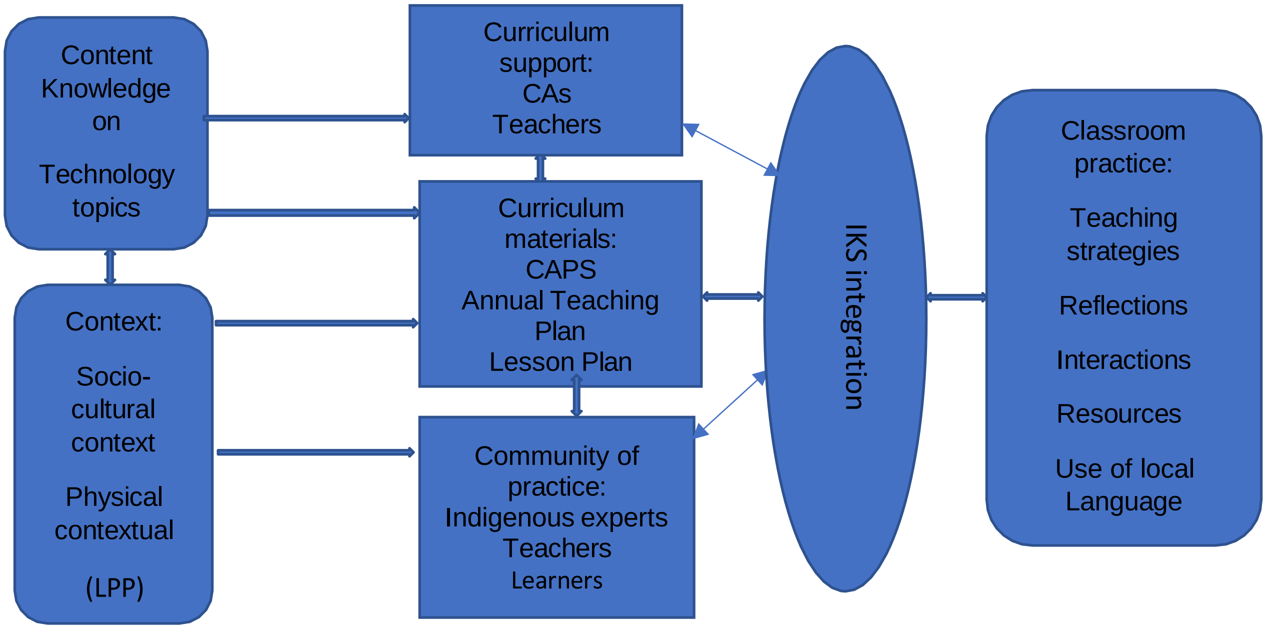


Figure 6.12: A model for the integration of IKS in Technology

The elements of content knowledge and context feed into Element 2 of the curriculum support, curriculum materials and CoP. These three elements are interlinked being fed from Element 1. Regarding curriculum support, teachers, learners and curriculum specialists should work together to ensure that the curriculum aims and goals are achieved through proper monitoring and support mechanisms are put in place. Teachers' competence should be displayed in the interpretation of the curriculum and teaching of the learners. An understanding of the curriculum content could assist in the understanding of the curriculum materials. The teachers and curriculum specialists would be able to adapt the curriculum materials such as textbooks, ATP, lesson plans and learners' tasks (formal and informal) to suit the contextualised and indiginised classroom. The contextualisation and indigenisation of the curriculum materials need expertise where CoP between the local indigenous experts, teachers and curriculum specialists could be formed to create the glossary of terms in Technology that will assist towards contextualisation of the curriculum materials that learners and teachers will resonate with.

In Element 3, the literature suggests that learning should be perceived and viewed as an ongoing and evolving creation of identity with social practices, hence, it should happen in a social context (Henning 2004; Cakmakci et.al. 2020). The contextualised content knowledge, with proper curriculum support and refined curriculum materials with the assistance of the experts to accommodate learners' local experiences, could lead to the integration of IKS in the Technology subject. In Element 4, the integration of IKS would lead to a proper classroom practice where teaching and learning become meaningful towards promoting the spirit of *Botho/Ubuntu* to build social cohesion amongst the learners and teachers. The teacher would need to adjust the teaching strategies to suit the integration of IKS during classroom practice. Learners would be able to learn through interaction and reflecting about their learning also using the language they understand better to narrate their experiences.

This model would be able to enhance Technology teachers' effective integration of IKS of the creative design process in systems and control activities during their teaching and learning process. Therefore, the content knowledge, context, curriculum support, curriculum materials, and CoP can lead to the integration of IKS towards transforming the classroom practice (5Cs-IKS-1C).

6.6 Conclusion

This chapter focused on the document analysis and the observations and findings that were synthesised. The findings on documents analyses revealed that in the four groupings of the source documents analysed, there was no integration of IKS, but only content knowledge coverage on Mechanical and Electrical Systems and Control, not even on the scenarios given to learners as tasks. Observation revealed that some teachers do the integration of IKS on an individual basis where some do not integrate. The cited reasons amongst others were lack of support and framework to guide them to do so. The synthesis of the interviews, document analysis and observation when triangulated revealed that there is no systematic way to determine whether the integration of IKS happens in creative design process activities when teaching systems and control topics/content. It was in rare cases where you could find the synergy between the three data sources, mostly when they dealt with aspects that are prescribed in an ATP. That is where it was found that IKS in general, is not integrated as confirmed across the participants. In the discussion section of the findings, the discussions were categorised into five themes i.e., Technology teacher's understanding of IKS, opportunities that the third IKS-inspired specific aim presents, Technology teachers' attempt to integrate IKS, learners' grasp of the integration of IKS, kind of support subject specialists give to teachers. Thus, the discussion section culminated in a model for Technology Education Classroom practice through the integration of IKS that identifies content knowledge, context, curriculum support, curriculum materials, and community of practice as leading to the **i**ntegration of IKS that transforms the **c**lassroom practice.

CHAPTER 7

SUMMARY, LIMITATIONS, RECOMMENDATIONS AND CONCLUSIONS

7.1 Introduction

The preceding chapter discussed the findings of the study which reflected on how Senior Phase Technology teachers integrate IKS in creative design activities when teaching the Systems and Control content. This chapter is the culmination of the study. It also presents the conclusions drawn from the study's findings, the implication to the classroom practice, the recommendations for Technology teachers, policy makers and implementers emanating from the findings and suggestions for further research.

7.2 Summary of findings

The study embarked on a case study design to establish how Senior Phase Technology teachers integrate IKS in creative design activities when teaching Systems and Control content in the Nkangala and Ehlanzeni districts of the Mpumalanga Province, South Africa. The summary of Chapters 1-6 on the issues raised in the study in line with the objectives are outlined as follows:

In introductory Chapter 1, the study provided the context of the research problem which enabled the stating of the research questions and the rationale of the study. Two of the five general aims of the National Curriculum Statement (NCS) by the South African Department of Basic Education are identified as the kind of knowledge, skills and values, and underpinning principles. The underpinning principles comprise social transformation, active and critical learning, high knowledge and high skills, progression, human rights, inclusivity, environment as social justice, valuing indigenous knowledge systems, credibility, quality and efficiency. The gap that exists is the realisation of knowledge, skills, and values concerning the underpinning principle of valuing indigenous knowledge systems (IKS). Hence, concepts associated with the study's aim were clearly defined. The knowledge, skills and values are defined by the specific aims of the Curriculum and

Assessment Policy Statement (CAPS), and the valuing of IKS can be located in the third specific aim which entails technology, society and environment which is outlined through the three aspects of indigenous technology, the impact of technology and the bias in technology. The principle of valuing IKS assisted in the investigation of the integration of indigenous knowledge in the creative design process and the understanding of the technological content of Systems and Control. This came against the backdrop that Technology Education, in general, "suffers" from a Western conceptualisation. Hence, the study was motivated by the researcher to establish the integration of IKS in creative design process activities in Systems and Control content by Senior Phase Technology teachers from two districts of Mpumalanga Province.

In Chapter 2, the theory of the situated learning theoretical (SLT) framework by Lave and Wenger (1998) and its augmenting theories were discussed and motivated. This summary of the chapter captures the key things which were addressed in the chapter. SLT values that the situated learning environment, knowledge and skills are attached to the context of real life. The theory is founded on situated cognition and situated learning. Hence, SLT can create a good opportunity for the recognition of the integration of IKS during the teaching of creative design process activities in Systems and Control in the Technology classroom for meaningful learning. The literature suggests that learning should be perceived and viewed as an ongoing and evolving creation of identity with social practices and should happen in a social context (Henning 2004:143, Cakmakci et.al. 2020). Consequently, learning that is embedded in the social, cultural and physical contexts is more effective than non-situational learning. The context of the present study is the classroom practice as conceptualised in the community of practice.

Practice is a way of gaining experience through meaningful structured situations that are crucial for real-life context (Lave & Wenger 1991). Social and cultural practices contribute towards the theoretical accounts of classical topics such as the creative design process in Systems and Control, which has to do with mind, rationality, and knowledge and emphasise how social order could be produced and reproduced in a real context. Hence, the community, culture, and school cannot be separated from teaching creative design activities in the Technology classroom. Thus, the engagement of IKS in creative design activities when teaching Systems and Control was critical in this instance (Kupe 2020). The implication of SLT in the study and the model of situated learning or cognition is grounded in the view that knowledge is contextually situated and is fundamentally influenced by the activity, context and culture in which is used. SLT embraces learning as a social activity that happens in the social context and the classroom environment that embraces social, cultural and physical contexts (Cakmakci et al. 2020). SLT is a well-grounded and well-researched theory with established models that represent it in various research contexts, namely, the legitimate peripheral participation (LPP), the community of practice (CoP) and the cognitive apprenticeship (CA).

From the perspective of LPP in the Technology classroom, learning is viewed as a social process where novices gained skills and knowledge through participation within a community of practitioners and eventually more towards full participation in the socio-cultural practices when dealing with creative design process activities in Systems and Control in the Technology classroom. The teacher as an expert becomes a full participant towards integrating IKS in teaching creative design processes in Systems and Control than the learners. The application of LPP in this study is represented in two scenarios, which are that the Technology teacher is regarded as an expert and learners as novices who are the LPPs, and the curriculum specialists are regarded as the experts and the novice teachers are regarded as the LLPs. The integration of IKS can provide an authentic learning environment that can promote the development of critical and analytical skills in learners and novice teachers through LPPs as IKS forms part of people's social, economic scientific and technological identity. Hence, Technology teachers' and curriculum specialists' understanding of IKS for the creative design process in Systems and Control was critical at this stage.

The SLT defines learning as the process that happens because of participating actively in a CoP (Lave & Wenger 1991; Herrera 2020). CoPs are defined as shared activities and identities, not as physical boundaries of the community. Hence, these shared activities could assist the present study to establish the attempts teachers make to integrate IKS in the creative design process activities in Systems and Control content. CoPs are a complete community that is composed of and dependent on both novices and experts.

Hence, the interaction between the novices and experts is common and informal with members usually co-located either in the classroom (learners and teachers) or educational cluster structure (teachers and curriculum specialists).

The present study recognises novices as learners and new teachers in the field of Technology Education teaching creative design processes in Senior Phase classrooms on the Systems and Control content. The expert is an experienced teacher who has been teaching creative design processes in the topic of Systems and Control in the Senior phase Technology Education classroom as well as the Curriculum specialists in Technology subject. The learners and or new teachers (novices) are peripheral members of the group in the sense that they yet require to learn or to teach the required skills towards integrating IKS in creative design activities in the Systems and Control activities to be fully functional members at the same time, playing an important role in the way groups work. It is within the integrated context where everyone learns, where knowledge and skills are shared, and where both novices and experts contribute. Hence, learners should learn through collaboration, in groups, observing existing practices, supporting expert teachers, taking basic tasks and gradually assuming responsibility for their learning in the creative design process in Systems and Control.

The development of cognitive concepts becomes handy in the learning contexts that recognise social and cultural factors towards promoting the spirit of *Botho/Ubuntu* in the CoP through collaboration amongst members. *Botho* is the African philosophical notion that values the Botho/Ubuntu principles towards emphasising interdependency and forming relations amongst novices and experts (Mavuru & Ramnarain 2017). The *Botho* philosophy embraces SLT, CoP and social constructivism when it comes to knowledge construction. Knowledge is socially constructed through personal experiences and collaboration in a socio-cultural context, where participants support and encourage one another throughout the learning process. Therefore, there is a need for *Botho*-oriented approaches and strategies towards facilitating teaching and learning to resonate with the socio-cultural contexts in the SLT, which is appropriate to CoP. In cognitive apprenticeship (CA), learning is a vital construct towards cognition and social growth in children but also reflects SLT. The chapter also explored that cognition is fundamentally a social activity and is distributed across members of a learning community and that knowledge is situated in the contexts, cultures and activities in which is produced and used.

The utilisation of the CA structure in teaching and learning brings special unique benefits for both teachers and learners. CA focuses on enculturing learners into adapting the cognitive process and skills of those who are LPP of a community through different methods. In the study, CA is used within the context of social interaction to give an analysis of the case study data that sought to explore how Senior Phase Technology teachers integrate IKS in the creative design process activities in Systems and Control content in the Technology classroom. The CA model also contributes towards exploring the opportunities IKS presents with regard to the teaching of the creative design process in Systems and Control in Technology. This is in line with the basic underlying principle that all knowledge, including IKS, scientific and technological knowledge is originally grounded in personal encounters with concrete situations (Korthagen 2010:103). Consequently, the learning environment should be designed to make targeted cognitive processes explicit and visible so that learners can observe, enact and practice in contexts that make sense to them and can also enhance their domain-specific as well as domain-general knowledge and skills. The knowledge in this study has its roots in practical situations such as creative design process skills in Systems and control and socially constructed that brings in the IKS aspects.

The CA builds onto four fundamental dimensions and a pedagogical frame with six processes to promote teaching learning in the creative design process. The four fundamental dimensions are identified as content, method, sequencing and sociology; and the six pedagogical processes include modelling, coaching, scaffolding, articulation, reflection and exploration (Collins et al. 1991). Therefore, there is a need for group or peer support amongst the teachers and learners learning in the Technology classroom regarding integrating the IKS with creative design process activities in Systems and Control. Hence, a framework was developed in Chapter 6 to assist the rethinking of an approach toward teaching the design process stages in Systems and Control in situated learning which would be possible based on the current case study. This contributes to teachers' teaching creative design activities in Systems and Control at a concrete level but also contributes towards a theoretical foundation for the realistic Technology classroom practice which could build on the integration of IKS.

Chapter 3 presented the relevant literature on the investigated phenomenon. The reviewed literature was generated on a conceptual basis. Technology's underpinning principles of technology, knowledge and philosophy set a clear context for the grounding of the present study. The broader clarification of these concepts in the literature bears a narrow and broad meaning from different contexts, cultures and sectors (Zuga 1997; Mapotse 2015; La Shun 2017; Gumbo 2018), which in turn results in clarifying the misconceptions about the current discourse. The literature also highlighted the principles of the design process, problem solving and creativity in Systems and Control in which the concept design is associated with a process and a product (Lawson 2005; Wong & Siu 2012; De Vries 2017). The literature further described the design process as a referent social practice that values the act of designing and the contingent activity of creative thinking (Middleton 2009; Marzin & De Vries 2013; Kwaira & Gumbo (2017). The process of creative thinking should culminate in the activities in the Technology classroom. Technology as a subject is the product of the curriculum reform process in South Africa in the sense that its curriculum was in the best space to transform towards the re-aligning of its relevancy based on its philosophical grounds to be inclusive to meet the needs of society more especially the indigenous societies.

The literature revealed that the Technology curriculum is structured in three aspects of skills, knowledge and, values and attitudes which create a window of opportunity for the integration of IK in teaching and learning activities in Systems and Control. The literature review further asserted the need for learners to cultivate cultural values through contextual learning even in Systems and Control, as technology is a human activity that engages knowledge and cultural resources to meet human needs. This assertion resonates well with the SLT and its augmented theories in Chapter 2. The literature further revealed that teachers do face challenges as they are supposed to be instrumental in integrating IKS within the creative design activities in Systems and Control. The literature review lined up some challenges that might contribute to teachers' hesitancy towards integrating IKS in creative design activities as teachers are trained in a curriculum that is Western-oriented, and the absence of practical examples of the activities that integrate IKS through engaging varying strategies involving various epistemologies (Vamanu 2014; Jacobs 2015). Some of the challenges were confirmed by the findings of the study as discussed in Chapters 5 and 6. Therefore, a need from the literature arose for the framework that could bridge some of these challenges to enable the Senior Phase Technology teachers to find it easier to teach creative design processes in Systems and within a context that resonates well with learners. Hence, the contribution of the study in Chapter 6, Subsection 6.5.6 is presented.

Chapter 4 presented a detailed qualitative enquiry and outlined the strategies that were used for case study design involving multiple cases (Zainal 2007; Baxter & Jack 2008; Yin 2009; Creswell & Creswell 2018; Kumatongo & Muzata 2021). In the chapter, the research approach and paradigms with their philosophical assumptions were discussed and justified. The study is embedded within an interpretive paradigm (as a major) and postcolonial indigenous paradigm (as a supporting paradigm) as it sought to uncover the way participants define and understand their situation, i.e., in the current inquiry, the meaning of the lived experiences of the Senior Phase Technology teachers, learners and Curriculum Specialists (Creswell 2008; Henning et al., 2010; Chilisa 2019). The research design, sampling strategies, data collection methods which include the interviews; observations, and document analysis methods that were used to collect data were discussed.

The data analysis strategies for the collected data were discussed. The strategies for the trustworthiness of the study that involve credibility, transferability, dependability and confirmability were considered in the study to address the issues of reliability and validity of the study findings on how Senior Phase Technology teachers integrate creativity and design activities of Systems and Control in the classroom during their teaching and learning (Miles & Huberman 1994; White & Marsh 2006; Bertram & Christiansen; 2020; Campbell et.al. 2020). The ethical issues were also outlined and discussed to protect the integrity of the participants and the institutions involved in the study. Subsequently, data was collected, captured, analysed, interpreted and discussed as in Chapters 5 and 6 from semi-structured interview transcripts, document analysis schedules and observation schedules.

Chapter 5 presented data and analyses of findings in line with the aim of the study which was to establish how Senior Phase Technology teachers integrate IKS in the creative design process activities when teaching Systems and Control content/topics in the classroom. The chapter reported on the semi-structured interview data that involved teachers, curriculum advisors, and learners. For these three groups of participants, the interview data findings were ventilated through the themes. Document analysis and observations were discussed in Chapter 6. Some of the findings were that participants generally regarded the concept of IKS as knowledge used in the olden days, a view that poses a challenge about downplaying IKS as it limits the view of its existence currently. Furthermore, the CAPS lacks sufficient guidelines on the integration of IKS in Technology. As much as CAPS is a policy that pronounces the importance of integrating IKS, there were mixed views on the interpretation and alignment of the content with IKS as required by the same policy. However, there was consensus across the districts and participants about the general understanding of the concept of IKS in the context of Technology subject, that it can enhance the learning of the content if it is only based on the contribution of the local community.

The annual teaching plan featured a lot during the interviews on time allocation and content coverage. However, both novice and experienced participants across districts affirmed that they do create space for learners to express their understanding of the concepts in Systems and Control in the language learners are comfortable or familiar with despite the ATP requirements. The participants across the districts and in both the experienced and novice categories viewed discussion, question-and-answer as well as the use of pictures as the teaching strategies they apply in their classrooms. However, not all the teaching strategies discussed support the integration of IKS. Participants applied different approaches to create opportunities to enable learners to bring in local knowledge for meaningful learning. On the reflection of learning in relation to IKS in Systems and Control, the findings revealed that participants had diverse views on the reflection of learning. Some participants indicated that they do create time for reflections on learning and some do not create time for reflections. Participants who did create time for reflection were able to give learners the freedom to reflect by allowing learners to narrate their experiences with the integration of IKS informally. Participants who did not create time to reflect on the integration of IKS cited that there was neither provision on the ATP nor time created for such an exercise to happen in class.

The challenges that participants experienced in integrating IKS when formulating the activities range from teaching in a multicultural classroom where there is a need to strike a balance between cultures, integrating IKS in the activities, and the time factor. The challenges prompted a need for the role of IKS experts in the integration of IKS. The findings revealed that participants across districts and categories agreed on the role that indigenous knowledge experts could play in helping towards the integration of IKS into Systems and Control content. The move was seen as the one that would advance the sharing of knowledge and experience amongst the experts, teacher participants, and learners. Finally, the findings in this study have shown that there are gaps in the coverage of the Technology subject content in relation to the integration of IKS across districts, participants (teachers, curriculum advisors and learners), as well as experienced and novice categories across the board.

As stated above, Chapter 6 focused on the document analysis and the observation findings that were synthesised. The major findings on documents analysis revealed that in the five groupings of the source documents analysed, there was no integration of IKS only content knowledge coverage on Mechanical and Electrical Systems and Control, not even on the scenarios given to learners as tasks. The observation data revealed that some teachers did the integration of IKS on an individual basis whereas some did not integrate it. The cited reasons, amongst others, were lack of support and framework to guide them to do so. The synthesis of the interviews, document analysis and observation, when triangulated, revealed that there is no systematic way to determine whether the integration of IKS happens in creative design process activities when teaching Systems and Control topics/content. It was in rare cases where a synergy between the three data sources was found, mostly when they dealt with aspects that are prescribed in an ATP.

That is where it was found that IKS in general is not entertained as confirmed by the participants.

The discussion of the findings was categorised into five themes, i.e., Technology teacher's understanding of IKS, opportunities that the third IKS-inspired specific aim presents, Technology teachers' attempt to integrate IKS, learners' grasp of the integration of IKS, kind of support subject specialists give to teachers. The discussion section culminated in a model for Technology Education Classroom practice through the integration of IKS that identifies content knowledge, context, curriculum support, curriculum materials, CoP as it leads to the integration of IKS that transforms the classroom practice. This is the contribution of the study.

Chapter 7 presented the summary, limitations, recommendations and conclusions of the study as outlined in this chapter.

7.3 Realisation of the research objectives

This section summarises the realisation of the research objectives. The study aimed to establish how Senior Phase Technology teachers can integrate IKS into the creative design process activities when teaching Systems and Control content in the classroom.

The study's specific objectives were to:

a) establish the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs as contained in the third specific aim of CAPS. This objective is aligned with the theme of Technology teachers' understanding of IKS and linked with the first research question. The empirical evidence drawn from the interviews, the document analysis and the observations, presented findings that led to the conclusions of the study. The general understanding of IKS across the districts and categories of teachers (novice and experienced) and learners was that it is viewed as the past knowledge or knowledge that was applied only in the olden days, a view that poses a challenge about downplaying IKS which limits the view of its existence currently. The research question is answered in Subsection 6.5.1 and Section 7.3.1 therefore the objective was achieved.

b) identify the opportunities that the third IKS-inspired specific aim presents to the Senior Phase with regard to the teaching of creative designs. This objective is aligned with the theme of the opportunities that the third IKS-inspired specific aim and linked with the second research question. The findings revealed that in both categories and across the two districts, some participants were able to locate aspects that relate to IKS in the Specific Aim 3 of Technology which is believed to be the base that sets the context to create opportunities for IKS' recognition in the teaching and learning of Technology. The IKS-inspired Specific Aim 3 opens the opportunity to support teachers planning for teaching in the context of their classrooms. On the opportunities that IKS presents for the teaching of the Systems and Control topics or content, the data revealed that different categories across the two districts had different views. The research question is answered in Subsection 6.5.2 and Section 7.3.2. Therefore, the objective was achieved.

c) explain how Senior Phase Technology teachers, attempt to integrate IKS in the creative design process. This objective is aligned with the theme of Technology teachers' attempt to integrate IKS and linked with the third research question. In the case of engaging IKS when designing and developing planning for activities in Systems and Control, the data revealed teacher participants did engage with the aspects of IKS in their activities, however, the annual teaching plan (ATP) becomes a constraint as they are expected to do as prescribed. The findings also show that there is no indication that teachers could find indigenous resources that will support them to integrate creative design processes in teaching the content in Systems and Control. The resources prescribed by the ATP are the only utilised resources in Technology classrooms. Moreover, in all the five groups of documents analysed, none was found to directly promote the integration of IKS. The research question is answered in Subsection 6.5.3 and Section 7.3.3. Therefore, the objective was achieved.

d) establish how Senior Phase learners, receive the integration of IKS in the creative design process when learning Systems and Control. This objective is aligned with the theme of learners' grasp of the integration of IKS and linked with the fourth research question. The findings suggested that the use of IKS/local knowledge would assist learners to understand the content much better and it would make sense for them to do well in the design process activities that involve Systems and Control activities. The findings further suggest that teachers should encourage learners to mention their own examples that exist in their locality, for example, the types of gears or systems they know to choose the one that they prefer to make a design. The research question is answered in Subsection 6.5.4 and Section 7.3.4. Therefore, the objective was achieved.

e) determine the kind of support subject specialists for Technology give to teachers towards the integration of IKS in creative design process activities in Systems and Control. This objective is aligned with the theme the kind of support subject specialists give to teachers and is linked with the fifth research question. The findings revealed that teachers were left on their own to decide on the issues of IKS integration. Furthermore, the findings revealed that there was no provision in their scheduled plan for the year to integrate IKS except encourage teachers to follow the ATP-prescribed content. This was evident in the documents analysed for Grade 9 ATP. Hence, there was no concerted commitment to integrate it practically. The research question is answered in Subsection 6.5.5 and Section 7.3.5. Therefore, the objective was achieved.

f) design a framework that can guide Senior Phase Technology teachers towards the effective integration of IKS in the creative design process. This objective is aligned with the theme of the framework for the effective integration of IKS and linked with the sixth research question. The contribution to the study culminated in the framework for Technology Education Classroom practice through the integration of IKS that identifies **c**ontent knowledge, **c**ontext, **c**urriculum support, **c**urriculum materials, and **c**ommunity of practice as lead to the integration of IKS that can transform the **c**lassroom practice (5Cs-IKS-1C) (Subsection 6.5.6). The research question is answered in Subsection 6.5.6 and Section 7.3.6. The study contributed a framework in 6.5.6. Therefore, the objective was achieved.

In a nutshell, the study mainly sought to answer the research questions to achieve the objectives. Therefore, the achievement of the objectives means that the study managed to establish how Senior Phase Technology teachers can integrate IKS in the creative design process activities in the classroom when teaching the Systems and Control content area.

7.4 Limitations of the Study

During the study some limitations were identified which might provide opportunities for future research. The study was limited to a qualitative research approach. However, the qualitative data was useful to establish how Senior Phase Technology teachers integrate IKS in the creative design process activities in the classroom when teaching the Systems and Control content. The subjectivity in the qualitative enquiry helped the researcher to gain an in-depth understanding of the cases in their natural context (Simons, 2009). The researcher used subjective interpretation of the qualitative data to gain an understanding on how Senior Phase Technology teachers can integrate IKS in the creative design process activities in the classroom when teaching the Systems and Control content. In hindsight, the inclusion of local indigenous experts could have been considered in the study. Furthermore, the findings could have been tested on a larger scale, i.e., beyond two cases.

The study was limited to a case study design. This study engaged multiple-case studies which after comparing the cases accorded an opportunity to generalise the findings within the sampled cases. The study involved two cases (D1 & D2) that comprise nine participants each, i.e., six teachers, one curriculum advisor, and two learners per case. The teacher participants were classified into two categories, three novice and three experienced Senior phase Technology teachers respectively per case. The two cases were studied in-depth to establish how Senior Phase Technology teachers can integrate IKS in the creative design process activities in the classroom when teaching the Systems and Control content. However, while everything possible was done to understand the case in question, the researcher may not rule out the possibility of the challenges and limitations of a case study such as small sample size, subjectivity, and findings not generalised (Yin 2009).

Semi-structured interviews, observations and document analysis were three data collection instruments used. These instruments accorded the researcher to present the rich data and the discussion of findings in Chapters 5 and 6. The researcher admits that administering these instruments and collating data was not easy due to the challenges that the case study presented. Another aspect is that data was collected during the time of Covid-19 restrictions. Some teaching strategies like collaborative learning, and group discussions were restricted; only demonstrations and teacher-centred approaches were promoted. Hence, the realisation of CoP in the classroom was minimal. The restrictions also limited the observations done on teachers and how novice and experienced teachers interacted with one another in their classroom and cluster meetings. Consequently, observations were left for volunteers, hence six teachers from the experienced category volunteered to be observed teaching in class. The observation of more lessons that include all categories covering novices may have revealed varieties of teaching approaches used by participant teachers and provided more information about the trends in the classroom. The study was limited to samples of only the five clustered documents.

7.5 Recommendations

The recommendations emanating from the study are outlined in three groups, namely policy, practices, and further research.

7.5.1 Policymakers and Implementers

The integration of IKS in creative design process activities in systems and Control content could be realised if the Mpumalanga Department of Basic Education can provide the following support:

- Create environments that are inclusive of all stakeholders when developing the teaching and learning materials that are supportive of the integration of local knowledge. This would help to address the issues of the socio-cultural and physical contexts where teaching and learning are taking place. Mpumalanga, especially by its rurality, is a host to the richness of indigenous knowledge that can enable this.

- Develop training materials that are supportive of African paradigms instead of focusing on the Western paradigms only. Teachers should be reskilled to enable them to engage with such paradigms in the case the material is more Westernised to strike the balance in their classroom practice. Teacher's development workshops should not underplay training in this aspect.
- The CAPS document should be interpreted in a manner that the curriculum principles are realised during its implementation. The correct interpretation of the CAPS document would assist teachers to value IKS when planning activities for teaching.
- ATP and the associated assessment tasks should be developed in a manner that gives the teacher flexibility to adapt it to suit their learners' contexts to promote local knowledge.
- Curriculum advisors, in their quest to do lesson studies, should consider providing a clear understanding of IKS by engaging with indigenous experts to assist teachers with the development of a glossary of concepts based on the theme for that particular term. This would enhance the easy integration of local knowledge during lesson planning.
- Curriculum advisors may demonstrate to Technology teachers how to reflect on the indigenous aspects of the planned activities during teaching.
- As much as decolonisation of the curriculum pushes the transformation agenda in the education sector, the Department of Basic Education in Mpumalanga should cater for the monitoring tool to evaluate the teaching and learning materials to make sure compliance with the recognition of local knowledge is realised. The 5Cs-IKS-1C framework suggested in this study could be a useful tool for developing such a monitoring tool.

7.5.2 Technology teachers

- Teachers should have a sound knowledge of the content in line with CAPS towards valuing the principles that are underpinning the curriculum in order to understand how the document value the integration of IKS in teaching Systems and Control content.

- Teachers should engage with local indigenous experts when developing some of the lesson plans, and problem-solving activities to promote the integration of local knowledge.
- Teachers should allow learners to use their indigenous languages to narrate or reflect on their learning. Learners' indigenous knowledge should always be respected when learning takes place in the Technology classroom.
- Teachers should improve their knowledge of the current issues by furthering their studies to improve their teaching practice approaches.
- Teachers should create an environment in their teaching that promotes conducive socio-cultural and physical contexts; this would lead to valuing the learners' culture which makes the learning meaningful.

7.5.3 Further research

Based on the study's findings, the following additional research is suggested:

- A similar study on a bigger scale could be explored that would involve more districts and or provinces using mixed methods.
- A study that merges the relationship between Western and indigenous paradigms in Technology to promote IKS.
- A study that engages local knowledge experts, education experts, academia, teachers, and learners on the role of IKS in 21st-century learning.
- A study to explore the role of the higher education sector in promoting awareness of the integration of IKS to transform school subject content.

7.6 Conclusion

This chapter summarises the conclusions stemming from the findings and recommendations. The study established that much needs to be done to guide the integration of IKS in creative design activities that involve Systems and Control. There is also a need for the Department of Basic Education in the two districts of Mpumalanga

Province to provide systematic support and skill teachers towards the integration of IKS in creative design process activities that involve the Systems and Control content area. The chapter also identifies issues such as content knowledge, context, curriculum support, curriculum materials, formation of a community of practice, IKS and classroom practice as key to the realisation of the integration of IKS in Technology (contribution of the study). These issues would assist to address the socio-cultural context, and physical context as learning is situated in the classroom. Teachers' sound content knowledge could play an important part as is the driver towards understanding the context in which content needs to be delivered. The correct interpretation of the CAPS document could assist teachers to lay a good ground for realising the underpinning principle of valuing indigenous knowledge in the teaching Systems and Control content area. The ATP assessment tasks need to be adjusted to cater for the integration of local knowledge. Curriculum advisors should strive to build a CoP where teachers of all categories and indigenous experts would share their expertise on the issues of IKS integration and develop a glossary of terms. The chapter concludes by highlighting the prospects for further research emanating from the study.

It is hoped that the recommendations made and the suggested framework contributed by the study will bridge the gap towards the integration of IKS in Technology, not only in the Systems and Control content area but in other content areas as well.

REFLECTION ON THE RESEARCH JOURNEY

The purpose of this section is to reflect on my experiences, learning and personal development during the research project. My reflection on this study is based on the title: "Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control." The CAPS is informed by the human rights principles on one hand, and the dominant Western knowledge systems that front the development of Technology and Technology Education curriculum. This project was motivated by the gap that exists in the realisation of knowledge, skills, and values in relation to the underpinning principle of valuing indigenous knowledge systems (IKS). The principle of valuing indigenous knowledge systems in CAPS was traced through the aspect of indigenous technology in technology society and environment strand that plays a pivotal role in this study. This case study established how Senior Phase Technology teachers integrate IKS in the creative design process activities when teaching Systems and Control content in the classroom. Hence the research project was meant to achieve the following research objectives which led to the research questions of the study.

The objectives of the study were to:

- Establish the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs as contained in the third specific aim of CAPS?
- Identify the opportunities that the third IKS-inspired specific aim presents to the Senior Phase with regards to the teaching of the creative designs.
- Explain how Senior Phase Technology teachers, attempt to integrate IKS in the creative design process.
- Establish how Senior Phase learners, receive the integration of IKS in the creative design process when learning Systems and Control.
- Determine the kind of support subject specialists for Technology Education, give to teachers towards the integration of IKS in creative design process activities in Systems and Control.
- Design a framework that can guide Senior Phase Technology teachers towards the effective integration of IKS in the creative design process.

Research questions:

- What is the Senior Phase Technology teachers' understanding of IKS with respect to the creative designs contained in the third specific aim of CAPS?
- What opportunities does this third IKS-inspired specific aim present to the Senior Phase Technology teachers with regard to the teaching of creative designs?
- How do Senior Phase Technology teachers attempt to integrate IKS into the creative design process?
- How do Senior Phase learners receive the integration of IKS in the creative design process when learning Systems and Control?
- What support do subject specialists for Technology Education give to teachers towards the integration of IKS in creative design process activities in Systems and Control?
- How can the teaching of Technology be framed such that it guides Senior Phase Technology teachers' effective integration of IKS in the creative design process?

The research process in this study started by identifying the problem and formulating the study objectives and research questions after a literature review search which was followed by identifying the suitable theoretical framework to ground the study. This process of in depth-literature study helped me to sharpen my research skills and gained insights into the importance of issues that covered teachers' understanding of indigenous knowledge and how they integrate it into creative design activities in systems and control topics. This helped me to broaden my research interest in IKS, and also appreciate the pleasure and challenges of undertaking a project of such a magnitude. The challenges were both personal health and during data collection and analysis. This happened as I was interacting with the participants across the two districts that involved learners, teachers, and curriculum advisors. The cooperation that I received starting from the provincial research unit, schools, and districts was a humbling experience.

I also gained some insight into the day-to-day issues affecting teachers and learners, their resilience, and their commitment to the teaching and learning of Technology subject. On the other hand, I found it fulfilling that at the end of the data collection process, some participants acknowledged that they had benefited from participating in this project as they found it helpful to reflect on their teaching practice in the classroom. Consequently, the outcomes of the study yielded positive results. Even though some teachers are trying to teach the Technology content in context, we now know from the findings of the study that in both districts, teachers struggle to integrate IKS. Some of the contributing factors to this are the prescribed materials and the annual teaching plan with strict timeframes that teachers use to teach the content. This set of teaching and learning materials does not promote the integration of IKS; there is also a lack of support from the curriculum support services on the integration of IKS. Therefore, this study's findings contribute to the knowledge and debate to transform classroom practice through the integration of IKS in the teaching and learning process.

The supervision of the project was of an exceptional standard as both Prof MT Gumbo and Prof TA Mapotse were thorough in their supervision, which helped me to understand how such studies should be conducted to an acceptable level. Feedback was given regularly. They were hands-on up to the last day of submitting the thesis for examination. Prof Gumbo also helped to outsource funding to fund the activities of the study. The supervisors' advice in starting with the draft chapters made things easier to develop data collection instruments and to apply for ethical clearance which helped me to focus on the identified problem. It was easy to integrate the findings into different chapters and beef them up with the supporting literature.

In conclusion, my PhD study journey was worthwhile to undertake.

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APPENDICES

APPENDICES A: LETTERS

APPENDIX 1: ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2022/02/09

Ref: **2022/03/09/55763812/12/AM**
Name: Mr EC Ndlovu
Student No.: 55763812

Dear Mr EC Ndlovu

Decision: Ethics Approval from 2022/03/09 to 2027/03/09

Researcher(s): Name: Mr EC Ndlovu
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Telephone: 0791963866

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

Name: Prof TA Mapotse
E-mail address: mapotta@unisa.ac.za
Telephone: --

Title of research:

Senior Phase Technology teachers' integration of indigenous creative design processes in systems and control

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 2022/03/09 to 2027/03/09.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2022/03/09 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.
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 **2027/03/09**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2022/03/09/55763812/12/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

Approved - decision template – updated 16 Feb 2017

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa

APPENDIX 2: LETTER OF REQUEST TO CONDUCT RESEARCH

Mr EC Ndlovu
University of South Africa
1 Preller Street
7-39 NSR Building
Muckleneuk
0002
Email: ndlovec@unisa.ac.za
Cell:0791963866

Date: 11/03/2022
The Head of Department
Mrs. LH Moyane
Mpumalanga Department of Basic Education
Attention Research and Development Unit
Private Bag x 11341
Mbombela
1200
Tel: 0137665114/5
email address: d.mtembu@mpuedu.gov.za

Dear Sir/Madam

Re: Request for Permission to Conduct Research at Ehlanzeni and Enkangala Education Districts

Title of the research study: Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control

I, Elliot Charles Ndlovu, am doing research towards a PhD in Education under the supervision of Professor MT Gumbo, a Research Professor, and Professor TA Mapotse, an Associate Professor, who are attached to the Department of Science and Technology Education at the University of South Africa.

The aim of the study is to establish how Senior Phase Technology teachers can integrate indigenous knowledge systems (IKS) in the creative design process activities when dealing with Systems and Control content in the classroom.

Twelve (12) Senior Phase Technology teachers, four (4) learners, and two (2) curriculum specialists, all from Ehlanzeni and Enkangala Education districts, will be selected to participate in this study. The reason for selecting the teachers, curriculum specialists, and learners from the two Education districts 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 of creative design in Systems and Control. The technology teachers in the two Education districts will demonstrate an understanding of cultural background and traditions related to IKS. The teachers have a variety of experiences that can contribute towards the rich and valuable information that will provide a deep insight into the understanding of how they can integrate IKS in the creative design process activities when teaching the Systems and Control section or content. On the other hand, the curriculum specialists from the two Education districts shall have worked with and supported teachers for a period of at least two years or more. The learners from the two districts should be familiar with the local socio-culture practices of their communities and are performing well in the Technology subject.

The participants will be briefed about the research objectives and processes. Teachers and curriculum specialists will be asked to complete the biographical information sheet at the beginning of the research to obtain. The interview process will start with focus groups that will comprise teachers and curriculum specialists in each of the two districts on two separate dates to be arranged. Teachers, curriculum specialists. The learners will be interviewed on a face-to-face basis depending on their consent and assent. Learners and teachers will be observed in class depending on the parents' and teachers' consent and learners' assent. If both teachers and parents consent and learners' assent, the lessons will be video recorded. Participation in this research by teachers and learners will be voluntary. In addition, all the participants will be allowed to withdraw their participation at any stage of the research process without being subjected to punitive actions.

The benefits of this study will be in the form of communication of the research findings to the schools and Mpumalanga Department of Basic Education.

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

Elliot Ndlovu
(Student - 55763812)

APPENDIX 3: PERMISSION GRANTED FROM MPUMALANGA DEPARTMENT OF BASIC EDUCATION

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Ikhaya Building, Government Boulevard, Riverside Park, Mpumalanga Province
Private Bag X11341, Mbombela, 1200.
Tel: 013 766 5552/5115, Toll Free Line: 0800 203 116

Litiko le Temfundvo, Umnyango we Fundo | Departement van Onderwys | Ndzawulo ya Dyondzo

Mr EC Ndlovu
UNISA
Cell: 079 196 3866
Email: ndlovuec@unisa.ac.za

RE: SENIOR PHASE TECHNOLOGY TEACHERS' INTERGRATED OF INDIGENOUS CREATIVE DESIGN PROCESS IN SYSTEMS AND CONTROL

Your application to conduct research study was received and is therefore acknowledged. The tittle of your research project reads: "**Senior phase technology teachers' Integrated of indigenous creative design process in systems and control".** I trust that the aims and the objectives of the study will benefit the whole department especially the beneficiaries. Your request is approved subject to you observing the provisions of the departmental research policy which is available in the department website. You are requested to adhere to your university's research ethics as spelt out in your research ethics.

In terms of the research policy, data or any research activity can be conducted after school hours as per appointment with affected participants and COVID -19 regulations to observed. You are also requested to share your findings with the relevant sections of the department so that we may consider implementing your findings if that will be in the best interest of the department. To this effect, your final approved research report (both soft and hard copy) should be submitted to the department so that your recommendations could be implemented. You may be required to prepare a presentation and present at the departments' annual research dialogue.

For more information kindly liaise with the department's research unit @ 013 766 5124/5148 0r n.madihlaba@mpuedu.gov.za

The department wishes you well in this important project and pledges to give you the necessary support you may need.

Moyane

MRS LH MOYANE
HEAD: EDUCATION

16 / 03 / 2022
DATE

MPUMALANGA

APPENDIX 4: LETTER OF CONSENT FOR TEACHER PARTICIPANTION

Date:

Dear Prospective Participant

I, Elliot Charles Ndlovu, am doing research towards a PhD in Education under the supervision of Professor MT Gumbo, a Research Professor, and Professor TA Mapotse, an Associate Professor, who are 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 Senior Phase Technology teachers can incorporate IKS in the creative design process activities when teaching Systems and Control content 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 Technology Education (TE) curriculum.

WHY AM I BEING INVITED TO PARTICIPATE?

We would like to invite you to participate in the study titled: Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control. 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 IKS in the creative design process activities when dealing with the Systems and Control section or content.

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 12 teachers from Ehlanzeni and Nkangala Education 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 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 focus groups, semi-structured interviews, observation, and document analysis. Regarding focus group and semi-structured interviews, you will be interviewed about:

- your understanding of IKS with respect to the creativity and design process contained in the third specific aim of CAPS.
- your understanding of the relationships between content and strategic knowledge that involve strategies to integrate IKS when teaching technology activities in Systems and Control.
- 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 creative design process in Systems and Control section.

You will be expected to dedicate 30-60 minutes of your time to face-to-face semi-structured interviews and at least 1 – 2 hours for focus group interviews. The face-to-face and focus group interviews will be run on separate dates.

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 design process and skills along with the elements of creativity and integration of IKS; 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, teacher's guide, and learner's guide; workshop/training materials and lesson plans.

You will be also requested to allow us to visit your classroom of which letters of consent will be sent to parents of the concerned Senior Phase class and learners will be requested to assent. We will also request you to assist us to identify learners who can participate in the interview depending on their assent and parent/guardian consent.

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 creative design process activities in the Systems and Control section/content area. 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 supervisors 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. The use of focus group interviews in this research will sometimes be impossible to make an absolute guarantee of confidentiality or anonymity as members in the group might know each other and where they teach. Focus group comprises of the selected individuals in an organised discussion in order to gain information about their views and experiences of a particular topic. Hence, it should be noted that, w*hile every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I* *cannot guarantee that other participants in the focus group will treat the information confidentially. I shall, however, encourage all participants to do so. For this reason, I advise you not to disclose personal sensitive information in the focus group.*

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

Hard 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, 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 CEDU Research Ethics Review Committee of the, 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 Mr. EC Ndlovu at 0791963866/0124296174 or email ndlovec@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 Mr. EC Ndlovu at 0791963866/0124296174 or use the email ndlovec@unisa.ac.za.

Should you have concerns about the way in which the research has been conducted, you may contact the supervisor (s), Prof MT Gumbo, on the email gumbomt@unisa.ac.za and/or Prof TA Mapotse on email mapotta@unisa.ac.za.

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

Sincerely Yours

EC Ndlovu

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): Elliot Charles Ndlovu

______________________________ ______________________________________

Researcher's signature Date

APPENDIX 5: LETTER OF CONSENT FOR CURRICULUM ADVISOR PARTICIPATION

Date:

Dear Prospective Participant

I, Elliot Charles Ndlovu, am doing research towards a PhD in Education under the supervision of Professor MT Gumbo, a Research Professor, and Professor TA Mapotse, an Associate Professor, who are 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 Senior Phase Technology teachers can incorporate IKS in the creative design process activities when teaching Systems and Control content 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 Technology Education (TE) curriculum.

WHY AM I BEING INVITED TO PARTICIPATE?

We would like to invite you to participate in the study titled: Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control. 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 IKS in the creative design process activities when dealing with the Systems and Control section or content.

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 2 curriculum specialists from Ehlanzeni and Nkangala 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 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 involves participating in semi-structured interviews and document analysis. Regarding semi-structured interviews, you will be interviewed (not in chronological order) about:

- your understanding of IKS with respect to the creativity and design process contained in the third specific aim of CAPS.
- Your experience of teachers' showing understanding of the relationships between content and strategic knowledge that involve strategies to integrate IKS when teaching technology activities in Systems and Control
- explore strategies that you are aware of which teachers use to teach Technology from IKS perspectives
- your knowledge of the subject from the IKS perspectives
- strategies used to support teachers to integrate IKS in their lessons
- the strategies you use to support teachers to teach Technology from IKS perspectives.
- the successes and failures of your strategies that you use to plan and teach Technology.
- your contribution towards the development of a framework to guide the effective integration of IKS in teaching the creative design process in the Systems and Control section.

You will be expected to dedicate 30-60 minutes of your time to a face-to-face semi-structured interview.

Document analysis will be carried out from the learning and teaching support material (LTSM) i.e. textbooks, teacher guide, learner guide. The pacesetters and workshop or training materials that you provide to the teachers.

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?

The potential benefits of taking part in this study, you will be able to gain an insight on how to integrate the IKS in creative design process activities in the Systems and Control section/content area. Furthermore, the research findings will be communicated to the participants, schools, and the Department of Basic Education in the form of feedback or digital copy of the report; and present the recommendations for future study to improve practice in different contexts than this. The benefits can only be realised through interacting and engaging in the research process with 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 will be done based on the information to be gathered through semi-structured interviews and document analysis. The consent form should be submitted. 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.

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 supervisors and I will be the only ones to have access to the data, and we will maintain confidentiality as from the beginning. We will not disclose your name and that of the district, even on recording there will not be any mention of your name or district. 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?

Hard 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, 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 CEDU Research Ethics Review Committee of the 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 Mr. EC Ndlovu at 0124296174 or email ndlovec@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 Mr. EC Ndlovu at 0791963866/0124296174 or use the email ndlovec@unisa.ac.za.

Should you have concerns about the way in which the research has been conducted, you may contact the supervisor (s), Prof MT Gumbo, on the email gumbomt@unisa.ac.za and/or Prof TA Mapotse on email mapotta@unisa.ac.za.

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

Sincerely Yours

EC Ndlovu

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): **Elliot Charles Ndlovu**

____

Researcher's signature Date

APPENDIX 6: LETTER OF ASSENT FOR LEARNER PARTICIPANT

Date:

Dear Leaner

Re: Request for Assent to Participate in a Research Project

Title: Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control

I am doing a study on how Senior Phase Technology teachers can incorporate IKS in the creative design process activities when teaching Systems and Control content in the classroom as part of my studies at the University of South Africa. Your principal has given me permission to do this study in your school. I would like to invite you to be a very special part of my study. I am doing this study so that I can find ways that your teachers and curriculum specialists can use to teach and support you better. This may help you and many other learners of your age in different schools.

This letter is to explain to you what I would like you to do. There may be some words you do not know in this letter. You may ask me or any other adult to explain any of these words that you do not know or understand. You may take a copy of this letter home to think about my invitation and talk to your parents about this before you decide if you want to be in this study.

I would like to interview you amongst others about your understanding of IKS with respect to the creativity and design process contained in the third specific aim of CAPS; your showing of understanding about the relationships between content and strategic knowledge that involve strategies that integrate IKS is used when learning technology activities in Systems and Control; explore with you strategies your teachers use to teach you Technology from IKS perspectives; your knowledge of the subject from the IKS perspectives; and understanding of IKS in the creative design process when learning Systems and Control section. You will be expected to dedicate 30-45 minutes of your time to face-to-face individual interviews. The interviews will be audio-recorded on your permission. Lesson observation will take place in your class grade of which if permission is granted the lesson will be video recorded. Necessary arrangements will be made with the teacher not to miss the valuable learning time because of this exercise.

I will write a report on the study, but I will not use your name in the report or say anything that will let other people know who you are. Participation is voluntary and you do not have to be part of this study if you don't want to take part. If you choose to be in the study, you may stop taking part at any time without penalty. You may tell me if you do not wish to answer any of my questions. No one will blame or criticise you. When I am finished with my study, I shall return to your school to give a short talk about some of the helpful and interesting things I found out in my study. I shall invite you to come and listen to my talk.

The benefits of this study are realised through interacting and engaging in the research process with the researcher.

Potential risks are not anticipated in this exercise as the Covid-19 regulations will be observed as stipulated by the Department of education.

You will not be reimbursed or receive any incentives for your participation in the research.

If you decide to be part of my study, you will be asked to sign the form on the next page. If you have any other questions about this study, you can talk to me or you can have your parent or another adult call me at 0124296174/0791963866. Do not sign the form until you have all your questions answered and understand what I would like you to do.

Researcher: EC Ndlovu Phone number: 0124296174/0791963866

Yours Sincerely

EC Ndlovu

(Researcher Unisa)

(Do not sign the written assent form if you have any questions. Ask your questions first and ensure that someone answers those questions.)

WRITTEN ASSENT

I have read this letter which asks me to be part of a study at my school. I have understood the information about my study and I know what I will be asked to do. I am willing to be in the study.

____________________ ____________________ ____________________

Learner's name (print): Learner's signature: Date:

____________________ ____________________ ____________________

Witness's name (print) Witness's signature Date:

(The witness is over 18 years old and present when signed.)

____________________ ____________________ ____________________

Parent/guardian's name (print) Parent/guardian's signature: Date:

Elliot Ndlovu

____________________ ____________________ ____________________

Researcher's name (print) Researcher's signature: Date:

APPENDIX 7: LETTER OF CONSENT FOR PARENTS

Dear Parent/Guardian

Request for Parental Consent for the Minor child to Participate in a Research Project

Your ______________<son/daughter/child> is invited to participate in a study entitled Senior Phase Technology teachers' integration of indigenous creative design processes in Systems and Control.

I am undertaking this study as part of my doctoral research at the University of South Africa. The purpose of the study is to establish how Senior Phase Technology teachers can incorporate IKS in the creative design process activities when teaching Systems and Control content in the classroom, and the possible benefits of the study are the improvement of the teaching of Technology subject through the incorporation of IKS. I am asking permission to include your child in this study because your child is in the Senior Phase class in which the research is to take place. I expect to have more other children participating in the study as the study I will collect research information from teachers and learners using document analysis, observations, and interviews.

If you allow your child to participate, I shall request him/her to:

- **Take part in an interview**

The interviews will seek to explore teachers'/learners' understanding of IKS with respect to the creativity and design process contained in the third specific aim of CAPS; teachers'/learners' showing understanding of the relationships between content and strategic knowledge that involve strategies to integrate IKS when teaching technology activities in Systems and Control; explore strategies teachers use to teach/learn Technology from IKS perspectives; knowledge of the subject from the IKS perspectives; and understanding of IKS in the creative design process when learning Systems and Control section. All the questions areas will be in a covered face-to-face interview. Your child will be expected to spend 30-45 minutes of his/her time in a face-to-face individual interview. The interview will be audio-recorded of which permission is sought.

- **Take part in lesson observation and document analysis**

The lesson observation will comprise of the learning environment; subject content; teacher and learner participation; teaching strategies, interactions, and type of activities that includes the aspects of design process and skills along with the elements of creativity and integration of IKS; and teacher and learner lesson reflections. The study will entail audio recorded interviews from the teacher and the learners, lesson observation (lesson can be video recorded on the basis that permission is granted and participants/parents/guardians have consented and assented). Document analysis will be carried out from the learning and teaching support material (LTSM), and learners' workbooks.

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and will only be disclosed with your permission. His/her responses will not be linked to his/her name or your name or the school's name in any written or verbal report based on this study. Such a report will be used for research purposes only.

There are no foreseeable risks to your child participating in the study. The Covid-19 protocol, and regulations will be prioritised and observed, and this matter will be discussed in-depth with all prospective participants in this study. Your child will receive no direct benefit from participating in the study, however, the possible benefits to education are taking part in this study; you will be able to gain an insight into how IKS is integrated into creative design process activities in the Systems and Control section/content area. Furthermore, the research findings will be communicated to the participants, schools, and the Department of Basic Education in the form of feedback or digital copy of the report; and present the recommendations for future study to improve practice in different contexts than this. The benefits can only be realised through interacting and engaging in the research process with the researcher. Neither your child nor you will receive any type of payment for participating in this study.

Your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusal to participate will not affect him/her in any way. Similarly, you can agree to allow your child to participate in the study now and change your mind later without any penalty.

The study will take place during regular classroom activities with the prior approval of the school and your child's teacher. However, if you do not want your child to participate, an alternative activity will be available through the help of the teacher not for him/her to lose on learning for that particular day.
In addition to your permission, your child must agree to participate in the study, and you and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation will be stored securely on a password locked computer in my locked office for five years after the study. Thereafter, records will be erased.

The benefits of this study are realised through interacting and engaging in the research process with the researcher.

There are no potential risks involved participating in this study. The Covid-19 regulations will be observed as stipulated by the Department of Basic Education.

There will be no reimbursement or any incentives for participation in the research.

If you have questions about this study, please contact me at 0124296174/0791963866; e-mail: ndlovec@unisa.ac.za. My study supervisors, Prof MT Gumbo and Prof TA Mapotse who are attached to the Department of Science and Technology Education, College of Education, University of South Africa may also be contacted. The e-mails of my supervisors are gumbomt@unisa.ac.za and mapotta@unisa.ac.za. Permission for the study has already been obtained from the Mpumalanga Department of Basic Education, and the Ethics Committee of the College of Education, UNISA.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. You may keep a copy of this letter. Name of child:

____

Sincerely

____________________	____________________	__________
Parent/guardian’s name (print)	Parent/guardian’s signature:	Date:
Elliot Ndlovu		
____________________	____________________	__________
Researcher’s name (print)	Researcher’s signature	Date:

APPENDICES B: DATA COLLECTION INSTRUMENTS

APPENDIX 8: TEACHER'S INTERVIEW SCHEDULE

Teachers' Interview Guide

- What is your understanding of IKS?
- What is your understanding of this concept in the context of Technology as a subject?
- Can you mention areas in the CAPS Technology that indicate IKS?
- In your opinion, is there a relationship between creativity and the design process? Elaborate.
- How familiar are the Systems and Control sections in the Senior Phase technology to you?
- How do you actualise creativity and design process in your teaching of Systems and Control?
- Have you ever thought of integrating IKS aspects in your teaching of the creative design process in Systems and Control?
- How does the local knowledge (IKS) impact your teaching of creative design process activities in Systems and Control?
- How do you relate IKS with the creative design process in Systems and Control teaching in the Senior Phase?
- What opportunities (if any) do IKS present for you towards teaching the creative design process in Systems and Control?
- How do you engage IKS when designing/developing/planning creative design activities/tasks in Systems and Control?
- Do the activities planned for the creative design process in Systems and Control promote the use of local knowledge towards understanding the meaning of what you teach?
- Do you create space in your teaching to allow learners to describe or explain their understanding of the meaning of concepts based on their contexts of IKS?

- How do you make sure that learners' creative design process activities are designed in a manner that promotes the integration of IKS/local knowledge and skills?
- What do you do to support learners to master the creative design process activities in Systems and Control based on their local knowledge context?
- What support do you put in place to allow learners to produce a clear description of IKS elements when dealing with creative design process skills in Systems and Control?
- Do you create opportunities for learners' reflections on IKS during the creative design activities in Systems and Control? Elaborate.
- How do you teach learners such that they can bring in IKS in their design activities in Systems and Control?
- What teaching strategies do you engage learners towards the realisation of IKS during the lesson on the creative design process in Systems and Control?
- What strategies do you apply to promote learners' engagements with IKS in learning creative design in Systems and Control?
- What do you do to make sure that the strategies you apply in your teaching are rooted in the learners' local knowledge (IKS)?
- What do you do, when teaching the creative design process in Systems and Control to encourage learners to interpret the information in relation to IKS?
- How do you assist learners to engage freely with IKS aspects towards expressing their opinions when learning the creative design process in Systems and Control?
- Do you sometimes invite indigenous knowledge experts from your community to share their knowledge about IKS in the creative design process that involves Systems and Control?
    - If yes, Elaborate.
    - If no, what are the prospects of getting hold of IKS experts in your classroom?
- What type of IKS oriented creative design activities in Systems and Control do you engage your learners in or outside the classroom? Give practical examples.
- How do you ensure that the integration of IKS is catered for in your creative design process activities in Systems and Control?

- Do the strategies that you use lead to integrate IKS in creative design activities successfully in Systems and Control?
- Are there any specific challenges that you encounter towards integrating IKS in creative design activities when teaching Systems and Control topics?
- What do you do to address these challenges?
- Tell me about the role you think indigenous knowledge holders/experts can play in sharing knowledge and skills about the creative design process in Systems and Control?
- Do you think there should be a framework to guide you in achieving the integration of IKS in your lesson planning?

  - If yes, what are the suggested elements that can be roped in towards developing such a framework?

  - If no, elaborate more.
- Is there anything else that you want to say which is not covered in this interview?

APPENDIX 9: LEARNER'S INTERVIEW SCHEDULE

Learners' Interview Guide

- What is your understanding of indigenous/local/home-grown knowledge?
- What is your understanding about IKS in Technology subject?
- Are you familiar with the CAPS Technology specific aim that is IKS oriented? Specify/Elaborate?
- How is IKS realised in your learning of Technology in relation to the creative design process in the Systems and Control section?
- What indigenous technologies can you think about from your environment/local context that you can relate with when learning Systems and Control? Specify.
- Are these indigenous technologies integrated when learning creative design processes in Systems and Control? Elaborate.
- How do IKS/local knowledge impact your learning of the creative design process in Systems and Control?
- Are the creative design activities in Systems and Control linked to your day-to-day experiences or socio-cultural context? Elaborate.
- How do you interact with your fellow learners on the application of the IKS/local knowledge in creative design activities of Systems and Control during the learning process?
- What is your take about the integration of IKS during learning the creative design process in Systems and Control?
- What approach(es) does your teacher use to help you learn IKS oriented creative design process from the Systems and Control sections in class?
- How do you find the teacher's approach(es) towards helping you to learn IKS oriented creative design process activities in Systems and Control?
- Have you ever been engaged with creative design process activities in Systems and Control during your own learning where local knowledge was promoted? Give examples.

- Are you encouraged to use your local knowledge when answering questions or discussing with fellow learners during the learning process in or outside the class? Elaborate.
- Are you given opportunities to express yourself in the local knowledge that you understand during learning of creative design in Systems and Control? Explain those opportunities.
- How do you reflect on your learning, using local knowledge in class with other learners?

APPENDIX 10: CURRICULUM SPECIALIST INTERVIEW SCHEDULE

Curriculum Specialists' Interview Guide

- What understanding of IKS do the teachers project?
- When you train teachers, do you bring in indigenous perspectives? How do you do this?
- How do you help teachers interpret the CAPS with reference to the Technology subject in relation to IKS?
- In relation to the indigenous knowledge aspect of CAPS, how familiar are the teachers with indigenous technologies that relate to the Systems and Control sections?
- Specific to the teaching of the creative design process in Systems and Control, what examples of IKS do they express?
- How do they integrate the IKS examples in Systems and Control?
- How do you guide teachers to actualise the third specific aim, especially with reference to the integration of indigenous technology when teaching creative design processes in Systems and Control?
- How do you guide teachers to the use and or integration of local knowledge (IKS) to impact their teaching of the creative design process in Systems and Control?
- How do you guide teachers regarding the content and teaching strategies which can promote the integration of IKS?
- What opportunities (if any) do IKS create towards teachers' teaching of the creative design process in Systems and Control?
- What strategies do you put in place to encourage or guide teachers to collaborate with communities or indigenous experts or elders to make sure that teaching and learning of creative design process is informed by those local contexts as a priority?
- How do you engage IKS when you design/develop/plan creative design activities/tasks for teachers in Systems and Control?

- Do the activities planned for creative design process in Systems and Control promote the use of local knowledge towards understanding the meaning of what they teach? Why?
- Do you create space in your training of teachers to allow them to describe or explain their understanding of the meaning of concepts from IKS perspectives? Briefly describe instances in which you have done this.
- How do you make sure that teachers' development of creative design process activities in Systems and Control promotes the integration of IKS/local knowledge and skills?
- What do you do to support teachers to reflect on the creative design process activities in Systems and Control based on the learners' local knowledge context?
- What support do you put in place to allow teachers to produce a clear description of IKS elements when dealing with creative design process skills in Systems and Control?
- Do you create opportunities for teachers' reflections on the IKS aspects during the creative design activities in Systems and Control? Elaborate.
- How do you engage teachers to the point where they are capacitated to bring in IKS when developing creative design activities in Systems and Control?
- What teaching approaches do you engage teachers towards integration of IKS during the lesson on the creative design process in Systems and Control?
- What strategies do you apply to promote teachers' engagements with IKS in the teaching of creative design in Systems and Control?
- What do you do to make sure that the strategies you apply in your training/support to teachers are rooted in local knowledge (IKS)?
- What do you do to encourage teachers to interpret the information in relation to IKS when training/supporting them in creative design process activities in Systems and Control?
- From your experience as you visit classrooms for support, how do learners receive the integration of IKS during their learning?
- What mechanism do you put in place to ensure that learners are assisted to realise the importance of IKS integration in their learning?

- Do you normally check learners’ written work? What is it that is reflected in line with IKS in their written work?
- In your reflection with teachers, what advice do you normally give towards helping learners to have a full appreciation of the integration of IKS in their learning of creative design activities in Systems and Control?
- How do you assist teachers to engage freely with the IKS aspects towards expressing their opinions when teaching the creative design process in Systems and Control?
- Are there challenges that you might be aware of on the side of the teachers towards integrating IKS aspects in creative design activities in Systems and Control? Specify and elaborate.
- What support mechanisms are in place to assist teachers to realise the importance of integrating IKS in their teaching of creative design process activities in the Systems and control section?
- How do you ensure that the integration of IKS is catered for in creative design process activities in Systems and Control topics during training and support of teachers?
- Do the strategies that you use when training and supporting teachers lead to integrating IKS in creative design activities successfully in Systems and Control? Elaborate.
- Is there any challenge that you encounter in integrating IKS in creative design activities when dealing with Systems and Control topics?
- What do you do to address the challenges?
- Do you think there should be a framework to guide you in achieving the integration of IKS in your teacher support planning?

  - If yes, what are the suggested elements that can be roped in towards developing such a framework?

  - If no, elaborate further.

APPENDIX 11: DOCUMENT ANALYSIS SCHEDULE

Document Analysis Tool

Document description: ___________________________

Grade: ____

(Tick the relevant level descriptor and give comment(s) when necessary)

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
Cognition	Information, concepts, Principles Cognitive processes	The document material does not present information, emphasize combining concepts and general principles that resonate with socio-cultural context of the teacher and learner.	The document material presents the information, emphasize combining concepts and general principles that resonate with socio-cultural context of the teacher and learner to a certain extent	The document material present information emphasizes combining concepts and general principles that resonate with socio-cultural context of the teacher and the learner	The document material present information emphasizes combining concepts and general principles that resonate with socio-cultural context of the teacher and the learner	
	Approach to the nature of problem-solving approach (the design process)	The document material does not advocate for the existence of general problem-solving approach - design process that promote creative thinking skills.	The document material does advocate the existence of problem-solving approach-design process that promote creative thinking skills to a certain extent.	The document material advocates the existence of problem solving-design process to promote creative thinking skills.	The document material completely advocates the existence of problem solving-design process that promote creative thinking skills.	
	Relations to everyday life experiences	The document does not express subject matter knowledge for individual learner based on their socio-	The document conveys and express subject matter knowledge for individual learner based on their socio-cultural	The document conveys and expresses subject matter knowledge for individual learner based on their socio-	The document fully conveys and expresses subject matter knowledge for individual learner based on their socio-	

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
		cultural context	context to a certain extent	cultural context.	cultural context	
	Subject content sequencing and complexity in relation to problem solving (design process).	The document does not address aspects of problem solving in a creative way based on authentic contexts rooted in real situation and does not address knowledge in an integrated manner within the subject content.	The document addresses some aspects of problem solving in a creative way based on authentic contexts rooted in real situation and addresses knowledge in an integrated manner within the subject content.	The document addresses aspects of problem solving in a creative way based on authentic contexts rooted in real situation and addresses knowledge in an integrated manner within the subject content.	The document fully addresses aspects of problem solving in a creative way based on authentic contexts rooted in real situation and addresses knowledge in an integrated manner within the subject content	
Learner	Learning context	The document material does not promote learner involvement in active learning that links concepts to concrete understanding and it does not assist a learner to acquire knowledge as presented in curriculum document	The document material partly promotes learner involvement in active learning that links concepts to concrete understanding and assists a learner to acquire knowledge as presented in curriculum document	The document material promotes learner involvement in active learning that links concepts to concrete understanding and assists a learner to acquire knowledge as presented in curriculum document	The document material promotes a fully substantiated learner involvement in active learning that links concepts to concrete understanding and assists a learner to acquire knowledge as presented in curriculum document	
	Opportunities for learner development	The document does not offer opportunities for learner cognitive development	The document offers to a certain extent opportunities for learner cognitive	The document offers opportunities for learner cognitive development	The document offers ample opportunities for learner cognitive development	

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
		and psychomotor skills (use of design process skills) through the diversification and complexity of the tasks that integrate IKS,	development and psychomotor skills (use of design process skills) through the diversification and complexity of the tasks that integrate IKS	and psychomotor skills (use of design process skills) through the diversification and complexity of the tasks that integrate IKS	and psychomotor skills (use of design process skills) through the diversification and complexity of the tasks that integrate IKS	
	Planned focus of tuition	The document material does not address individual and or a group need, and shared interests of learners based on their local knowledge (IK) and socio-cultural context	The document material to a certain extent addresses a individual and or a group needs, and shared interests of learners based on their local knowledge (IK) and socio-cultural context	The document material addresses individual and or group needs, and shared interests of learners based on their local knowledge (IK) and socio-cultural context	The document fully material addresses individual and or group needs, and shared interests of learners based on their local knowledge (IK) and socio-cultural context	
	Learning structure	The document material is not designed to create a structured and unstructured learning environment as required that is diversified to cater for the local knowledge (IK) in order to enable different learning styles for learners to	The document material is designed to create some structured and unstructured learning environment as required that is diversified to cater for the local knowledge (IK) in order to enable different learning styles for learners to	The document material is designed to create a structured and unstructured learning environment as required that is diversified to cater for the local knowledge (IK) in order to enable different learning styles for learners to	The document material is fully designed to create a structured and unstructured learning environment that is diversified to cater for the local knowledge (IK) as required to enable different learning styles for learners to understand	

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
		understand the subject knowledge	understand the subject knowledge	understand the subject knowledge	the subject knowledge	
Teacher	Curriculum design	The curriculum material does not take into consideration the selection of the subject matter tasks, the rationale regarding learners, the setting of context (accommodate local knowledge) and addresses teacher's anticipated role during teaching and learning in the classroom	The curriculum material takes into consideration the selection of the subject matter tasks, the rationale regarding learners, the setting of context (accommodate local knowledge) and addresses teacher's anticipated role during teaching and learning to a certain extent	The curriculum material takes into consideration the selection of the subject matter tasks, the rationale regarding learners, the setting of context (accommodate local knowledge) and addresses teacher's anticipated role during teaching and learning in the classroom	The curriculum material completely takes into consideration the selection of the subject matter tasks, the rationale regarding learners, the setting of context (accommodate local knowledge) and addresses teacher's anticipated role during teaching and learning in the classroom	
	Teacher autonomy	The material does not contain specific objectives or outcomes, teaching strategies are not specified, background material, it does not offer teaching alternatives and does not give room for the teacher to develop own material that caters for the	The material contains some specific objectives or outcomes, teaching strategies are specified, background material, it offers teaching alternatives and partially gives room for the teacher to develop own material that caters for the socio-cultural context	The material contains specific objectives or outcomes, teaching strategies are specified, background material, it offers teaching alternatives and gives room for the teacher to own material that caters for the socio-cultural context	The material entirely contains specific objectives or outcomes, teaching strategies are specified, background material, it offers teaching alternatives and effectively gives room for the teacher to develop own material that caters for the socio-cultural	

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
		socio-cultural context he/she teaches.	he/she teaches to a certain extent.	he/she teaches.	context he/she teaches.	
	Role in teaching	The document material does not suggest any central role for a teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IK and it is not supportive in guiding learners in independent learning	The document material partially suggests a central role for a teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IK and supportive in guiding learners in independent learning	The document material suggests a central role for a teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IK and supportive in guiding learners in independent learning	The document material suggests a central role for a teacher as a source of subject matter knowledge to diversify knowledge and skills to cater for IK and supportive in guiding learners in independent learning	
	Consideration of needs	The document material does not draw awareness for the need for special training to teach the subject content knowledge in an integrated manner with IK, possible difficulties are not addressed, and it does not reflect consideration of opinions and attitudes	The document material draws some awareness for the need for special training to teach the subject content knowledge in an integrated manner with IK, possible difficulties are addressed, and it reflects consideration of opinions and attitudes to a certain extent	The document material draws awareness for the need for special training to teach the subject content knowledge in an integrated manner with IK, possible difficulties are addressed, and it reflects consideration of opinions and attitudes	The document material largely draws awareness for the need for special training to teach the subject content knowledge in an integrated manner with IK, possible difficulties are addressed, and it reflects consideration of opinions and attitudes	

Domain	Category	Level 1	Level 2	Level 3	Level 4	Comment(s)
Situation	Environment	The document material does not explicitly emphasize the context that shows the influence of the local knowledge (IK) on the development of the subject knowledge	The document material emphasizes to a certain extent the context that shows some influence the influence of the local knowledge (IK) on the development of the subject knowledge	The document material emphasizes the context that shows the influence of the local knowledge (IK) on the development of the subject knowledge	The document material clearly emphasizes the context that shows influence the influence of the local knowledge (IK) on the development of the subject knowledge	
	Interaction between socio-cultural context and the curriculum	The document material does not reflect on the ideological concerns and socio-cultural needs in the curriculum (accommodate local knowledge)	The document material partially reflects on the ideological concerns and socio-cultural needs in the curriculum (accommodate local knowledge)	The document material reflects on the ideological concerns and socio-cultural needs in the curriculum (accommodate local knowledge)	The document material extensively reflects on the ideological concerns and socio-cultural needs in the curriculum (accommodate local knowledge)	

APPENDIX 12: OBSERVATION SCHEDULE

Class Observation Tool

Lesson Presentation Observation Tool		
Pre-lesson delivery:		
1. Pre-lesson document review • Grade: • Lesson topic: • Lesson objectives/outcomes: • Duration of the lesson:		
2. Gaining access to the classroom • Seating arrangements • Number of learners • Space for easy movement		
3. Classroom teaching and learning environment • Conducive for teaching and learning: • Learning environment clearly defined:	**Yes/motivate**	**No/motivate**
4. Availability and use of teaching and learning resources • Is/are there materials and or resources available? • Is any teaching material besides textbooks used?		
During Lesson Delivery:		
1. What is being taught?		
2. Is the lesson topic clear?		
3. What appears to be the main purpose of the lesson? (Tick the relevant items) • Learning a procedure • Developing a new concept or skill • Practising a concept or skill • Application of a concept or skill • Learning new knowledge or information • Revising/reviewing work already covered		

Lesson Presentation Observation Tool		
Pre-lesson delivery:		
4. Learning environment: Does the learning environment-	YES/motivate	No/motivate
• promote socio-cultural and physical contexts?		
• develop IKS identity to both teacher and learner?		
• promote collaborative learning (e.g. group discussions etc.)?		
• encourage the expression of emotions and use of other languages than the language of teaching and learning towards the articulation of knowledge and skills in relation to IKS?		
• promotes activity, storytelling, and narration based on learners' experiences informed by their IKS background?		
5. Learners:	Yes/motivate	No/motivate
• take participation in their groups seriously.		
• able to observe existing local knowledge practices and link them to their learning.		
• supportive to each other and to their teacher in a collaborative way to promote principles of ubuntu.		
• take basic tasks as part of their responsibility towards promoting IKS in their learning.		
• able to narrate stories to articulate the concepts based on their context to understand the tasks.		
5. Teacher: • Are the tasks appropriate to the grade?		
• Does the teacher interpret and elaborate the information based on learners' contextual (IKS) experiences?		
6. Subject content competence: • Does the teacher demonstrate enough knowledge of the subject content?		
• Is the content and methods adapted suitably for the learners' grade and socio-cultural context?		
• Do teachers' approaches to the subject matter help the learners to understand different aspects of the subject content in line with their socio-cultural context?		
• Does the teacher classify all types of knowledge and skills to cater for local knowledge (IKS)?		

Lesson Presentation Observation Tool		
Pre-lesson delivery:		
• Does the teacher expand the opportunities for learners to relate the content with the realities of their day-to-day experiences of their communities?		
7. Teaching strategies, interactions, and activities: • Which teaching method(s) does the teacher use in his /her teaching?		
• Does the teacher have control over the teaching and learning strategies that promote IKS in the classroom?		
• Does the teacher offer information and insights beyond what is available in the class? Give example(s).		
• Is the teacher available to take suggestions from the learners or adapt methods to accommodate IKS?		
• Do the developed tasks or activities help to promote a community of practice (CoP) and integration of IKS in the classroom?		
• Does the teacher motivate the learners to use their local knowledge during the learning process?		
• Are the learning barriers towards integrating IKS identified, and addressed?		
8. Reflections: • Are lesson objectives met?		
• Are the learners' abilities to complete the activities in line with IKS supported?		
• How do the learners deliver proof of learning? (i.e. written or oral task).		
• Are there recommendations required by needy learners to achieve the same lesson objectives with the rest of the class and the strength (high points) and weaknesses (low points) of the lesson in relation to the integration of IKS? (Inclusivity)		
• Does the general lesson presentation suggest improvements in the next lesson?		

APPENDICES C: EVIDENCE DOCUMENTS

APPENDIX 13: TEACHER SEMI-STRUCTURED INTERVIEWS TRANSCRIPT

Teacher's semi-structured interviews transcript

Researcher: As a teacher teaching Technology in the Senior Phase, what is your understanding of IKS?

Participant: (understanding) Okay, as an educator I think let me start by just explaining the Indigenous knowledge, I think the concept is having about three elements. The first thing is the term indigenous. To me, when you say indigenous, my understanding is that we're referring to the old things that were used to be used back then before. So I think those are part of the culture, the traditions, and then when it comes to knowledge, this one is common, something that we know, something that we use every day, and then the part of the system, we know that there is a system under technology system educator, my understanding of a system that is something that is used of different elements, that are working together to just to perform a specific function. So, when I am looking at indigenous knowledge systems, so to me is when I am looking at the systems that were used back then how to do things and the knowledge that was used back then how to do things. So that is my understanding of the indigenous, knowledge systems.

Follow up question-Researcher: Don't you think this indigenous is still applicable in your communities now?

Participant: (still practice ingenuity but not part of the curriculum) they are applicable in our community; they are always used. But as a teacher, sometimes we will, we will draw a line between what we teach and the technology and what we have in the community. So those are the two lines, but these things still exist they are there, even though Western technology is taking its dominant these days. But those things are still there in particular, you will go to the deep rural areas, and you will find the indigenous knowledge systems.

Follow-up-Researcher: This means you are trying to say people still practice their indigeneity but is not part of your school curriculum.

Participant: Yes, and they do practice it. What is in fact, what is drawing the line between what is being practiced in the societies more especially in rural areas in what we are teaching in the schools that the installment or the resources that we use the textbooks, the ATPs that we are given by the department. They don't consider the local knowledge, but they bring what is on the curriculum, which is more related to the Western culture and practices. But what is happening in the community exactly, is not being catered on the documents, or on the necessary resources that we use. So that is why there is this line to say this is what we use at home and then this is what we do in school. But those things when you try to be practical in terms of the concept. You can see that no, this concept is linked with what we're doing in the rural areas, but because a concept is going to be assessed in this level of being a concept, not in a practical part of it, that is why there is this line, and we don't draw more attention on the indigenous or the rural knowledge. We look at what you have in the text.

Follow-up-researcher: This means you are trying to say these things they run parallel, they don't mix.

Participant: Yes, they don't mix.

Researcher: you do one at home in your community, you do the other at school.

Researcher: Okay, what is your understanding of this concept in the context of technology as the subject?

Participant: Indigenous knowledge system, well this one is, in our teaching daily, it's rare to find these things because these days, we normally look at the new knowledge that we have under technology. Because technology has to do with problem-solving, we use a specific concept to solve a specific problem. But when you look at the indigenous knowledge in the classroom, it's not that dominant, it's something that we do at home. And then we come and do the subject here in class. So, there is also that line,

Follow up question-researcher: which means you are trying to say there is no link on the indigenous way of solving practical problems than what you are doing to solve problem-solving in the classroom?

Participant: For me, me, at my level, I can draw, I can have that link. But when teaching for the purpose of assessing, I cannot draw that line because it will end up confusing the learners. But at my level, I can be able to relate to say, that this thing is similar to what

I'm teaching here. So, as I said before, the only thing that is creating the division is the content taught in the content assessed. That is why there is this tool. But if the local knowledge was considered in the content that we are teaching, there was going to be a link, it was going to be simple to link but now it's difficult because you get the concept in that textbook talking about something that is not in the local area. So that is why there is this link line between these two things. But for me at my level, I can be able to link to say, oh, okay, this is related to 1, 2, 3. But for teaching and learning purposes, it's quite difficult to link these two, okay, because they end up confusing the learners.

Researcher: All right, can you mention areas in the caps technology that indicate IKS aspects?

Respondent: CAPS- Eeh! thinking about processing the way food we used to be processed a long time ago, I remember a topic where they talk about storage how food used to be stored a long time ago, they used to dig a hole that that one is on the content. I just don't remember the correct textbook. But there used to dig a hole to store the food more specialty the maize meal stores the food under the ground. So, the question is why under the ground, because they prevent it against the moist and other small organisms that can affect that particular product.

Further Question-Researcher: Do you think there is this thing in an outcome in caps that informs that or aim?

Participant: On a record correctly the aims of caps it's about the knowledge, the concept and then you speak about the process. Yeah, I think it's aim number three. It does talk about the impact on the environment, impact on the environment, but not exactly. Indigenous knowledge systems, (but it talks about indigenous knowledge). No, not exactly, there is impact. Indigenous knowledge and biases. Yes, biases again in technology, yeah.

Researcher: in your opinion Is there a relationship between creativity and the design process?

Participant: Yes, (elaborate). I think the design process it's one of the basic elements that enable creativity because when you're dealing with the design process there is an aspect, we'll talk about design that brings in the issue of drawings. So, possibly the issue of making so these days, certainly, that will include because as a teacher, that's where I see the learners' creativity when designing, because they come up with different types of designs. So, there is a link between the two.

Follow up question (researcher): Or which means you see it's found on when you do the design stage?

Participant: design stages, you will get that creative even when you're making that particular project, you can see the creativity there so as I'm saying, the design part of it is the one that we use to enable the creativity.

Follow up (Researcher): this means according to what you're saying, it's it is between the design and the making stages.

(**Participant:** Yes).

Researcher: How familiar are the Systems and Control sections in the Senior Phase technology to you?

Participant: systems control I am familiar with this one. As I said, we speak about systems to talk about different elements that are working together to perform a specific function. Normally, when I start to introduce the issue of systems and control, I normally make a practical example for the learners, and I talk about the sound system. So, why are we saying this thing is a sound system? then I will ask a few questions, but what do we have when we say this thing is a sound system? What do we have, then they will tell you that you have the speaker we have the CD player, and you will have an amplifier. So, another question if these things, they are not working together oh, we're going to get the product, what is the product we will say this is a sound system what is it that you can get out then we know we are getting a sound out of the sound system. But this element if you check each and every element is playing its own role, the speaker the function of the speaker, and they are familiar with the speaker, it is the one that is going to give you the sound, you want to place the sound and then what is the function of the CD player in the sound system is the one that converts the cording of the music into the speaker and then the amplifier they will tell you that this one is for creating bass in some so, when you say sound system, something that used different elements just to work together. So, the part of control is that we use systems to control so many things. Because for example, when you go to any, any place these days in town you get these automatic opening doors. So, the question is how is that thing working, when you approach the door, the door will open what is controlling that thing. And then that's where you start to go deep and explain that there you also have different elements that it's controlling the system, you must have something that will sense there and then we'll have something that's supposed to open the door. So, we'll talk about systems and control it's something that uses different elements it can control a specific function. So, to those are the ideas and the concepts around the concepts, systems, and control.

Follow up (researcher): So how do you explain this concept to your learners to understand it very well? under which concepts do you use most to define your speaker your sound and the electricity or battery? Because obviously, they cannot be a sound if there's no battery (answer -yes) so how so which concept to use to illustrate these three stages?

Participant: Another practical example that I normally give learners who deal with the systems and control I also refer him to his cell phone because it's something that they always use every day, because I wanted to make it practical for them because one thing that I've realised is these are modernized learners know what they no longer interested on things that were released back then.

Follow up researcher): yes, but what I'm saying is even the cell phone has a battery and have to talk, they have to get the sound to hear somebody talking, what are the representation of the battery, the talking, and the sound?

Participant: okay because in Grade 9 normally when you talk about the system having three elements is the part of the input and then you have a part of the processing okay then you must have the output. So, in any example that you give them, you need to be able to explain what the input is there, for example, you will mention a sound system what is the input maybe on the sound system someone must have a CD to play, and you cannot play the CD without if the sound system does not have power. So, that will be part of the input then the part of processing, what is it that is being processed there you must have the CD being processed by the CD player and then output what is it you get sound. So, that's when you are starting now to take the common thing that they know into the content because these are the three elements that they should have when they are assessing anything that has to do systems approach always inputs process output plays a very important role in teaching systems and control.

Follow up (researcher): what are these contents that are involved in systems and control, the contents that you deal with -the concepts that are the content that is entailed in systems and control? Because just to clarify more, you will realise that it's no longer called the umbrella systems and control but there are elements, the subtopics that you are dealing with to recall those two sub-topics because systems and control is a very big topic. It entails what?

Participant: It has a lot of sub-topics, such as what mechanical systems are, you would have mechanical systems and control, and electrical systems and control, these are the topics under systems and control in the Senior Phase.

Researcher: How do you actualize creativity and design in your teaching of systems and control? Because we spoke about the system's approach and the contents that are involved. But when you deal with systems and control, how do you actualize the issue of creativity and the design process?

Participant: Normally for the sake of creativity, because that's what we do under design. we always speak of the design brief and stuff like that. But for it to be more actualized we normally give these learners different types of pictures of different ideas. And then when we say design something that is different out of this. So, the aim is to show them the different ideas that are existing, then they need to bring up their own creativity just to change to bring more development in terms of what it's being designed.

Researcher: have you ever thought of integrating aspects of IKS in your teaching of the creative design processes in systems and control? Like now, you explain the process (ukuthi), you give them the scenarios and you even put pictures to enhance their design skills. And then that's where creativity pops out as they deal with this content of systems and control be it mechanical or electrical or electronics or digital systems. So, my question is, have you ever thought of integrating the local knowledge or IKS about those things in class?

Participant: not exactly, like I have explained that when you look at the concept there are illustrations that are in the textbooks, and then at the end of the day focus on what is supposed to be assessed. So, it's quite difficult, to bring in the local knowledge. More specifically, when you're teaching, it's quite difficult because you are scared to find the learners now responding to what is not going to be assessed, because that is the challenge, the content that we teach the content that we assess, and we assess based on what was taught. So that is, the difficult part of it is creating the line. When you teach, you focus on what it's been given in the annual teaching plan (ATP), and what is in your textbook. So, bringing in the local, or the local content, knowledge might confuse the learners.

Follow up (researcher): Okay, in the case of where you teach about pulleys, for example, (yes- **participant)**,

Researcher: Haven't you thought of the way they use pulleys in their local content to solve a particular problem, like for example, using a rope to tie, a beast when they want to slaughter it? And why do they do this in such cases, for example, fetching water from the well? And using these things, and where they fetch water using the borehole system, where they hold the lever and they run around. Have you ever thought of maybe putting some of those examples as they learn about these mechanisms in your teaching?

Participant: those things were used before. So, like I said that the generation that we are teaching these days is it's more on the modern part of doing things. Because normally when I'm teaching pulleys, the only example that you can give them that they're more familiar with, can refer them to a car engine. Because they are pulleys. They're inside the car engine and the car engine is something that they know. And another example that can be local to them but which, they no longer participate in is what we used to call in our language Umjinko (a swing). I don't know what to call it in English - a swing because when you look at the swing, they normally used to put the pulleys up there so that it can allow the rope to move up and down. But they were not using the pulley as the concept that we have is as a circle and groove on it, they will tie the rope on a tree, but the rope will be allowed to move on the tree up and down. So, to move these kids from what is in the book or the textbook and what and what we see these days on the TV in something that was practiced a long time ago, it's quite difficult something that is being practiced in their societies, it's quite difficult for them to conceptualise it more especially when they're supposed to link it with what we're teaching them in class. But those things were there, and they have practiced a long time ago. But for me as a teacher to use those things as examples, I will have a challenge because when we are supposed to assess, and then they start to refer to those things. That is not the content that we normally look at.

Follow up (researcher): have you ever maybe explored with them as learners ukuthi how do you relate this with what you're doing at home or in your community?

Participant: I've never, I've never got a response, okay for learners where they will identify something that was used a long time ago, which is related to the concept that I'm teaching in class.

Follow up (Researcher): Okay. Don't you think the Integration of IKS can help in this case for them to understand the very same content you're talking about with ease?

Participant: Definitely. Okay, because, like I was saying that these things, they move parallel, but the only person who considered the parallel, it's me on my understanding as a teacher, but for them, that this thing is there at home day at home, they're using it every day. It's quite difficult, to raise the resources that we use. They focus more on the Western concept or illustration, but not the local part of it. That is why I made an example of, or we are teaching process and when they talk about storing storage of food. I have done not or, I forgot the name of the textbook, but it's the old version of a textbook, the new versions of the textbook, they use modern examples of storing food.

Follow up (Researcher): this means in short, the text that they are using to learn this thing in class, it's 100%, Western-oriented than local.

Participant: Yes (okay).

Researcher: What opportunities, if any, do you think IKS can present for you, for you towards teaching the creative design processes in systems and control?

Participant: the IKS can make our teaching and learning to be more practical, which could enhance the learners' understanding because understanding something that you do daily, is not simple, as understanding something that you will speak along the way. So, I think if the IKS can be considered, particularly with the authors that are writing our books that are accredited by the department, I think that can make our teaching to be simple, and it can make the learning part for learners also simple because they will do they will be assessed or taught about something that they do daily because technology something that we utilise everywhere every day. Most of the things that we do will utilise the concept around technology but, the concept of technology, common everyone is talking about something that is having a Western concept. Hence, it's something that we have because it's just the use of knowledge. So, it's something that we used to have many times ago. So, I think the IKS can enhance teaching and learning.

Researcher: Do you engage IKS when designing/developing/planning creative design activities/tasks in Systems and Control?

Participant: Recently, I've tried a because I remember the task that they give the learners was talking about a rural area around, just to move the concept away from talking about things that they know. So, they had these mini practical activities that we are doing these days. So, the scenario that they were talking about, was local because we're talking about structures. So, I've structured the scenario in a way that it describes the weaknesses in their school, just to bring it down local so that they can be able to familiarise themselves with what is happening local because the scenario was around the issue of inclusivity that the schools need to be able to accommodate learners who are able to walk and learners who also seating on a wheelchair. So, we are assessing the infrastructure in terms of structures and structures accommodating learners who are using a wheelchair. So, the concept was around that. So, they will learn something about something that is within the school, something that they can relate to because the task was about designing and making stairs in the ramp. So, they were supposed to evaluate your school whether it is an inclusive school so that it can be able to accommodate learners who are able to walk in learners that are not able to walk.

Follow up (Researcher): so how did you encourage them to promote their local knowledge towards understanding that scenario.

Participant: normally I use examples that are local for example, we classify structures for me, I normally refer them to the guys that we have around the road that we have people who are building what we call butler doors, normally. So those people what type of structure is, and they will know that is a frame structure. So, this thing is done locally, and someone just cuts in and joins different types of metals. And then you will have that thing as a structure. So, to promote this local, normally use local examples, that you're talking about the solid structure, you don't have to look at something that is the normal rock that you see that thing it is a solid structure on its own. So do that example that we use, I reflect back on what they have on their community. I prefer more examples locally; we have people who are doing the structures that they have locally for an example.

Researcher: what do you do to support learners to master the creative design process activities in systems and control based on their local knowledge or context just to beef up from what you have or were just saying now?

Participant: On one thing that I use the examples, I prefer more examples that we have local like issues of structures. So they were people who were getting the structures around, or if so you ask them the different types of structures that they have, for example, I'll say to compare the gate that you have at home, look at your neighbor's kid to look at your kid, the way the main aim is to design and look at the differences, look at the weaknesses of your gate and look at the weaknesses of your neighbor's key and try to develop something that is different from what they have. And something that can be more enhanced from what they're hearing. So, to make sure they at least have the creativity, and I don't like the issue of giving them pictures, I know might give them a practical example look at 1,2,3 around the environment. So, tell me what your idea is of those two towards the loyal variable to the practical part of it, it becomes simple for them because they see these things every day.

Researcher: What support do you put in place to allow learners to produce a clear description of these IKS or local knowledge elements when they are in this creative design in systems and control? how when it comes to the activities, the support that you give them, when they do these types of activities, to encourage them to use local knowledge.

Participant: Normally, when we do projects, we ask these kids to bring the used materials from home. For example, if maybe we are to design preachers ask them to go and collect materials that were used such as cut boxes and everything that is being recycled. So, it's something that they get from the community and then they bring it to class then you start to make the project out of that.

Follow up – researcher: what are the elements of systems and control there? For example, they bring cut boxes to build a car, yeah, but the wheels are part of systems and control in that case.

Participant: Yeah.

Researcher: Do you create sometimes opportunities for learners to reflect on their IKS in design activities in systems and control where you allow them to express themselves with a local understanding of what they've done? Do you normally give such opportunities?

Participant: on that one, I normally compromise when it comes to the language, okay. I allow learners to present the concept in their own language they understand, more especially when they are presenting not when they writing, I would ask them that you can present in your own language.

Follow up (Researcher): What about during the group discussions?

Participant: even during group discussions they use their own language when they're presenting. But when they are presenting normally, we encourage them to use English, but sometimes allow them to also present in their own language because I also understand most of the language that they use.

Researcher: how do you teach learners that they can bring in IKS in their design activities in systems and control?

Participant: For them to be able to bring a case in. For me, I guess I used most of the local content examples referred to something that is local, the task, when I designed the task, I quote something that is local on the task so that they can be able to relate to say no, this is something that we see everything to the manner in which I present the task I make it to be local. The concept that I use if I have to mention a place use a place that is local so that they can be able to understand.

Follow up (researcher): Have you ever thought maybe to call an elder to come and explain their experiences about these systems and control elements? As elders within the community, because schools allow them, they are stakeholders have you ever thought about that to create an opportunity to have them come and explain some of these things?

Participant: No, inviting an elder to the school I never thought of that one but we normally give them maybe questions, you will refer them to go and ask, particularly with your elders, in bringing what they're saying. That is part of finding out how things were done a long time ago.

Researcher: Okay, thank you very much, what teaching strategies do you engage learners with towards the realisation of IKS during Lesson?

Participant: No, I display pictures of the things that we used to do a long time ago that's how I bring them back I will use pictures of things that you normally use a long time ago for example, the textbook that I was talking about I just made posters made a copy of that that the illustration that I gave you today so that they can see how the part of storage was done a long time ago so it's something that we relate to pictures because around the community a few things that are linked with the knowledge that was used long term but now we normally use pictures and videos just to show you how this is how I've just done long term. **Researcher:** So, this means that is the way you are promoting so that learners can get engaged with IKS, okay.

Researcher: What do you make sure that the strategies that you're applying are rooted in the learners' local knowledge?

Participant: It's quite difficult to do it, it's quite difficult considering the Western concept that we have these days because when I'm teaching I try to make sure that they bring something that is something that is common to the learner something that they are aware in something that they know so we want to bring that old concept or knowledge it's quite difficult because they can't relate to looking at their generation it becomes difficult for them so it's not something that we use as a strategy to make sure that they link their knowledge with what we have their local.

Researcher: Previously, you said you used to allow them to use pictures and allow them to use their language and sometimes videos, okay, and how do you assist learners to engage freely with IKS aspects towards expressing their opinions when learning the creative design processes in systems and control by these do sometimes allow them to narrate telling stories about these things and whatever. How do you engage them freely with IKS towards expressing their opinions?

Participant: However, that one will only allow them to use their mother tongue. More, especially with group discussions or peer discussions to use their mother tongue, sometimes you're going to ask questions, we also promote that no, you can put it in your own language, then I will just rephrase it in English so that it can link with the content that we are having on the textbook.

Researcher: How do you ensure that the integration of IK s is catered for in your creative design process activities in symptom control?

Participant: At one for me, it's always textbook based IKS doesn't do not come in regularly.

Researcher: Okay, do the strategies that you use lead to integrate IKS in creative designing successfully in systems and control? It's a follow up to that one.

Participant: Maybe when I do illustrations and explanations, I will give examples that come from the local knowledge.

Researcher: Okay. Are there any specific challenges that you encounter towards integrating IKS in creative design activities when teaching systems and control topics?

Participant: IKS and systems and control particularly when you look at the materials we use and that we have, it's quite difficult to take the challenge because of the concept that they used in the illustration that they used in the materials that we use these days. So it becomes a challenge.

Researcher: What do you do to address some of these challenges?

Participant: This one I normally change the concept and address them in my in our home language. If it's an activity, we try to put it in a local context that activity but normally I will do it verbally, just to narrate it in a way that fits our local context. But also go back to the textbook, because the big challenge that we must use that to move these kids away from the textbook to the local context, it becomes difficult for them to draw the link between the two even though you're trying to enhance the understanding based on something that they know. But when you take them back to what is in the textbook now, it becomes a little bit difficult to link them.

Researcher: Okay, how do you promote the community of practice in your, in your class, by a community of practice we mean learners who have knowledge and learners who don't have much knowledge put together to share their experiences during the learning process.

Participant: Normally with that, we used to do group work, before COVID, we used to do a couple of learners working in a group. So we're taking the issue of group dynamics with their creativity and the way they do things. It's quite different. And they also come from different families. So if you mix them in a group, then that's where you will get those dynamics. They are doing things in a different way.

Researcher: Okay, tell me about the role you think indigenous knowledge holders or experts can play in sharing knowledge and skills about creative design processes in systems and control in your community, the experts of indigeneity or knowledge holders that, you know, what role do you think they can play?

Participant: I think that that can preserve the community's culture. They can also promote the community's cards because for example, if you check how the communities used to communicate a long time ago, and you check the way things are done now if they were given a chance to be in class, it was going to preserve the community, the culture of that particular community, the way in the manner in which we dress these days, and how we used to dress back then. So if we have those things preserved and taught in class, I think it was going to preserve and promote the culture of that, that community, that the types of carpets that we used before we used to mold, things like the mat, that was the mat that was used before. So if these things were taught, I think it was going to promote the culture of that particular community. It would also want to promote the economy of that community with people who will go to buy and promote those things, that now everyone is moving to Western things.

Researcher: Do you think they should be a framework to guide you in achieving the integration of IKS?

Participant: Definitely that one would work.

Researcher: which suggested elements do you think can be roped in, towards developing such a framework?

Participant: is supposed to have a link between the concept that are used in the textbook and the concept that we use in a local area because when you check the practice, it's the same, but the manner in which was conceptualised, it's not the same. So that's why it becomes difficult for learners to draw the line unless you add the level where you can understand to say no, okay, if you're talking about a system, the swing the old swing that was done a long time ago, it's simple. It's the same thing as the swing that has been explained in the classroom. So I think they manage it just conceptualise the diagrams that we use in the textbook if they can be able to draw the link between the two, but back then this is how it was used, then this is how it is being used. So, I think that it can work.

Researcher: Okay, is there anything else that you want to say, which is not covered in this interview regarding these things that we've been talking about?

Participant: Well, I think we've covered everything. We've covered almost everything because the interview is based on mechanical systems, but the one cut across the subject, there are so many links between the old knowledge and the new knowledge that we have in the customer. Something that was what was done before, just the concepts now, they are more modernised.

Researcher: Thank you very much for giving me your time to answer some of these questions.

APPENDIX 14: CURRICULUM ADVISOR'S SEMI-STRUCTURED INTERVIEW TRANSCRIP

Researcher: Thank you very much for allowing us this opportunity to interview you sir, and feel free to respond the way you can to the questions that we're going to ask you, what is your understanding of the IKS (indigenous knowledge systems) to the teachers' project or local knowledge?

Participant: My understanding regarding the knowledge, indigenous knowledge, to the teachers is that teachers need to be orientated to this area because it's one area that has been neglected when it comes to the implementation of CAPS.

Researcher: Okay, when you train teachers, do you bring in indigenous perspectives or local knowledge perspectives?

Participant: As we go about with our workshops, in terms of training teachers, this area of the indigenous knowledge system is not entertained, like we are not giving them any knowledge regarding this area.

Researcher: All right, how do you help teachers interpret the CAPS with reference to the technology subject?

Participant: So, in terms of helping teachers, is that the approach that we take is that of ensuring that teachers are developing their lessons by paying attention to the annual teaching plan. So, in other words, this annual teaching plan that then becomes our framework is like our driver. And then when looking at it, the ATP, this indigenous knowledge system, as an area that will be integrated into the teaching of the subject is not included in the ATP,

Researcher: okay, in relation to the indigenous knowledge aspects of caps. How familiar are the teachers with indigenous technologies that relate to the content of systems and control?

Participant: teachers are familiar with the indigenous knowledge system, especially when given examples to say, this is one area, that can be related to indigenous knowledge systems when dealing with the systems and control that if you don't give them examples, and you don't share or relate that to the subject, then it's like a, they're not going to be interested in that area.

Researcher: Specifically, teaching the design process, in the mechanical systems or electrical systems, what examples of IKS do teachers normally express as you visit them in schools?

Participant: No, this area is not addressed at all, it's not addressed The reason for not addressing this one is that the teachers are not taking the integrative approach. In terms of planning, their lesson ensures that as they are handling these systems and control, they need to bring in examples from their local area, so that they can make it simple for the learners to understand,

Researcher: but do you normally encourage them when you do training?

Participant: In terms of our training, we don't encourage them as I indicated earlier that we stick to the ATP.

Researcher: And this ATP was it developed by you?

Participant: No, it is not developed by us, it is developed by the National Department.

Follow up - Researcher: you get them from the national department filter down (to schools) to provinces and districts and schools. Yes. So, this means it's a top-down approach, (exactly). which means in your case, you don't have time where you can sit down and say, okay, let's modify it to suit our area you have to implement it (as it is). Okay, now I get the story. How do they integrate local knowledge examples in systems and control contents, in the instances where you find they are trying to integrate the local knowledge?

Participant: In terms of the local knowledge this area is not, is not well addressed. Yeah, is still a gray area.

Researcher: which means they move with ATP, yeah, we move with ATP, these others are just falling on the peri pheri, and it's fine.

Participant: The reason for moving in that way is that the amount of time that is allocated to the subject encourages them to stick to the ATP because, in a week, teachers have got only two hours for the subject. So, they are trying to ensure that by the end of the term, they've addressed all the content areas as indicated in the ATP.

Researcher: This means that they use a religious approach, which is indoctrination. You do it as it is, you don't add anything to it and move forward now I see, which means it's results-driven, not knowledge-driven.

Participant: Exactly.

Researcher: So, how do you sometimes guide those teachers to actualise the 3rd specific aim, especially with reference to the integration of indigenous technology when teaching creative design activities in systems and control?

Participant: You see the area that deals with creativity is not entertained. In the sense that when it comes when giving learners this project is like that is when learners are supposed to show their everyday ability to display their creativity. But the manner in which these scenarios are written, they don't demand that the learners become creative like let me give you example where the learners are supposed to design and make a rescue system from the resources that learners are using examples of rescue systems are already given.

Researcher: Okay if your learners are not able to come up with their own creativity.

Participant: So, in other words, when learners are given such projects, they should be given to the point where learners need to use their creativity so that they come up with their own models in terms of solving the problem. So can you see that it becomes difficult for learners to be creative, when we have to make a rescue system, you go to the examples that are already available in terms of the rescue system. And then It's difficult to come up with your own particular going to be given a problem and then require you to come up with your own design own solution your own design and your model and so and then it can work.

Researcher: Oh yeah. Now I see the pattern. So, this means the approach that is used sets aside the issue of creativity it's a do as you see it, yes. You don't have to think and produce your very own which means there's no innovation, no creativity that is being and, how are these mini-PATs designed, because seemingly that's where these things are happening.

Participant: In terms of learners, developing these PATs the area where learners are supposed to be creative is very limited like I've just indicated when the learners are to make a rescue system there is nothing with the creative more creativity that is going to be involved. So

Researcher: Thanks for that aspect and then for that angle. And how do you guide teachers to use or integrate local knowledge to impact their teaching of these activities in systems and control?

Participant: The issue of creativity regarding the local knowledge systems is very limited in terms of ensuring that impacts the teaching of the systems and control.

Researcher: So, how do you guide teachers regarding the content and teaching strategies, which can promote the integration of local knowledge?

Participant: In terms of guiding teachers, that area needs to be improved, because, when the curriculum technology was introduced, this area of integration was well entertained, but when CAPS was introduced, then we moved away from it. Integration, which means it took away also the creativity part in the design where learners would come up with their own solutions. So, it means the solution is already there for them is just to put the parts together, to see that something happens, they just join the dots.

Researcher: What opportunities if any, do you think IKS can create for teachers' teaching of the creative design activities in systems and control?

Participant: There are so many opportunities where we can introduce the knowledge systems in ensuring that especially when developing the material for the training of teachers, that is one area where we can incorporate it.

Researcher: So, what do you do you get the time where you develop material for teachers or it, or you are restricted to assessment tasks only, we do develop materials but at a very minimal level.

Participant: So then, the provincial coordinators, these are the people who are developing material and they train, and they train us on the material.

Researcher: So, you train teachers. So, do we have this sample of material?

Participant: Yeah, I do have the material, yes, Okay I would like to see the material, but most of the material, once it has been developed, we go through it to check some of the things and then we go and train teachers. But in other cases, we sit as a team in terms of grades, and then we develop the material. So, in those teams, what is the principal objective is to is for you to get a common approach on how to interpret this document to teach us or you to seek to come up with some new items to include in the material. The issue of coming up with something new is limited, very limited. This means the primary objective is to get a common approach to how you're going to train the teachers. So, in other words, we want to ensure that the officials who are training in Nkangala, are training the same thing as we are training at Ehlanzeni or Gert Sibanda. We are taking a common approach.

Researcher: This means you make it universally for the province so that when the teacher maybe attends in Nkangala from Ehlanzeni, should get the same thing or content as when they are in Ehlanzeni.

Yeah.

Researcher: So, what strategies do you put in place to encourage or guide teachers to collaborate with communities or indigenous experts or elders to make sure that teaching and learning of these creative design activities are informed by those local contexts as a priority?

Participant: We don't have strategies here. Okay, yeah.

Researcher: Okay. There was no way in which you encouraged them to also involve the local people who are experts in the local knowledge. Okay. It's fine. how do you engage indigenous knowledge systems when you design, develop, plan, or create activities or tasks for teachers in mechanical or electrical systems?

Participant: in terms of (clarity seeking)

Researcher: When, like you said you develop some materials at a minimal level though you said earlier on, it's normally not the case that you could see that the indigenous aspects of it (no this one you answered it) do the activities planned for these contents promote the use of local knowledge towards understanding the meaning of what they teach? in terms of the activities that you develop, do they, for example, promote the use of local knowledge that maybe they can even give examples about things that are happening in their locality.

Participant: So, we don't promote it.

Researcher: Okay, the use of the local knowledge you encourage them to stick to the plan as it is.

Participant: to the plan, in other ways, this is an area where we need to develop because once we have developed from this area, then we will ensure that we include other areas as indicated in the policy, the area that deals with the impact of technology, the biases because now is like these three areas, are no longer entertained now, they're not, so even if they are entertaining, they are entertaining as part of separate entities from the main content which means the realisation of the three specific aims is not done in an integrated manner. They are just done as separate entities you deal with design steps you are done, you come and deal with content and you give them activities to apply those steps and the correct approach was that one-off integrating you deal with structures yeah and then integrate with it with the local knowledge system deal with the electrical system then you integrate with the knowledge system go to processing then you integrate with the so like these integrations. So, which means you mean one can suggest that now that we talk of the ministers talking about decolonisation the curriculum, we need to revert to that approach. So as to see ourselves that these things are realised, exactly.

Researcher: Okay. How do you make sure that teachers' development promotes the integration of IKS or local knowledge and skills?

Participant: In order to ensure that there is development teachers just develop, so that when you have this material, you normally call them, and you develop them?

Researcher: So, how do you ensure that in your development, you also encourage that they use local examples?

Participant: So, as I indicated earlier, in terms of us developing the material for the workshop, this area of ensuring that there is development in teachers should be included in the whole package that we develop because as we are training them, then we'll bring in the knowledge system, then they will take that to their school and then they will be able to integrate with confidence because they shall have learned something from the workshop,

Researcher: Okay. so, what do you think could be the support to be put in place to allow teachers to produce a clear description of these local knowledge elements when teaching these contents?

Participant: The support that teachers will require is training them yes because it's like an is like is one area that has that is neglected. Then once it is neglected, then people are not going to be interested in so if they're going to be trained, then they're going to become aware. Yes. And as they are being aware, they're going to develop interest. Then they will take their interest to the learners, and then that is how it will grow.

Researcher: Like you are saying, I was interviewing one teacher yesterday, and he came with one perspective, which we don't normally look at what is in the community, which learners are familiar with, my community is rich with farming with its farming sugar cane, and my community has got a coal mine, in my community is reach in culture a Swati culture, then, as we're running the interview, he said, I start to realise that when we talk of sound, I don't translate the air that I speak about on pneumatics, I relate it only to compressors, forgetting that sometimes we blow a horn, exactly, that is compressed air coming from me. And normally in our communities, when the chief wants people, at imbizo, they blow the horn, the one that he said he never thought can be linked to pneumatics and hydraulics. And even simple cooking, that thing that we use to cook is made out of wood. And then there you can also relate the principles of a lever with something that they do on a day-to-day basis, then they will be able to understand the abstractions. So, I'm on your point, when you said you see a need to integrate such things meaning training so that they can be able to be aware of these, it doesn't mean that they are shifting away from teaching the content, but they are enhancing the understanding.

Participant: So, can we also indicate that the manner in which we approach the content that we teach is like, we don't think deeply about what is involved, yes, we just take whatever is given to us is like we are lacking this area of critical thinking just take it as is. And see, then that is why we are not producing creative and critical thinkers. So, which means it should start with us because, at a given point, learners need to question some of the things as we bring those activities to class to say, but how is that possible, sir. So, in other ways, as we come to class, they take everything as given. They don't question anything. And then that approach, if it needs to be revised because they need to question that is why at the end, the teacher is going to end up asking, is there any equation? then learners are going to be silent because they are not used to questioning things, the very same thing that is happening in our communities. And parents are called to a school parents meeting. Sitting there, they are being given information about the school funds, they don't question anything, they don't even contribute to say, but as a community, we need to come up with fundraising campaigns, these are the things that you can do. They just take everything that is given by the SGB and the school management team, and then there is the end of the day. So then that area of questioning is very, very important. And then this area of questioning should be included, especially in the curriculum.

Researcher: This means you are saying teachers and curriculum advisors need to be given time to have a say in critically engaging with a document. It is being used by the system, and the way it's designed is creating a community of followers.

Participant: Exactly. Not a community of people who critically look at this thing and say, why don't we do it this fashion in our own context is that.,

Researcher: yeah, no, I get it so, do you sometimes create opportunities for teachers to do reflections on their training?

Participant: that area is also lacking, it's lacking, we don't do reflections. The reasons for not doing reflections are so many, one of them is that we don't have enough time. Okay, it’s like you call them for an hour, you learned for an hour, it is done they must leave. And then other cases, you end up not finishing the whole material that you've prepared, you to see. So, in other words, the way you are supposed to invite them to reflect on the activities that they did in term one, we don't have time for that when they are called to the second term's workshop, we go straight to the second term's activities, then you're rushing because your hour is coming to an end (laughs).

Researcher: it's fine, how do you engage teachers to the point where they are capacitated to bring in the indigenous knowledge system or local knowledge system when they deal with these contents,

Participant: We don't engage, (you don't engage), as you said, they are given the material, this material that you're going to use, we have to approach it this way. This is the end we're going to do 1,2,3, bye-bye.

Researcher: Okay, now it's fine, what teaching approaches, do you engage teachers towards the integration of this IKS or recognition of this IKS during the lesson when they do present their lessons?

Participant: This area is lacking Buti. Yeah, it's like the issue of the knowledge systems in terms of the teaching approaches. It's lacking because what I found, I picked up from schools on both sides. It is that side and this side is that since COVID came in they were restricted to group learners. So, this means a teacher is the one who's supposed to demonstrate the teaching. So that way, the whole teaching methodology of the subject is like it has been compromised.

Researcher: What strategies do you apply to promote teachers' engagement with local knowledge in the teaching of these content of systems and control? the strategies that you apply yourself when you train them.

Participant: The strategies that we normally apply would include the hands-on approach, in other words, teachers are required to bring in the real objects to class. So that when talking about the meshing of gears, learners should be able to see that, the teacher must be able to demonstrate. You should be able to demonstrate and then learners see that kind of meshing taking place.

Researcher: I can attest that I have seen it happening in different classes I observed. Okay, no, that's fine. What do you do to make sure that the strategies you apply in your training or support to teachers are rooted in local knowledge?

Participant: The approach that we take is not rooted in local knowledge, it's just rooted in the context of ATP.

Researcher: it's fine, what do you do to encourage teachers to integrate information in relation to local knowledge, when training or supporting them?

So, we have to encourage them like as we were unpacking the equations, saying that this is an area.

Researcher: Okay, from your experience, as you visit classrooms for support. How do learners receive the use of local knowledge when teachers are teaching them?

Participant: You know, what we do as a district we develop what we call, or we have got a project, that is called a lesson study. So the lesson study, encourages team teaching what we do, we look for a school, and then we organise the teacher to say, on this date, you are going to teach this area, then we organise local teachers in that area, then you sit down with them, then we develop a lesson, oh, then from there, we are going to we would normally let the educator demonstrate in terms of showing us as to how is he or she going to teach it the following day, or when we have got the visitors.

Researcher: which means you are doing what we call a community of practice of some kind?

Participant: Not necessarily teachers should come together to share knowledge so as to have a common understanding and approach. So that if somebody visits this school, that school, and that school you find that these teachers are almost at the same level. Yeah,

Researcher: I can attest to that, because one teacher said to me that he discovered the simplest way of dealing with pneumatics and hydraulics, then he was requested to share it with his colleagues exactly in the district. So, now, these teachers are following the same thing, which is very good, even to the novice teachers, that they learn from best practices, yes, and they are all able to view these things at the same level.

Participant: Thank you, it means that when it comes to the local knowledge system, we needed to use the very same approach because normally teachers do not have the same understanding because as a system, we have young teachers and then we have very old teachers. So, then this group of teachers is supposed to be operating at the very same level, regardless of age and experience, promotion of a principle of Ubuntu you create a community of practice based on lesson studies. So that we learn from each other and be effective in our classrooms of which you as their supporter or their leader, you are able to have a picture of what is going to happen in their classes even if you don't visit their classrooms. On the other hand, we are saying to the teachers don't suffer in isolation. If there is one area that you don't understand your shout Yeah. So that you are going to be assisted. So that along the way, we develop confidence, and then at the end, you'll be able to teach that area well Okay, and master it at the end.

Researcher: but do you make follow-ups to visit some schools and check whether they're doing it in their classes?

Participant: That is a challenge because once they've done it because we are few in the district, we normally don't do follow-ups. Yeah, we don't do follow-ups.

Researcher: Thank you, I learned a lot here, what mechanisms do you put in place to ensure that learners are assisted to realise the importance of local knowledge in their learning?

Participant: in terms of mechanisms regarding the knowledge system, we have none, but we do have mechanisms for ensuring that the correct content for that given term is being done (okay). We normally call for moderation in the following term so that we look at areas of best practices and areas of improvement. So then check the assessment activities developed by the teacher. We look at the manner in which the moderations were conducted by the H O D, and then we are able to sport at areas of improvement and then best practices from other schools. And then we are able to take that to the teachers when they are conducting workshops to say as we do this, and that this area was done well by other schools we can always say use the same approach in case you are struggling to that area.

Researcher: And then, do you normally check learners' written work?

Participant: Yes, we do check learners' work as we visit schools because in checking the learners' work, we normally want to check their content coverage and curriculum content coverage. So, we use the learners' books because the ATP indicates to say, these are the areas that you should be covered in a given week. So, as we visit the school, we make sure. We check the learners' books and vice versa the ATP to say this area, but learners were not given any activity regarding this area. So, then the teacher then is then given a direction to say this area should be covered as well, this area was covered, then this area has not been covered this area, more examples should be given, then in terms of teachers doing remedial, then they will sort of pledge to say, or this area was not covered. So, then they sort of address it.

Researcher: This means even when you do check these learners' work the thought is to check whether their written work includes the context in which they learn.

Participant: It never came, because you are looking specifically at what ATP is saying, exactly.

Researcher: In your reflection with teachers, what advice do you normally give towards helping learners to have a full appreciation of the integration of local knowledge in their learning of these contents?

Participant: In terms of doing reflections, with the teachers like you said, normally, you moderate what they have done this term, it's one process of reflection. Yeah, which at the end you give feedback yeah, with teachers, yeah.

Researcher: So, in that case, have you ever given advice to teachers to help learners fully appreciate the integration of local knowledge, or of which you said earlier on it's something that needs to be considered (it has to be improved)?

Participant: because remember, I indicated to say that the integration, when doing integration, we needed to integrate regarding this area, the knowledge system, the biases, and the impact, but on top of that, there is one critical area the critical thinking skills without learners critically thinking about material engaging then learners are not going to be creative at the end because they need to critically question, they need to critically think about any other material that they are given. So that they can be in a position to critically develop and be creative in terms of developing new products.

Researcher: how do you assist teachers to engage freely with local knowledge aspects towards expressing their opinions when teaching these contents in systems and control?

Participant: in terms of teaching the systems and control, we are not assisting teachers to engage freely with knowledge systems. so, they will have to stick to what is there in ATP and the textbook that they have. Okay, so, in other words, we are textbook driven, yeah you understand that these textbooks when they were developed, were not given the mandate to address this area, should the developers be given the mandate to address these knowledge systems. I'm thinking that all our textbooks were going to be guiding teachers to address the issue of the knowledge system in terms of them unpacking their content, you understand. So, in other words, the material developers should also be given time to think about these knowledge systems in terms of them developing the material, ensuring that that thing is taken to the classroom.

Researcher: because I tend to believe that the department put some guidelines on how they want the textbooks to be developed and I think they do have the evaluation form to that effect

Participant: Yes, they do have a checklist, this is what we want, this is what we want and all those things. So, which in that evaluation criteria, we need to include these aspects, It has to be included then things will then start to happen.

Researcher: how do you ensure that the integration of this local knowledge in activities, topics during training and support of teachers, integration of IKS in creative design activities, in systems and control during training and support teachers, how do you ensure that this integration happens?

Participant: So, when training teachers now, this area of integration of local knowledge aspects is not entertained. So, in other words, since it's a gray area, meaning that it is going to be one of our areas of development, it has to be developed.

Researcher: This means that this interview exposes the gap that exists. So, are there any challenges that teachers encounter in integrating local knowledge that you know?

I don't think we would have some challenges because it is not attempted it has not been attempted.

Researcher: Okay, but were you aware that some teachers are doing it anyway?

Participant: Yeah. I am aware.

Researcher: I was observing one teacher yesterday who did very brilliantly to teach the pneumatic and hydraulic systems within the context in which these learners are coming from because they even in class identify a learner whom they say yeah, this one answer you sir, because he's a Ganda-Ganda, driver, when they were talking about shock absorbers, some of the tractors and stuff, things that they do, because, in that community, they specialize in with farming. Yes. So, these are some of the things that we are talking about. So, he did it very excellently. So, this means even in this case, some might be doing it though they are not getting it from the training just to enhance their understanding of the content.

Participant: Others would be doing it in a way of giving the learners exemplars you understand or in a way of simplifying the content, then they would do it in that way.

Researcher: Okay, so that will be the way to address the challenge is just to encourage teachers, even if it's not part of ATP, but they must be able to give local examples of exactly where these things are applicable.

Researcher: And then do you think there should be a framework to guide teachers in achieving this integration of local knowledge?

Participant: We can't do without a knowledge framework.

Researcher: So, what aspects do you suggest could be added to this framework?

aspects to be included or elements that you think, if we can include 1,2,3,4, I think it can make wide support and guideline to teachers.

Participant: My elements would include integration. Integration, in the sense that we've got the content areas. Yes, when we look at each content area, then we look at an area where we'll integrate the knowledge system work or the local knowledge system work within a certain content area, which means we say take a content area, piecemeal, we locate some content a local knowledge into it, and we show the final product at the end. Meaning that with the systems and control that we are dealing with like we will be looking at an area where we are going to integrate the knowledge system and, in the systems, and control yes and content, that if they are dealing with pneumatic or hydraulic or gears or whatever then we show the local knowledge that can go with those things as they teach in the classroom.

Researcher: Sir, thank you very much for your time this interview was so informative and fruitful that even as an interviewer I learned a lot from this interaction. Thank you very much.

APPENDIX 15: LEARNERS SEMI-STRUCTURED INTERVIEW TRANSCRIPT

Researcher: Thank you very much for coming to participate in this interview. Just feel free to share your opinions about what I'm going to ask you. What is your understanding of indigenous or local or homegrown knowledge?

Participant: My understanding is that, like, any knowledge you learn from home will be useful in school or anywhere.

Researcher: Okay, are you familiar with the CAPS Technology document?

Participant: No, I'm not familiar.

Researcher: Okay. What about the specific aim that is IKS oriented?

Participant: I am not familiar with that completely.

Researcher: Okay. So how is IKS or local knowledge realised in your learning of technology in relation to the design process in systems and control content?

Participant: When you say that, it reminds me that during the start of the session, say explain that in the olden times, people used wells to get their water. That's when I realised that it connects indigenous and modern connects because we used to do that in the past.

Researcher: So how were they able to determine what mechanism they used to fetch the water from the well?

Participant: Like they used to have a curved wheel in the middle and a rope that went down with a bucket tied on it, that is when they then collected the water and they pulled it using their effort? That's what we learned in technology, that is how people had water.

Researcher: Okay, but have you experienced that yourself?

Participant: No, I have not. Okay.

Researcher: Did your parents experience it at once? did you check with them?

Participant: I have never asked them.

Researcher: Okay, okay, what indigenous technologies can you think about from your environment or local context, indigenous technologies that relate to mechanical or electrical systems?

Participant: At home, we have a generator, it's pretty big. You can't lift it on your own. So usually, my dad ties a rope on it and uses the same kind of knowledge we learn today to pull it and place it.

Researcher: Okay. Did he once tell you the reason why he uses the rope to pull it or have you ever asked him?

Participant: I once did he said it would be too heavy to lift off his own strength and soon be strong enough. So, he uses a rope to pull his van down to the ground. Okay.

Researcher: And are these indigenous technologies integrated when learning Design process in mechanical systems or electrical systems?

Participant: I don't think so. We don't have actual practical examples. We just have words. Okay, we do we basically don't have that much knowledge.

Researcher: So, this means these words are what the teacher is telling you,

Participant: exactly and is more on, what is in the textbook than related with day-to-day.

Researcher: Okay. How does local knowledge impact your learning of creative design in mechanical systems? The local knowledge, how does it impact your learning of these mechanical systems or electrical systems?

Participant: Usually, I learn stuff before I come to school. Like in mathematics before I even came into school, my sister used to play with me using maths. So, I learned maths before I even came to school. Does that count as something on the question?

Yeah, well along those lines, but we're looking specifically to mechanical systems and electrical systems and so you know, anyway, it's fine.

Researcher: Are the design activities in mechanical systems, or electrical systems, linked to day-to-day experiences?

Participant: I don't usually do these kinds of things at home.

Researcher: But in class, do they manage to link them with your day-to-day experience when they teach you? (no), Okay, how do you interact with your fellow learners on the application of the local knowledge in the activities of mechanical systems or electronic systems?

Participant: usually when they don't understand something one of my friends usually teach as it turns since the teacher was too busy to explain to me so like today in mechanical advantage he the punk ropes were Mr said that we should check the direction of the rope I didn't hear that part, but my friend actually explained it to me that we should look at the direction of the rope to actually count how many ropes are used in the mechanical advantage.

Researcher: So, that made you understand which language did you use? Did he use the local language to explain to you or he used the instructional language?

Participant: He used all kinds of speaking to me and individually speak and mix of English and local knowledge.

Researcher: Good. So that in itself makes you understand these concepts much better?

Participant: Yes, okay.

Researcher: What is your take about the integration of local knowledge or IKS during learning of the design process in mechanical systems?

Participant: can you repeat the question?

Researcher: What is your take about integrating local knowledge in the learning of mechanical systems or electrical systems?

Participant: I think they should give more practical examples for learners to actually understand the stuff better, okay.

Researcher: Based also on the learner's understanding?

Participant: Exactly, most learners don't get it until they see it visually on paper.

Researcher: Okay. What approaches does your teacher use in most cases to help you learn or during the learning process?

Participant: Well, our teacher usually gives us practical examples using unpractical verbal examples, today he told us that wells remember about wells and how they used to use them to get water. So, our teacher uses it very well to make us understand better since he can actually use it visually, he has to do it verbally.

Researcher: Okay. So, but do you think if he could use an approach where he would involve you as learners and get your experiences that could help a lot in your learning,

Participant: yes, it could.

Researcher: okay. How do you find the teacher's approach towards helping you to learn IKS-oriented activities and mechanical or electrical systems?

Participant: I find his teaching methods quite enjoyable. He has a little comedy in it little fear those are the teachers I kind of like okay,

Researcher: have you ever been engaged with the activities in the mechanical systems or electrical systems during your own learning where local knowledge is promoted,

Participant: (No),

Researcher: Okay. So, do you think if they can approach it along that angle, it can be helpful?

Participant: Yes, pretty much so.

Researcher: Okay, are you encouraged to use your local knowledge when answering questions or discussing with fellow learners during learning?

Participant: sometimes we are encouraged even though we have actually never done it because some learners might have so it easy for them to understand better

Researcher: Are you given opportunities to express yourself in your local knowledge? I mean, in the local knowledge that to understand during learning of mechanical systems or electrical systems?

Participant: no.

Researcher: But do you think if that opportunity can be given to you can you make use of it?

Participant: Yes, I would make use of it.

Researcher: But normally do you ask your parents after learning about some other things how they understand them at home?

Participant: Yes, I usually ask my mother.

Researcher: Okay. Is she so helpful?

Participant: Actually. she's really helpful.

Researcher: Okay. How do you reflect on your learning using local knowledge with fellow learners in class?

Participant: local learning local knowledge helped me Yes, yes, yes. Usually, when studying some other stuff like a home language, I am unusually taught the stuff by my grandmother. Yeah. So basically, her knowledge helps me to get better in school.

Researcher: So, which means your grandmother has got a lot of rich local knowledge about things.

Participant: She has been here for a while. Okay.

Researcher: Have you ever asked her about some of the concepts that you learn? And what do they call it in your local language?

Participant: I usually don't get the chance I only visit her only a few days on holidays.

Researcher: Okay. No, thank you very much for availing yourself of this time. I think we have just concluded our interview all the best.

APPENDIX 16: ANNUAL TEACHING PLAN

GRADE 9 TERM 2

TERM 2 **49 days**	**Week 1**	**Week 2**	**Week 3**	**Week 4**
CAPS Topics	**Mechanical Systems and Control Investigation skills**		**Mechanical Systems and Control Investigation skills**	
Topics / Concepts, Skills and Values	• Revise: syringe mechanics using two equal sized syringes linked by a tube. • Force transfer between the syringes filled with: ○ Compressed air – pneumatic system. ○ Water – hydraulic system. • Action research: learners experiment / teacher demonstrates with two different sizes of syringes linked by a tub and filled with hydraulic fluid (water). Learners experience force transfer with either force multiplication or force division • Gases (like air) are compressible. Liquids (like water, oils) are incompressible. Pascal's principle – pressure exerted on one part of a hydraulic system will be transferred equally, without any loss, in all directions to other parts of the system. • Note that equal volumes of liquid are moved through the systems, and this results in different extensions (amount of movement) where syringes (cylinders) are of different sizes, so less distance/more force (MA > 1); and more distance /less force (MA < 1).(why is this part left out?) • The hydraulic press (including simple calculations). • The hydraulic jack. • Investigation: Design considerations ~ fit-for-purpose: ■ Evaluate the design of the hydraulic jack in terms of: • Who is it for? What is it for? Will it do the job? What should it be made of? What should it cost? Is it cost-effective? Does it look good (aesthetics)? Is it safe/easy to use for the end user (ergonomics)? • Draw a systems diagram that describes how a hydraulic jack function.		• Action research: practical investigations: • Use a single wheel fixed pulley to change the direction of pull (MA = 1). • Use a single wheel moveable pulley to change the direction of pull (MA > 0). • Use a pulley block system (block and tackle) to determine the relationship between loadbearing ropes on moveable pulley wheels and M.A (force multiplication). • Investigate: learners find out about the following mechanical control systems: ○ Ratchet and pawl. ○ Disc brake. ○ Bicycle brake. ○ Cleat.	
Requisite pre-knowledge	Mechanical systems and control		Mechanical Systems and Control	

Resources to enhance learning	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.	Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.
Informal Assessment	Informal Assessment	Informal Assessment
SBA (Formal)		

TERM 2 **49 days**	**Week 5**	**Week 6**	**Week 7**	**Week 8**
CAPS Topics	**Mechanical systems and control Investigation skills and Evaluation skills**		**Mechanical systems and control Investigation skills Design and Making**	
Topics / Concepts, Skills and Values	• Lead learners as they **revise** the interactions of the following: • Spur gears of equal size counter-rotating. • Spur gears of unequal size counter-rotating – note velocity/force relationships. • Spur gears using an idler to synchronise rotation. • Lead learners as they find out about the interactions of the following: ○ Bevel gears of equal size – axis of rotation 90o. ○ Bevel gears of unequal size – axis of rotation 90o – note velocity/force relationships. ○ Rack-and-pinion gear system as found on automatic gates and steering racks. • Worm gear system for large reduction in speed and increase in force.		• **Artistic Drawing**: single vanishing point perspective. ■ Learners draw a 3D wooden object using single VP perspective. They enhance the drawing • showing the texture of the wood grain, colour and shadows. • Learners use single VP perspective to draw an inside view of the classroom.	
Requisite pre-knowledge	Mechanical systems and control		**Mechanical systems and control Graphic Communication Skills**	
Resources (other than textbook) **to enhance learning**	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.		DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource "YouTube videos" etc.	

Assessment	**Informal Assessment:** Remediation	Informal	Informal
	SBA (Formal)		

TERM 2 **49 days**	**Week 9**	**Week 10**	
CAPS Topics	**Investigation Design**		
Topics / Concepts, Skills and Values	• Investigate the situation so that an appropriate machine can be designed to solve the problem, need or want given in the scenario. Investigate the possible mechanisms and controls to be used together to make the machine. • The design brief: each learner writes his/her suggestion for the design giving specifications and constraints. • Sketches: each learner produces two sketches of viable possible designs. And then decide on a final solution • **Plan: working drawings** • Learners produce drawings for their model/prototype using first angle orthographic projection. • Each learner draws a plan of the design OR, if it is very complex, one or more aspects of the design. Each learner must demonstrate her/his competency in using this drawing technique.		Revision of content
Requisite pre-knowledge	Investigation Skills Design Skills		
Resources (other than textbook) **to enhance learning**	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	Informal Assessment		

SBA (Formal)	Formal Controlled Test

GRADE 9 TERM 3

TERM 3 48 days	Week 1	Week 2	Week 3	Week 4
CAPS Topics	**Electrical Systems & Control Investigation skills**		**Electronic Systems & Control Investigation skills**	
Topics / Concepts, Skills and Values	• **Revise 1 – component symbols:** - Cells in series and parallel. - Lamps in series and parallel. - Switches in series (AND logic) and parallel (OR logic). - Current in the circuit – conventional current flows from positive to negative. • **Revise 2 – simple circuits:** - One cell, switch, two lamps in series. - Two cells in series, switch, two lamps in series. • **Ohm's law quantitatively**: *as voltage increases, current increases if resistance is constant*. Action research: testing Ohm's Law practically – measure the voltage (potential difference) and the current strength in each of the following circuits: One cell connected to a 20W resistor – note the voltmeter and ammeter readings. • Two cells connected to the 20W resistor – note the voltmeter and ammeter readings. • Three cells connected to the 20W resistor – note the voltmeter and ammeter readings • Plot the readings on a graph and determine the relationship between potential difference and • current strength while keeping the resistance constant.		Calculate Values **Note**: **R** - *represents the resistance of a resistor in ohms*......[Ω]. **V** - *represents the potential difference in volts* [V]. **I** - *represents the current strength in amperes*............[A]. Calculate values: $R = \frac{V}{I}$ use to calculate R if V and I are known. $V = IR$ use to calculate V if I and R are known. $I = \frac{V}{R}$ use to calculate I if V and R are known. Switches: Manual switches controlled by the user, e.g. Push SPST, SPDT, DPDT Diodes and LED (Light Emitting Diode): A diode is a component that allows current to flow in one direction only. A LED allows current to flow in one direction only and also gives off light and is often used as an indicator that a circuit is 'ON'. Resistor colour codes: • Low value resistors often have their resistance value printed on them in numbers. • Higher value resistors are coded using coloured bands. The first three bands give the value of the resistor in ohms. The fourth band is an accuracy rating as a percentage.	

Requisite pre-knowledge	• simple circuit components, component symbols: simple circuits: input devices, control devices and output devices • Ohm's law qualitatively • Alternating current	Resistors as output devices
esources (other than textbook) **to enhance learning**	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	Informal	Informal
SBA (Formal)		

TERM 3 **48 days**	**Week 5**	**Week 6**	**Week 7**	**Week 8**
CAPS Topics	**Electronic Systems & Control Investigation & Design skills**		**Investigate: Electronic Systems & Control Investigation & Design skills**	

<table>
<tr>
<td>Topics / Concepts, Skills

and

Values</td>
<td>Transistors: only npn-type will be used at this level.
A transistor is a device that can act as a switch and it can amplify a small current
Sensors – important input devices:
• LDR (Light Dependent Resistor) – a component whose resistance decreases with light [dark: high resistance; bright light: – low resistance]. with light [dark high resistance; bright light – low resistance].
• Thermistor: a component whose resistance varies with temperature. Two types exist:
• -- + t: resistance increases with increasing temperature.
• -- - t: resistance decreases with increasing temperature.
• • Touch or moisture detector: a component that can be bridged using a ‘wet’ finger, thus completing the circuit, indicating the touch.
• Capacitors: a component which can store and then release electrical energy.
• Simple electronic circuits:
• Learners draw, these simple electronic circuits:
• LED, 470Ω resistor, switch, and 4,5V series battery.
• LDR, buzzer, 3V series battery.</td>
<td>THE DESIGN BRIEF: Each learner writes his/her suggestion for the design with specifications & constraints.

SKETCHES Each learner draws the circuit diagram. Each learner produces a sketch in 3D showing the device that will use the electronic circuit</td>
</tr>
<tr>
<td></td>
<td>• NPN transistor, buzzer or bell, thermistor, variable resistor, 1kΩ resistor, 6V series battery
• 6V series battery, LED, 470Ω resistor, 1 000μF capacitor, switch. Formal: INVESTIGATE the situation and the nature of the need so that an appropriate circuit can be chosen to solve the problem, need or want given in the scenario. • A given circuit must be incorporated into the design of a device that will use the electronics to address the problem, need or want.</td>
<td></td>
</tr>
<tr>
<td>Requisite pre-knowledge</td>
<td>Electrical Circuit diagrams</td>
<td>Investigation and design skills</td>
</tr>
</table>

Resources to enhance learning	DBE Sasol Inzalo workbooks/ Textbooks and any applicable resource “YouTube videos” etc.		DBE Sasol Inzalo workbooks/ textbooks and any applicable resource etc.
Informal Assessment: Remediation			
SBA (Formal)	Informal Assessment/ Formal Assessment		**Formal Assessment: PAT 2**

APPENDIX 17: EDITORIAL CERTIFICATE

EDITORIAL
CERTIFICATE

Author: Elliot Charles Ndlovu

Document title: SENIOR PHASE TECHNOLOGY TEACHERS' INTEGRATION OF INDIGENOUS CREATIVE DESIGN PROCESSES IN SYSTEMS AND CONTROL

Date issued: 02/07/2023

This document certifies that the above manuscript was proofread and edited by Prof Gift Mheta (PhD, Linguistics).

The document was edited for proper English language, grammar, punctuation, spelling and overall style. The editor endeavoured to ensure that the author's intended meaning was not altered during the review. All amendments were tracked with the Microsoft Word "Track Changes" feature. Therefore, the authors had the option to reject or accept each change individually.

Kind regards

Prof Gift Mheta (Cell: 073 954 8913)