A PEDAGOGY FOR TECHNOLOGY EDUCATION: AN INDIGENOUS PERSPECTIVE

by

Richard Maluleke

Submitted in accordance with the requirements
for the degree of

Doctor of Education – with specialisation in Curriculum Studies

at the
University of South Africa

Supervisor: Prof M.T. Gumbo

JULY 2019

DECLARATION

Name: **RICHARD MALULEKE**

Student number: **47288906**

Degree: **Doctor of Education – with specialisation in Curriculum Studies**

A PEDAGOGY FOR TECHNOLOGY EDUCATION: AN INDIGENOUS PERSPECTIVE

I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

_____   15 – 09 – 2019

SIGNATURE   DATE

(R. MALULEKE)

DEDICATION

This study is dedicated to my late father, Freddy Risenga Maluleke, who is my hero and taught me that education is valuable in this life, and that through commitment I can acquire it. I embarked on this study because I really wanted to impress him as he believed in my ability to achieve my personal goals. When he told me to start school, I did not know that he was also blessing me to rise to this level. He taught me to be an educational warrior. I owe this achievement to him. The Bible says that obedience is better than sacrifice, and I am now reaping the benefit.

I salute you, Mafambayexe, Ndhuma, Mun'wanati, Makahlule, Maxakadzi!

ACKNOWLEDGEMENTS

ABSTRACT

The promotion of Afrocentric education is a current issue in Africa. This study aimed to establish the role of indigenous knowledge (IK) in the development of Senior Phase learners' design skills in Technology Education (TE). The study was guided by the constructivist theory, which is based on the assumption that prior learning can play a role in learning. When learning new things in a TE class, learners can benefit from their daily experiences in deriving meaning. Three schools from the Vhembe district in Limpopo Province participated in this study. The purposive sampling technique was used to select Technology teachers, heads of departments, TE specialists, learners and parents from these schools to participate in the study. Data were collected by way of individual and focus group interviews, participant observations and the analysis of documents and artifacts. The findings revealed that IK can increase learners' understanding and acquisition of design skills. However, this study revealed that the integration of IK can be hampered by factors such as the teachers' inability to use indigenous artifacts, the use of unvaried assessment methods, and a negative attitude towards culturally relevant pedagogy and IK. This study ultimately contributed an indigenous knowledge-based design process (IKBDP). Unlike the current conventional approach, an IKBDP has the potential to transform the teaching of Technology, thereby giving recognition to IK and accommodating learners from indigenous backgrounds.

Keywords: design, design process, design skills, indigenous knowledge, technology, Technology Education, procedural knowledge, conceptual knowledge

NKOMISO LOWU NGA NA VUXOKOXOKO BYA NDZAVISISO WA DYONDZO

Ku yisa emahlweni dyondzo yo vona swilo hi tihlo ra Xiafrika, i mhaka leyi nga le mahlweni eAfrika. Ndzavisiso lowu wu na xikongomelo xa ku vona ndzima ya vutivi bya ndhavuko ku nga indigenoous knowledge (IK) eka nhluvuko wa vadyondzi va xiyimo xa le henhla hi swikili swa dizayini ya dyondzo ya theknoloji ku nga *Technology Education (TE).* Ndzavisiso wu leteriwe hi *constructivist theory*, leyi yi seketeriweke hi mianakanyo kumbe vonelo ra leswo dyondzo leyi vanhu va taka na yona ya khale (prior learning) yi nga tlanga ndzima eku dyondzeni. Loko ku dyondziwa leswintshwa eka klasi ya TE, vadyondzi va nga vuyeriwa hi ku landza ntokoto wa vona wa masiku eku kumeni tinhlamuselo. Swikolo swinharhu eka distriki ya Vhembe eka Xifundzhankulu xa Limpopo swi ve na xiavo eka ndzavisiso lowu. Xikongomelo xa thekniki ya ku endla sampuli xi tirhisiwe ku langa mathicara ya Technology, tinhloko ta tindzhawulo, vatokoti va TE, vadyondzi na vatswari eka swikolo leswi va ve na xiavo eka ndzavisiso. Ku hlengeletiwe data eka munhu hi wun'we wun'we na le ka mintlawa ya xikongomelo lexi hi ku endla mimburisano ya ti-interview, ku xiyaxiya leswi swi endliwaka hi vateki va xiavo na nxopanxopo wa tidokumente na swilo leswi swi endliweke hi mavoko (artifacts). Vuyelo bya ndzavisiso byi kombe leswo IK yi nga pfuneta ku twisisa ka vadyondzi na ku kuma swikili swa dizayini. Kambe, ndzavisiso lowu wu kombise leswo ku katsiwa ka IK swi nga kavanyetiwa hi swilo swo fana na ku tsandzeka ka mathicara ku tirhisa swiendliwa swa mavoko swa ndhavuko, ku tirhisiwa ka tindlela to ka ti nga cinciwi ta nkambelo, na mianakanyo leyi nga ri ku leyinene mayelana na ndlela ya madyondziselo na IK. Ndzavisiso lowu ekuheteleleni wu pfunete fambiselo ra leswi vuriwaka indigenous knowledge-based design process (IKBDP). Hi ku hambana na fambiselo ra ntolovelo, IKBDP yi na ntamo wo cinca madyondziselo ya TE, no pfuneta ku amukela IK no angarhela vadyondzi lava va humaku eka fambiselo ra vutivi bya ndhavuko.

Marito ya nkoka: design (dizayini), design process (prosese ya dizayini), design skills (swikili swa dizayini), indigenous knowledge (vutivi bya ndhavuko), technology (theknoloji), Technology Education (Dyondzo ya Theknoloji), procedural knowledge, conceptual knowledge

TSHOBOKANYO

Tsweletso ya thuto ya Seaforika ke ntlha e e tsweletseng ga jaana mo Aforika. Maikaelelo a thutopatlisiso e ne e le go lebelela seabe sa kitso ya tshimologo (IK) mo tlhabololong ya bokgoni jwa thadiso jwa barutwana ba Legato le Legolwane mo Thutong ya Thekenoloji (TE). Thutopatlisiso e kaetswe ke tiori e e elang tlhoko ka moo batho ba ikagelang bokao ka gona (constructivist theory), e e ikaegileng ka mogopolo wa gore thuto e e ntseng e le gona e ka nna le seabe mo go ithuteng. Fa barutwana ba ithuta dilo tse dintšhwa mo phaposiborutelong ya TE, ba ka ungwelwa go tswa mo maitemogelong a bona go bona bokao. Dikolo di le tharo go tswa kwa kgaolong ya Vhembe kwa Porofenseng ya Limpopo di nnile le seabe mo thutopatlisisong eno. Go dirisitswe thekeniki ya go tlhopha sampole go ya ka maitlhomo a thutopatlisiso go tlhopha barutabana ba Thekenoloji, ditlhogo tsa mafapha, baitseanape ba TE, barutwana le batsadi go tswa kwa dikolong tseno go nna le seabe mo thutopatlisisong. *Data* e kokoantswe ka tsela ya go dirisa dipotsolotso tsa batho bongwe ka bongwe le ditlhopha tse di tlhophilweng, go ela banniseabe tlhoko le tshekatsheko ya dikwalo le dilwana tsa tiro ya diatla. Diphitlhelelo di senotse gore IK e ka oketsa go tlhaloganya ga barutwana le go iponela bokgoni jwa go thadisa. Le fa go le jalo, thutopatlisiso eno e senotse gore go akarediwa ga IK go ka sitisiwa ke dintlha di tshwana le fa barutabana ba sa kgone go dirisa dilwana tsa tiro ya diatla tsa tshimologo, tiriso ya mekgwa ya tlhatlhobo e e sa farologanang, le megopolo e e sa siamang e e lebisiwang kwa katisong e e maleba mo setsong le IK. Kwa bokhutlong, thutopatlisiso eno e tshwaetse ka thulaganyo ya thadiso e e ikaegileng ka kitso ya tshimologo (IKBDP). Go farologana le mokgwa wa tlwaelo, IKBDP e na le kgonagalo ya go ka fetola go rutwa ga TE, mme ka go rialo e lemoga IK le go akaretsa barutwana ba ba nang le lemorago la tsa tshimologo.

Mafoko a botlhokwa: thadiso, thulaganyo ya thadiso, bokgoni jwa to thadisa, kitso ya tshimologo, thekenoloji, Thuto ya Thekenoloji, kitso ya thulaganyo, kitso ya megopolo

LIST OF ABBREVIATIONS USED IN THIS STUDY

ATP- Annual teaching plan

CAPS- Curriculum and Assessment Policy Statement

CRE- Culturally responsive education

CRP- Culturally relevant pedagogy

DBE- Department of Basic Education

HoD- Head of Department

IDMEC- Investigate, design, make, evaluate and communicate

IK- Indigenous knowledge

IKBDP- Indigenous knowledge-based design process

IKS- Indigenous knowledge systems

IP- Indigenous pedagogy

ITEA- International Technology and Engineering Educators Association

LTSM- Learning and teaching support materials

MKO- More knowledgeable other

TDM- Total Design Method

TE- Technology Education

TES- Technology Education specialist

WK- Western knowledge

ZPD- Zone of proximal development

TABLE OF CONTENTS

CHAPTER ONE

STUDY ORIENTATION

CHAPTER TWO

THEORETICAL AND CONCEPTUAL FRAMEWORKS

CHAPTER THREE

DESIGN SKILLS AND INDIGENOUS KNOWLEDGE

CHAPTER 4

RESEARCH DESIGN AND METHODS

CHAPTER FIVE

FINDINGS AND DISCUSSION

CHAPTER SIX

SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

APPENDICES

LIST OF FIGURES

CHAPTER ONE

STUDY ORIENTATION

1.1 INTRODUCTION

Indigenous knowledge has the potential to enhance learners' acquisition of design skills and should therefore be integrated in the teaching and learning of Technology at schools. The reliance of learning exclusively on western knowledge may have a detrimental effect on indigenous learners studying the subject Technology. Since indigenous knowledge (IK) is regarded as inferior to western knowledge (WK), its inclusion in formal learning is regarded as inappropriate. However, too much reliance on WK is likely to disadvantage indigenous learners. According to Yishak and Gumbo (2014:181), curricula imported from other nations may not yield good results. The implementation of imported western curricula, which exclude local knowledge, may be unsuccessful. Convergent aspects of IK and WK can be merged in the curriculum in order to have a balanced curriculum. In South Africa, indigenous learners go to school possessing an enormous amount of IK acquired from their communities through their interaction with community members. Unfortunately this wide range of knowledge is neither applied nor recognised in their formal learning in schools, yet IK can be used to contextualise and promote learning. According to Gumbo (2014:387), the infusion of indigenous technology in curricula can improve teaching and learning, particularly in the case of learners from indigenous communities. IK could play a crucial role in facilitating the acquisition of design skills in TE, which is the phenomenon that was investigated in this qualitative study. According to Creswell (2012:16), qualitative study is more appropriate for dealing with research problems when the variables are not known to the researchers and need to be examined. Due to the oral nature of IK, qualitative research is also suitable for researching IK issues.

The influence of IK on the learning of Technology is a topical issue that is under-researched in the South African school context. The aim with this study is to fill this void, with specific reference to the role that IK can play in learners' acquisition of design skills. According to Hays (2009:202), South Africa's indigenous knowledge systems policy indicates that the curriculum should include indigenous knowledge systems (IKS) in the education system, but fails to show how this knowledge can be integrated. Gumbo (2014:387) concurs that learning can be more

successful when learners learn about things that are related to their cultures. Learning can proceed smoothly if it is directly related to what learners know. Thus the teaching of Technology should integrate IK. The content of TE, which is systematically premeditated, can be used as a tool to close the gap between IK and WK. TE lessons are incomplete unless they also draw from IK perspectives so as to benefit indigenous learners and open up the minds of non-indigenous learners to other forms of knowledge and technology.

This chapter has so far provided a brief introduction in which the purpose of the study was stated and the importance of the role IK can play in learners' acquisition of design skills in TE was highlighted. In the next section the background and rationale for this study will be explained, followed by a discussion of the research problem, the research questions, and the aims and objectives of this study. The chapter concludes with a clarification of the keywords used in the study and a structural overview of the thesis.

1.2 BACKGROUND TO THIS STUDY

Many contextual factors can impede the acquisition of design skills. One of these factors is the widening gap between what indigenous learners are taught at school and their cultural experiences. According to Doyle and Hill (2008:44), distancing teaching at schools from the learners' community and cultural experiences has a negative effect on their learning. Doyle and Hill (2008:44) further state that many indigenous learners, particularly in remote areas, struggle at school because the curriculum components are not sufficiently practical and relevant to their experiences. If it excludes IK, an imported western-oriented curriculum may hinder the acquisition of acutely needed skills in South Africa. The South African government has already made a concerted effort to encourage the development of an Afrocentric curriculum that is more suitable for South African learners. IK does not receive much attention in Technology classes.

Gumbo and Williams' (2014:486) found evidence of minimal infusion of indigenous technology in the teaching of Technology in both New Zealand and South Africa. Gumbo (2014:387) adds that the integration of IK in South African classrooms is very limited and proposes the inclusion of the content of indigenous technology in the South African curriculum. Teachers should also ensure that they teach learners about indigenous technology. According to Gumbo (2012:445),

teachers thus far do not appear to take advantage of this opportunity at the implementation stage. The Department of Basic Education (2011) encourages the implementation of a curriculum that promotes IK through the principles undergirding the curriculum, indicating a need for sufficient guidance on the integration of IK. According to Gumbo and Williams (2014:486), teachers only minimally integrate IK as it is included only in small sections of textbooks, which is not sufficient. According to Gumbo (2012:445), the integration of indigenous technologies in the learning of Technology should comply with the curriculum policy, which incorporates both IKS principles and indigenous technologies, specifically in TE (Department of Basic Education, 2011:10).

The TE curriculum needs vigorous implementation that takes into account the Afrocentric perspective in order to hone design skills that are urgently needed for economic growth in the country. The Department of Presidency (2011:71) maintains that technology can play a pivotal role in promoting economic growth in Africa and points out that less-developed countries not only lack skilled labour and capital, but also use them less efficiently. In order for any country to develop, investment in human capital development is essential. The country should therefore concentrate much more on developing scarce skills, such as design skills. The Department of Presidency (2011:70) further explains that development in the areas of science and technology is very important as it can promote economic development and change the lives of many people. Many countries in the world are trying to increase their economic growth to attain better standards of living. The teaching of science and technology can play a very significant role in economic development as it can promote a technological and scientific revolution that can act as an agent for economic growth. TE can play a vital role in helping learners to acquire the scarce skills that the country needs. The Department of Presidency (2011:72) concludes that to promote technological advancement, the national government should make a concerted effort to deliver quality education to the citizens.

Gumbo (2014:387) states that TE can be used to facilitate economic activities and human interaction. Training in the various fields of technology is essential to ensure an adequate workforce of the future. According to the Department of Labour (2003:1), the South African economy continues to experience a shortage of people with the necessary skills, which results in unemployment and poverty. One of the major reasons for the skills shortage is the policies

of the pre-1994 apartheid government in South Africa. Unfortunately there is no quick-fix solution for the skills shortage that has developed over a long period (Department of Labour, 2003:1). The Department of Higher Education and Training (2013:4) states that skills development has a key role to play in addressing the triple challenge of unemployment, poverty and inequality in South Africa. Gumbo (2015a:30), who criticises Africa for attempting to raise revenues by exporting its resources and failing to invest in its human capital development, advises that human capital should be developed to process raw materials into valuable products that can be exported more profitably.

Education that does not integrate IK has a negative effect on learners as many learners do not succeed and ultimately drop out due to the irrelevancy of curriculum. Helme and Lamb (2011:2) posit that in order to improve the academic achievement of indigenous learners, they should be acknowledged and supported by the school culture and leadership. The Organisation for Economic Co-operation and Development (OECD) (2012:48) states that education designed to include other education systems can help to deliver quality education for all learners in schools. IK can be used to enhance the engineering skills needed to process our raw materials into valuable products in order to generate more foreign capital. TE, presented from an Afrocentric perspective, can be used to develop the design skills needed to process resources for the benefit of African countries in Afrocentric contexts.

In order for Africa to be competitive in the global market, investment in human capital development cannot be ignored. It is therefore essential to develop design skills in Technology learners to equip them to provide the necessary human capital for the future. Gumbo (2015a:44) posits that Africa is making a concerted effort to invest in its human capital by encouraging education institutions and educators to review their curricula and integrate IKS for skills development. According to Abejuela III (2007:207), indigenous people possess knowledge that can contribute to the development of a relevant curriculum to equip their children with skills, knowledge and values that will enable them to contribute to society. Abejuela III (2007:207) argues that one of the reasons for indigenous people's support of culturally responsive education is that their children in mainstream schools are taught things that are not related to their daily lives.

Throughout the ages, communities have been engaged in activities designed to improve the well-being of their members and have initiated and taken responsibility for such activities. Human beings have always been involved in activities designed to meet their survival needs. Mkapa (2004:1) states that for as long as people have walked on earth, they have sought more knowledge to find ways to feed their families, remain healthy, argue with their neighbours and improve their understanding of their environments, and have employed different means to solve their problems and meet their needs. People may use their artistic skills to produce indigenous technologies to solve their problems and meet their needs at a given time. The cultural products made by indigenous people may help learners to acquire design skills of the type applied by engineers who design sophisticated products. According to a statement by the United Nations (2005:9), indigenous people are entitled to quality education that accommodates different worldviews. This means that learners must receive education that accommodates various languages and indigenous knowledge, and be taught other cultural perspectives that promote human dignity. National curricula often exclude the cultures, histories and spiritual values of indigenous peoples and reinforce stereotypes (United Nations, 2005:9). Since useful IK exists in communities, Technology teachers should incorporate such IK in their lessons to aid learning and the development of design skills.

According to the Department of Science and Technology (2004:17), the Curriculum and Assessment Policy Statement (CAPS) acknowledges the importance of, and specifically includes IK in TE. In this regard the Department of Basic Education (2011:5) states that learners should appreciate the value of IKS in learning and Technology teachers should make use of IK to assist learners' acquisition of design skills. According to Gumbo (2015a:44), learners who can see themselves represented in the material that they read are likely to be more interested in the work and to perform well. The integration of IK in the learning of Technology will promote learners' interest in Technology and their ability to develop design skills. The integration of IK plays a pivotal role in helping learners develop a clear understanding of technological concepts. Kaino (2013:83) recommends the inclusion of IK in the curriculum design process to help learners to understand concepts and retain knowledge for a long time. According to Gumbo (2001:240), quality learning must take place in the learners' cultural contexts. Quality education is therefore education that does not exclude learners' background knowledge.

The integration of IK in teaching the subject Technology can help to prepare learners for a better future by teaching them to design products that will satisfy human needs. According to the United Nations (2005:9), education is a means to reduce poverty. When Technology is taught from the perspective of the learners' authentic contexts, it can be better understood and will ultimately help to reduce unemployment. TE that is embedded in IK can help learners to acquire technological skills, such as engineering skills, needed in modern economies. According to the Department of Basic Education (2011:8), TE can help the country to produce the engineers, artisans and technicians needed for progress. Gumbo (2015b:68) states that re-contextualised TE teaching that integrates IK can contribute to producing professionals with the design skills they need to actively participate in the development of technology.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTIONS

The pressing need for design skills in South Africa, as discussed in the preceding sections (1.1 and 1.2), leads to the core problem investigated in this study, which is the underrepresentation of IK in the curriculum and the teaching of Senior Phase Technology at schools. Failure to incorporate IK in teaching could be the reason for learners' inadequate understanding of the design concept in Technology, which hampers the acquisition of design skills. The main research question guiding this study is:

What is the role of IK in developing Senior Phase learners' design skills in TE?

The secondary research questions emanating from this main research question are:

- What is the value of IK in developing design skills in TE?
- Which IK can be incorporated in TE to promote Senior Phase learners' acquisition of design skills?
- Which teaching and learning strategies can be used to promote the incorporation of IK for the development of the Senior Phase learners' design skills?
- Which assessment strategies can be used to accommodate IK in the assessment of Senior Phase learners' design skills?

1.4 AIM AND OBJECTIVES OF THIS STUDY

Aims:

The overall aim of this study was to determine the role of IK in developing Senior Phase learners' design skills in TE in order to reframe the design process from an IK perspective.

Objectives:

- To describe the value of IK in developing design skills in TE.
- To identify the IK that can be integrated in TE to promote the acquisition of design skills by Senior Phase learners.
- To examine the teaching and learning strategies that can be used to promote the incorporation of IK for the development of the Senior Phase learners' design skills.
- To explore the assessment strategies that can be used to accommodate IK in the assessment of the Senior Phase learners' design skills.

1.5 IMPORTANCE OF THIS STUDY

The contribution of IK to TE in the South African school context has not yet been thoroughly investigated and relatively little research has been undertaken on its integration in the teaching of Technology. This study is therefore relevant as it seeks to investigate how IK can be integrated in the real learning of Technology in the Senior Phase. It is also well-timed as TE in South Africa is still evolving and its findings will help Technology teachers and curriculum planners to find value and relevance in the inclusion of IK in the teaching of design skills to learners, and to recognise the need to fully integrate IK in the TE curriculum. According to a statement issued by the Department of Science and Technology (2004:9), one of the aims of the IKS policy is to promote the inclusion of IK so as to contribute to the creation of employment opportunities and increase wealth, thereby expanding the economy. Hays (2009:204) states that IK is valuable in its own right and can therefore enrich learning.

Mathematics, Science and TE in South Africa have been experiencing serious problems since 1953, when Bantu Education was introduced (Gauteng Department of Education, 2010:8). In the World Competitiveness Report 2013, South Africa's position in education was ranked 146th out of 148 countries (Department of Higher Education and Training, 2013:4). This is a

regrettable position. Poor performance in the so-called gateway subjects, which are Mathematics, Science and Technology, has been blamed for this situation. In order to bring about a change in this regard, effective strategies should be sought to promote the acquisition of the specific skills needed by industry. According to Gumbo (2013:1), curriculum reviews that do not support the thriving of TE may prevent the development of the skills demanded by industry. An investigation of the role that IK could play in learners' acquisition of design skills could help to place the focus on the development of capabilities that industry will require from the future workforce.

1.6 CLARIFICATION OF KEY CONCEPTS

1.6.1 Design

According to Yu, Lin and Hung (2010:436), design is constructive and concerned with how things are made. The International Technology and Engineering Educators Association (ITEA) (2000:237) defines design as an iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants to solve problems. Design has also been defined as a process through which one creates and transforms ideas and concepts into a product that satisfies certain requirements (Mourton, 2012:3). Indigenous people use the resources in their environment to design products that they need. TE is about minds-on and hands-on activities; thus, when learners design during formal education, they can start with minds-on activities to plan what can be designed to solve technological problems. Indigenous people start by dealing with concrete objects and then move on to abstract concepts. Mirian III (2012:73) maintains that hands-on, reality-based learning activities are crucial as they can help learners to internalise concepts, and Singh (2014:6) agrees that hands-on practical experience during learning expands learners' thought processes. According to Mirian III (2012:19), hands-on learning activities facilitate learning because learners have a context that aids the recalling and use of knowledge. Lodhi and Mikulecky (2010:94) confirm that indigenous people use practical experiences acquired through observation to solve their problems and meet their needs. Awori, Vetere and Smith (2015:2) suggest that indigenous people gain meaning through lived experiences, which primarily involve face-to-face interactions with other people and concrete objects. After actively engaging with concrete objects, indigenous people may conceptualise the correct steps to follow to make a particular product. When indigenous people want to make a product, they

start with hands-on activities and ultimately try to understand the procedure. To promote the effective learning of design skills in TE, learners must move from the known to the unknown. Gumbo (2014: 387) asserts that learning is successful if teachers are able to relate the subject matter to their learners' cultural background and philosophy of life. Technology learners should be allowed to use their IK when they are generating new ideas for solving human problems. When they are designing technological products, they can compare their ideas for new products with familiar existing products used in their communities.

1.6.2 Design process

According to the International TE Association (ITEA) (2000:237), the design process is a systematic problem-solving strategy with criteria and constraints and is used to develop many possible solutions to solve problems or satisfy human needs and wants. The Department of Basic Education (2011:67) concurs that the design process is a creative and interactive approach used to develop solutions to identified problems. Bosch, Hendrics and Tarling (2013:9) are of the opinion that TE is developed by using a well-defined design process to solve technological problems. Indigenous people start making traditional products without the necessary skills, but gradually develop those skills. Technology learners in the formal education system should acquire knowledge about the design process in order to develop the ability to design technological solutions. Indigenous people may make products without being guided by procedural steps, but eventually they develop routine ways of making products to solve their problems and meet their needs. According to Awori et al. (2015:2), indigenous people can create meaning and generate solutions to their problems through socio-physical interactions with nature, people and objects. They can be collectively engaged in a design activity without any formal procedure. Indigenous people making products that they need in their communities depend heavily on spontaneous knowledge. Dyson (2002:188) states that indigenous people learn by trial and error and explains that they gradually come closer to the ideal through a series of increasingly refined approximations, unguided by teacher corrections, whereas learners in the formal education system are expected to follow certain steps that can lead to the creation of models to solve their technological problems and meet their needs. Potgieter (2011:76) posits that the design process describes everything that should happen in a particular technological endeavour, from the inception of an idea, throughout the development and to the conclusion of such endeavour. Bosch et al. (2013:9) state that there

are five steps in the design process, namely: investigate, design, make, evaluate and communicate. These steps will be looked at more closely in the discussion of the relevant literature. Technology learners should learn to solve problems, but if they are to learn to do that effectively, Technology teachers should teach them how to design solutions motivated by problems that exist in their contexts.

1.6.3 Design skills

Yu et al. (2010:437) define design skills as the ability to implement steps in design processes to solve science-related design problems. These skills are needed to create new products. Indigenous people apply certain skills to create new products to solve technological problems. In TE, learners are exposed to activities that promote the acquisition of design skills and can utilise indigenous skills to solve real problems to meet human needs. Technology learners are required to become competent in the design skills that are needed in the various technological fields without forgetting their own indigenous knowledge. Dyson (2002:191) posits that projects are important as they can assist learners to apply that which they have learnt in the world of work. Technology learners should engage in projects to develop design skills needed for making new artifacts. They can complement their technological design skills, which include investigating, designing (development of initial ideas), making, evaluating and communicating (Department of Basic Education, 2011:67), with indigenous skills to design products to solve problems.

1.6.4 Indigenous knowledge

Mapara (2009:140) defines IK as knowledge possessed by indigenous people in an area in which they have lived and earned a living for many years. Puri (2007:358) concedes that indigenous people acquire IK through the accumulation of experiences, informal experiments and an intimate understanding of the environment in a particular culture. Mapara (2009:140) adds that IK includes those forms of knowledge that the inhabitants of the formerly colonised countries used to make a living. It is the knowledge that indigenous people apply to solve their daily problems. IK can play a crucial role in helping local people to make valuable products.

1.6.5 Technology Education

TE is the act of teaching Technology to learners. Pudi (2007:37) describes TE as a comprehensive experience-based educational programme that allows learners to investigate and experience the means by which people meet their needs and wants, solve problems and increase their capabilities. It is the school subject that exposes learners to the technological skills used by engineers and technologists to create new products. According to the ITEA (2000:242), TE provides opportunities for learners to learn about the processes and knowledge related to technology that are needed to solve problems and expand human capabilities.

In the South African school curriculum, the terms TE and Technology are used to refer to the subject Technology taught in the Senior Phase, therefore the two concepts will be used interchangeably in this study. Technology as a subject seeks to help learners to use knowledge, skills, values and resources to develop products to solve problems and meet people's needs and wants, taking into consideration social and environmental factors (Department of Basic Education, 2011:8). Technology learners should acquire good background knowledge when they develop products with a view to solving problems. The acquisition of IK (culture-related knowledge) is essential for designing suitable products for a particular society and environment.

1.6.6 Technology

The ITEA (2000:242) broadly defines Technology as human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and enhance human capabilities. Technology is concerned with the modification of the natural environment to satisfy perceived human needs and wants. According to Ter-Morshuizen, Thatcher and Thomson (1997:49), Technology places the focus on how to meet people's needs and how to obtain, retrieve, utilise and record information. When we design, we use knowledge of the past and present to speculate on and plan new products. Technology learners may be able to design better products or new prototypes for solving technological problems if they incorporate existing IK.

1.7 THESIS STRUCTURE

This thesis comprises of six chapters, which are briefly summarised below.

Chapter 1: Study orientation

Chapter 1 introduces the topic by providing some background information and a discussion of the research problem, the aim of the study and the rationale behind this study. The key words used in the study are also clarified.

Chapter 2: Theoretical and conceptual frameworks

Chapter 2 contains a discussion of the theoretical framework that informed this study, which is based on the constructivist theory. The value of prior knowledge in TE learners is discussed in detail in this chapter.

Chapter 3: Design skills and indigenous knowledge

Chapter 3 contains a review of the relevant scholarly literature consulted for the purpose of this investigation of the relationship between IK and design skills in TE, and the incorporation of IK in the teaching and assessment of design skills. It explores the role of IK in the acquisition of design skills and how indigenous technologies can contribute to the development of those skills in TE classrooms.

Chapter 4: Research design and methods

In Chapter 4, the research design, the profiles of the research sites and participants are discussed. The research methodology and the instruments used to collect data are described in detail. The ethical issues that were considered are also discussed, as well as the different strategies employed to enhance the trustworthiness and authenticity of this research project.

Chapter 5: Findings and discussions

In Chapter 5, the data analysis is presented and the findings are discussed.

Chapter 6: Summary, conclusions, limitations and recommendations

Chapter 6 contains a reflection on the findings of the study and the answers to the research questions. Conclusions are drawn and recommendations are made for further related research.

CHAPTER TWO

THEORETICAL AND CONCEPTUAL FRAMEWORKS

2.1 INTRODUCTION

In this chapter, the theoretical and conceptual frameworks that underlie this study of the role of IK in promoting the acquisition of design skills are reviewed. A brief general look at the constructivist theory is followed by a discussion of the social constructivist theory. Strategies such as scaffolding, which more knowledgeable others can use to assist learners in the zone of proximal development to acquire design skills are also discussed, as well as how learners can be actively engaged when integrating IK in their acquisition of design skills. Finally, the focus is placed on how Technology teachers can use IK acquired through social and individual learning to enhance learners' design skills.

2.2 SOCIAL CONSTRUCTIVIST THEORY

The constructivist theory has dominated the education landscape for many decades. Yager (1996:119) states that constructivism is a 300-year-old concept directed at correcting past failures, thereby improving curricula and teaching strategies. Swan (2005:10) suggests that constructivism can be used to improve teaching strategies, e.g. by using it as a theory of learning rather than instruction, and to inform pedagogy. It would appear that instruction is not a preferred term as, in an educational context, it denotes instructing rather than facilitating, thus denying constructivism room to thrive. This assertion is confirmed by Engdasew (2013), who carried out descriptive survey research with the main objective of investigating the appropriateness of the didactics of constructivism in the TE teaching process and identified prominent constraints that hinder the implementation of constructivist didactics in TE classes. Constraints such as the diversity of learners' interests and teachers' insufficient IK could hamper the implementation of constructivist teaching in TE classes. According to Engdasew (2013:392), constructivists believe that learning should involve social negotiation and mediation, which implies that social interaction and cooperation play a role in the development of socially relevant skills and knowledge. Furthermore, constructivists recommend that the contents of skills in lessons must be relevant and within the learners' prior knowledge and skills framework.

For the purpose of this study, 42 teachers and 147 students were selected from four TE departments, namely Work Technology, Automotive Technology, Construction Technology and Manufacturing Technology. These departments were selected by using the purposive sampling technique as their programmes consisted exclusively of technological education.

Full-time teachers at the University who were certified to present pedagogical skills improvement programmes were selected. The final-year students in each department were selected through simple random sampling techniques. Data was gathered from teachers and students by way of questionnaires. The classroom and workshop teaching processes were observed using a structurally designed observation checklist.

The Total Design Method (TDM) for conducting surveys was followed in all the stages of the compilation and administering of the questionnaire. Both the quantitative and qualitative data provided by the completed questionnaires was critically analysed. The quantitative data was tabulated and computed using the statistical package for social science (SPSS version-20 for Windows). Descriptive parameters, including the Chi-square test and percentage were employed to organise and analyse the quantitative data. Data gathered through observations was tabulated and qualitatively analysed and served to supplement the quantitative data obtained through the questionnaire. The results showed that, according to 59,8% of the students, Technology teachers did not perform prior skills analysis and rarely practised before conducting a new technological lesson to activate their prior skills and experiences.

Engdasew's study reveals an absence of skills, including those skills that teacher-trainees could contribute to the training programme. It was evident that Technology teachers were not using practical examples to teach Technology and were also not encouraging their learners to use their new skills. It was further revealed that Technology teachers were not sufficiently trained in the application of the constructivist theory. The concern that arises from this situation is that inadequately trained teachers will not be able to assist learners in the developing of their design skills, and will not allow them to be creatively informed by their contexts. This phenomenon lends itself to investigation.

According to the constructivist theory, Technology teachers can use the prior knowledge of learners to teach content, promote effective learning and teach them to generate new ideas (Bryant, 2010:25) and different answers. Depending on the context of the knowledge involved and a learner's personal understanding, there can be more than one right answer. Technology teachers have the opportunity to tap into learners' prior knowledge by using inquiry-based learning. Bransford, Brown and Cocking (2004:10) state that constructivism is anchored on the principle and framework of learner-centred education that pays attention to the knowledge, skills, attitudes and beliefs of learners. Constructivism can create an atmosphere in which IK is respected and utilised in schools. This is an important observation, especially for a subject such as TE, since its content and teaching are predominantly conceptualised from a western perspective at the expense of locally available indigenous agricultural, metallurgical, engineering, etc. technologies.

Several studies that have been conducted help us understand and support the argument in favour of the incorporation of IK in teaching. However, those studies do not include practical guidelines. The study undertaken by Pawilen (2013:21) explored the kind of IK that can be integrated in the school curriculum and, drawing from constructivism, the author advocates the idea that learners' experiences must be the starting point for learning. However, no practical examples are offered of IK that ought to be included in the teaching of Technology. Mawere (2015:63) also argues for the incorporation of IK in schools in order to enhance learning, but fails to advise on teaching strategies that can promote the integration of IK in classrooms. De Beer and Mothwa (2013:453) acknowledge that the rich IK and cultural practices can assist learning and state that a good teacher makes use of the existing knowledge of learners when teaching new knowledge and skills. However, they too fail to suggest teaching strategies that would be suitable for integrating IK as prior knowledge to enhance learning. Meyiwa, Letsekha and Wiebesiek (2013:4) conducted a study to explore ways in which IK can be used to promote learning and employed participatory action research to gain an understanding of how IK could assist learning. However, no attempt is made to show how local indigenous people can be engaged in incorporating IK in classrooms.

Furthermore, Phiri (2008:32) explains that constructivists believe that all learners can succeed in creating new understandings or meanings based on past experiences. This author suggests

that, before introducing new concepts, teachers should consider and draw from learners' prior knowledge, but does not elaborate on the indigenous pedagogies that can promote the integration of IK in learning. Lemus, Seraphin, Coopersmith and Correa (2014:9) advise teachers to use practical examples that exist in the learners' communities. Evaluation generally does not make provision for culturally relevant assessment. Since this study was based on the constructivist theory, it should have established assessment strategies that allow for the use of IK as prior knowledge, but falls short in that respect. This study by Lemus et al. (2014:9) shows that learners' evaluations strongly supported the cultural field trip, but the evaluations did not include knowledge acquired during the trip.

As mentioned above, these studies were all found lacking as they failed to show how IK can be practically integrated in teaching. The current study closes the gap identified in these studies as it investigated real examples of IK that could be considered for inclusion in the teaching of design skills in TE and incorporated, as part of the investigation, available relevant teaching strategies aligned with indigenous approaches, which could be used to incorporate IK in the teaching of design skills.

2.3 LIMITATIONS OF THE SOCIAL CONSTRUCTIVIST THEORY

Teachers who are not conversant with different knowledge systems will not be able to customise the curriculum to accommodate each learner, since the IK of individual learners in a TE classroom may differ enormously. Learners' worldviews, which are informed by their diverse backgrounds, contain rich knowledge that could enhance their learning of new design skills in TE. Constructivist theory is criticised for its ambiguity in respect of learning outcomes. Karagiorgi and Symeou (2005:22) argue that teachers will not be able to plan effectively if the learning outcomes are not clear. It is difficult for constructivist teachers to propose clear learning outcomes as learning cannot be accurately predicted. This is congruent with the claim by Karagiorgi and Symeou (2005:19) that teachers who use constructivist theory cannot clearly state in advance what knowledge and skills learners must acquire. Constructivist teachers are not able to pre-specify the pedagogical content as learning can be determined by learners' prior learning, which teachers cannot predict before new learning unfolds. According to Karagiorgi and Symeou (2005:22), the constructivist's belief that learners can create their own

unique knowledge is problematic to curriculum designers as it is impossible to design a curriculum that will suit every learner.

Even though the social constructivist theory has been effective in teaching for many years, it is criticised for failing to provide clear guidelines on assessment. One of the disadvantages of the social constructivist theory is that it may be difficult for teachers to assess activities that have more than one correct answer. In this regard Jonassen (1991:12) points out that constructivists believe that learners can have different views about reality. Karagiorgi and Symeou (2005:22) lament the fact that the assessment that is intended to assess learners in accordance with their individual, unique knowledge is a conundrum to many teachers. The social constructivist theory provides for learners to answer a question in different ways, so that they may give many different answers that will all be correct. This is consistent with Jonassen's (1991:12) suggestion that evaluation should allow learners to give different answers.

The objectivist and constructivist assumptions of learning and teaching differ greatly. According to Jonassen (1991:10), objectivism holds that learners should learn similar things and that education should be aimed at assisting them to acquire the existing knowledge. In objectivist teaching, teachers may teach learners the learning content regarded as the only truth. Constructivist teachers, on the contrary, allow their learners to use their prior knowledge to come up with different meanings, which may or may not be correct. Correcting learners' prior knowledge is time consuming and requires teachers to have a thorough knowledge of the IK that learners may possess. According to Kussumua (2007:21), unlike those in constructivist classrooms, learners in objectivist classrooms are expected to be quiet. Kussumua (2007:21) adds that teachers who follow a constructivist approach have to be knowledgeable about the learning content. Technology teachers who apply the social constructivist theory need to possess a thorough knowledge of IK content in order to guide their learners to succeed in acquiring design skills.

Kussumua (2007:21) states that constructivist teachers allow their learners to express divergent ideas and do not attempt to restrict them to thinking in a particular way. The major technological breakthroughs are due to the willingness of people to continuously explore new avenues. From Rutland's (2009:56) perspective, it can be argued that Technology teachers

should create a favourable atmosphere for learners to explore new ideas. Where a constructivist approach to learning is followed, learners are not intimidated and are given latitude to keep on trying new ways of doing things. The researcher believes that learners should be encouraged to keep on trying new ways of making new products, rather than be satisfied with routine ways.

The constructivist and objectivist educational theories have different assumptions about learning. Vrasidas (2000:12) writes that the objectivist paradigm is based on the assumption that there is a real world, and the purpose of education is to map the entities of that world on the learners' minds, and further states that, according to the constructivist paradigm, learners can create new knowledge when they interact with each other and with others in their communities. Both the abovementioned educational theories can play a significant role in learning. The constructivist and objectivist theories are progressive learning theories and are widely used to promote learning in contemporary classrooms. The two theories were contrasted to ascertain which one would benefit learners the most when an infusion of IK for the acquisition of design skills occurs. The choice of a theory depends on the learning environment in which it will be applied. According to Vrasidas (2000:14), objective and constructivist theories may be used in different learning situations. In this study, the constructivist theory can be most successful in helping Technology learners to acquire design skills through the integration of IK. Bada (2015:67) explains that constructivist teachers use learners' existing knowledge to make new meaning, whereas the social constructivist learning theory requires them to use their existing knowledge, for instance their IK. The objective learning theory, however, is not relevant for promoting the acquisition of design skills as teachers are expected to transfer knowledge and skills to learners without being flexible and without accommodating other forms of knowledge and learner participation. Bada (2015:67) describes objectivist learning theory as prescribing that learners should not construct new knowledge, but should simply receive knowledge from their teachers. Objectivist learning is limited by the fact that it holds on to the traditional style of teaching and teacher dominance, the linear approach, talking down to learners, and so forth.

This study is framed by the social constructivist theory, which offers more advantages. For example, this theory advocates interaction between learners during learning activities, as

learning does not occur in solitude. Hussain (2012:179) describes classrooms as social entities in which learners interact with each other and their teachers(s) while acquiring new skills and knowledge. This approach motivates Technology learners to learn from each other by sharing their distinct knowledge, which may include IK, whereas the objectivist approach does not promote the integration of IK in teaching and learning and may deny learners opportunities to acquire design skills and enhance their understanding by also drawing from IK. Nam and Smith-Jackson (2007:25) point out that teachers who apply the objectivist theory expect their learners to attain only established outcomes. This means that they could be limited to designing new technological products that relate to only conventional technologies, and not to indigenous environments.

The social constructivist theory was chosen for the current study on account of its appropriateness and its strength in respect of accommodating other knowledge systems, such as IK. This theory enables learners to use their IK, which can play a crucial role in promoting the acquisition of design skills. De Beer and Mothwa (2013:453) maintain that the IK existing in our communities can be used to facilitate learning. The social constructivist theory can provide a platform for learners to actively interact with each other to design new technological products as IK stems from indigenous communities that are characterised by group activities modelled by the Lekgotla principle.

2.4 VYGOTSKY'S TWO MAIN PRINCIPLES FOR PROMOTING LEARNING: MKO AND ZPD

Galloway (2010:48) posits that in order to gain an understanding of the social constructivist theory, teachers must be conversant with Vygotsky's two major principles, namely the more knowledgeable other (MKO) and the zone of proximal development (ZPD) principles. The influence of MKOs and ZPD, which provide a reason for an alternative pedagogy that can ensure the integration of IK, will be dealt with in the following subsections.

2.4.1 The role of more knowledgeable others (MKOs) in learning
MKOs are more experienced people and may, in the context of this study, include Technology teachers, but also other knowledge-bearers and experts such as indigenous elders and community members. Galloway (2010:48) defines MKOs as any adults who are more

knowledgeable than the learners. However, it should be noted that learners are also knowledge generators who are informed by their own contexts. Indigenous communities can equip Technology learners with traditional skills for making indigenous products.

According to Driver, Asoko, Leach, Mortimer and Scott (1994:8), learners are not likely to discover for themselves how to enter into the community of discourse. This implies that Technology learners need support from their teachers and should be allowed space, from a pedagogical perspective, to showcase how they can be successful in solving technological problems. They need both expert Technology teachers and indigenous elders who possess IK to assist them in acquiring design skills and introduce them to technological concepts and skills. The MKOs in TE are better placed to align the learning of TE content with real situations. They can design real problem situations for which learners can find solutions under the teachers' guidance. Galloway (2010:48) explains that an MKO need not be a person at all, but can be a document; and indigenous sculpture, for example a fish sculpture that can teach learners about different shapes, sizes, materials, and so forth; or indigenous clay pot designs, processes and finishing techniques. The designs painted on indigenous artifacts may contribute immensely towards facilitating design activities such as drawing initial design ideas. It may be assumed that Technology learners from indigenous communities have acquired more knowledge about design aspects. This knowledge can be utilised in designing technological models. Galloway (2010:48) points out that knowledgeable classmates may also be regarded as MKOs. The important thing about MKOs is that they must have more knowledge than the learners about the topic being taught. Learning is effective when there is interaction between a learner and the MKOs. This means that whoever the MKOs are, they are expected to actively engage learners since, according to Vygotsky' social constructivist theory, learning is a social activity.

2.4.2 Optimisation of learning in the zone of proximal development (ZPD)
Swan (2005:4) and Criticos, Long, Moletsane, Mthiyane and Mays (2009:157) explain that another important concept in Vygotsky's learning theory is his notion of the ZPD, the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. According to Moletsane, Stofile and Raymond

(2013:63), in the ZPD a learner has a potential to learn, but is unable to learn on his/her own and needs assistance. It is thus important to teach Technology learners in a way that relates learning to familiar contexts, which will boost their understanding and improve their chances of reaching the ZPD. According to Galloway (2010:48), Vygotsky believed that MKOs who use scaffolding at the ZPD improve their learners' understanding. Assistance must cease once a learner has acquired the required skills. With their technological expertise, the indigenous people guide and help to develop the children's design activities in the home or local environment and can thus be regarded as home-based teachers. Indigenous people learn by doing, utilising the knowledge and skills they possess, and the children are allowed to practise and master new skills.

2.4.3 Individual construction of knowledge

Every learner has a duty to ensure that learning occurs. According to Powell and Kalina (2009:241), unlike Piaget's constructivist theory that advocates the individual learning of new knowledge, social constructivism is concerned with social interaction, which is based on how groups construct knowledge. Cole, John-Steiner, Scribner and Souberman (1978:57) argue that every function in the child's cultural development appears twice: on the social level through interactions with other people, and later on the individual level inside the learner. The learners acquire new concepts through interaction with other people and thereafter internalise the new concepts. Indigenous people can share their IK with others in their communities, but each individual is responsible for mentally processing that knowledge. Technology learners may also acquire knowledge through interaction with different people from their environment, but they will use only the knowledge they have processed ultimately. Powell and Kalina (2009:241) explain that in cognitive constructivism, learning takes place individually in the human brain. Jordan, Carlile and Stack (2008:59) concur that new knowledge is internalised and processed in the human brain.

Ornstein and Hunkins (2004:117) view reality as the result of an individual's constructivism. The idea that no ultimate shared reality exists is explained by the fact that no two people actually view reality from the same vantage point or bring identical personal histories to the process of learning and thinking. This means that Technology learners from indigenous communities may use their IK to contemplate unique technological solutions by considering

how their elders had solved problems by making new products needed by their communities. Technology teachers should be concerned about the viability of solutions to technological problems. Von Glasersfeld (1995: 4) maintains that there are multiple truths that can be used to understand the world. Teachers should understand that indigenous ways of solving problems are correct as long as they can solve problems in indigenous communities. Like western knowledge, which is continuously being enriched by way of new research, IK may also need to be enhanced through intensive research to improve its success. Human problems can be solved in different ways (Von Glasersfeld, 1995:4) and Technology teachers should teach their learners that there are multiple truths and that technological problems can also be solved in many ways. They should not shy away from thinking of how to make new products, but should never underestimate the value of IK for solving problems.

Learners do not arrive at school empty-headed; they come to every lesson with practical schemata. Criticos et al. (2009:155) state that the learners' schemata may be incorrect and that their incorrect ideas must be corrected by teachers. Any learning may occur either through assimilation or a process of accommodation. According to Green (2010:137), schemata shape what we will remember and it is much easier to recall things that fit in with your schema as they are easier to retrieve. Hergenhahn and Olson (2013:271) explain that learners use assimilation to understand new concepts that match their current understanding. Technology learners should be encouraged to utilise their cognitive structures of both assimilation and accommodation to solve technological problems. The acquisition of IK, either assimilated or accommodated in TE classrooms, can assist them in solving technological problems. Some aspects of IK can be easily assimilated, while others cannot be assimilated at all. Hergenhahn and Olson (2013:272) posit that events for which the learner has schemata that fit into new learning are readily assimilated, while events for which the learner has schemata that do not fit into new learning necessitate accommodation. Assimilation occurs when a new experience does not require any change in the existing structure. The new design skills taught in formal learning can be assimilated if they are congruent with learners' IK, for example when Technology learners solve a problem by building a temporary house for workers and they use the knowledge and skills that they have acquired at home. If the acquired knowledge and skills work in this new situation, the cognitive structure does not need to be altered. The existing cognitive structure solves the problem at hand and will therefore be assimilated.

Learning that necessitates accommodation results in the modification of the cognitive structure. Schirmer, Casbon and Twiss (1997:691) explain that learners need to accommodate new concepts that do not match their current understanding and Hergenhahn and Olson (2013:272) state that such modification can be roughly equated to intellectual growth as accommodation provides a major vehicle for intellectual development. According to Hergenhahn and Olson (2013:272), the level of accommodation is usually influenced by an individual's existing knowledge. Learners with less knowledge of the concepts that are being taught use more accommodation as most of the things they learn do not match that which they know. Learners with IK are disadvantaged in learning as most of what they know does not correspond with new design skills taught in TE classrooms. Learners of western descent have an advantage in learning as their existing cognitive structures (schemata) can be applied in formal learning and they are able to use assimilation and accommodation simultaneously in the learning process. This means that indigenous learners are alienated from formal learning when teachers adopt only western examples in their teaching.

According to Skamp (2015:14), personal constructivism purports that change takes place in the learner's head. Technology learners generate ideas that are intended to solve identified technological problems. They can use their cognitive skills to generate ideas when they are engaged in finding solutions to solve technological problems. Technology teachers can use brainstorming methods to stimulate learners to individually construct meanings, and oral questions to encourage learners to generate ideas. According to Ankiewicz and De Swardt (2001:71), a Technology teacher can pose a question and allow learners to approach the problem with numerous ideas. All ideas, whether good, bad or crazy, should be considered. Brainstorming can help Technology learners to benefit from each other's ideas. After brainstorming different ideas, Technology learners may be allowed to add or expand on each other's ideas (Ankiewicz & De Swardt, 2001:71). Adams (2005:14) adds that in order to encourage creative thinking, learners should be allowed to brainstorm ideas. Fails, Guha and Druin (2012:97) confirm that when learners brainstorm ideas, they will generate multiple ideas that can be used for solving problems. When no more ideas are forthcoming, the learners examine all the ideas and, with the help of the teacher, select the best ones (Ankiewicz & De Swardt, 2001:71). Technology learners who have learned to analyse stories and folktales as

part of their IK should be able to analyse new information and make new meanings. The elders in indigenous communities as repositories of knowledge can tell the children stories and folktales that can play a role in stimulating Technology learners to think. Stories and folktales have hidden meanings that must be dissected by listeners. Indigenous people can also use riddles to stimulate learners to think. The meanings are often related to real life. Technology learners who are trained to seek meanings in indigenous riddles and proverbs will also be able to identify problems and find novel solutions in TE design scenarios.

The quality or success of any teaching is strongly influenced by the theories advocated by teachers in their classrooms. Technology teachers should select the most successful learning theory in a particular learning environment. The above discussions emphasised the necessity of the application of the social constructivist theory to assist learners' acquisition of design skills. The social constructivist theory has special practical implications for teaching and learning, and for the integration of IK in the subject Technology. Prior knowledge can have a positive impact in the acquisition of design skills as Technology learners can use IK to facilitate new learning. Learners with more prior knowledge, such as IK, can perform better than their counterparts who have little or no IK. It is therefore recommended that Technology learners should combine their IK with other forms of knowledge when learning new design skills.

This study emphasises the value of the social constructivist theory as a major progressive theory that can be applied to integrate IK in teaching to promote the acquisition of design skills. One of the strengths of constructivist theory is that it allows learners to use their prior knowledge as a starting point when learning new skills. The constructivist approach also allows learners to learn in different ways and in real contexts, which promotes the acquisition of design skills. Successful learning occurs in the real context, therefore Technology teachers can use contextual teaching and learning to integrate IK. Technology learners should always be actively engaged in learning when teachers allow them to freely express their ideas from a social constructivist perspective. This is crucial in Technology as a subject in which creativity, criticality and innovation are among the central skills that need to be honed. Technology learners are expected to continuously interact in order to learn from each other. Effective learning can be promoted if learners learn from other people and artifacts in different places, including indigenous places. MKOs can help learners to acquire design skills in the ZPD.

2.5 NEW LEARNING BUILDS ON PRIOR KNOWLEDGE

Teaching that takes into consideration what learners already know can have a very positive impact on the promotion of effective learning. McNair and Clarke (2007:271) sought to establish whether teachers do in fact rely on prior knowledge to assist learning. Using a case study method to give a systematic description of the reality of the classroom, they selected three schools based on the teachers' levels of experience and willingness to be involved in the study. The study of McNair and Clarke (2007) found that where interdependence between what was taught by the teacher and the learners' existing knowledge was less evident, teachers tended to over-emphasise curricular content and task completion at the expense of understanding the activity. However, where interdependence was more marked, learners became actively engaged. McNair and Clarke (2007:272) state that teachers should always try to help learners to understand how technological products are made. To achieve this, it is important that teachers allow learners to have a voice in their learning. It is advisable for teachers to link their lessons to the daily lives of learners (Maluleke, 2013:17). If the technological activities are related to what learners know, they may be better able to complete their Technology projects. McNair and Clarke (2007:271) further point out that teachers need to be able to build on their learners' histories. Enabling learners to use their previous experiences can be a good starting point for design (skills) thinking (McNair & Clarke, 2007:272). Bransford et al. (2004:10) agree that prior knowledge can affect learners' retention of the contents they have learnt. The ability to link IK with new situations may facilitate the acquisition of design skills in the learning of Technology. Gray and Macblain (2012:21) aver that learning is mostly influenced by what learners have already learnt. It is thus assumed that the learners involved in this study possessed rich experience and prior knowledge (IK) that played a crucial role in their acquisition of design skills and their ability to solve problem in TE classes.

Weegar and Pacis (2012:6) state that the primary role of teachers is to motivate learners to construct their own knowledge through their personal experiences and argue that this can be done most effectively if Technology learners are encouraged to relate their learning activities to IK. Teachers have a responsibility to ensure that the learners' design projects are in tandem with their indigenous environments. This will enhance the learners' technological understanding as they will not see technology as something that is far removed from their

indigenous environments, but will realise that it can contribute towards sustainable development. For example, their skill in making grain baskets can be used to make gift baskets. Weegar and Pacis (2012:7) state that projects help learners to learn through independent discovery. In other words, they can acquire skills by relating what they learn to their personal experiences.

Fraser (2006:16) posits that lesson plans should always be derived from the learners' cultural context. Technology teachers can then, for example, use IK and skills such as the traditional moulding skill to motivate learners to actively participate in learning. According to Turuk (2008:247), the constructivist theory emphasises the need for learners to use their existing knowledge to understand new subject matter. Technology learners can use IK to connect to a new learning experience and create a new technological solution. Weegar and Pacis (2012:14) explain that the overall philosophy of constructivism holds that learners impose meaning on the world in accordance with their own unique experiences. The teaching of design skills in TE should therefore infuse IK in order to promote learning. Bettencourt (1993:47) states that, like all human beings, learners construct knowledge from personal life experiences in their homes and communities, and that those experiences and the knowledge gathered constitute the foundation for learning.

The teaching of design skills without infusing IK can limit learning and understanding. This claim is corroborated by Bettencourt (1993:47), who argues that assuming that learners are blank slates is inviting pedagogical trouble, since all learners are endowed with rich knowledge of how things work in their environments. Fraser (2006:16) adds that learners do not arrive at school without any knowledge and should therefore not be treated by their Technology teachers as having nothing to contribute to the learning situation. The IK of learners acquired through their unique experiences, cultural backgrounds, community activities and informal learning must be recognised (Fraser, 2006:16). This means that Technology teachers should abandon the notion that learners come to school as empty vessels needing to be filled with new knowledge and design skills. Bettencourt (1993:47) emphasises the value of learners' ideas, conceptions and views as the basis for learning and knowing. Knowledge and skills acquired through incidental learning in their environments may be used for new learning at school.

The effects of IK can be either positive or negative. Svinicki (1993:1) explains that the effect of prior knowledge can be positive if it is valid and relevant. However, incorrect prior knowledge can be detrimental to a learner when new subject matter is being learned. Technology teachers need to be able to detect IK misconceptions that can hamper learning. Incorrect prior knowledge has to be diagnosed at the beginning of each lesson and should be corrected immediately to enhance the acquisition of design skills. Svinicki (1993:2) purports that any incorrect bit of prior knowledge that is not corrected could prevent learners from understanding an entire lesson. Technology teachers should correct any incorrect IK that may hamper learners' comprehension of new design skills. They should be vigilant in detecting any misconceptions of IK and attend to them immediately in order to promote the smooth acquisition of design skills.

Technology learners should be equipped to transfer their IK to new situations. Ertmer and Newby (2013:49) explain that transfer refers to the application of existing knowledge to other settings. The acquisition of certain skills or information facilitates learners' understanding of more complex and advanced skills in related fields (Mwamwenda, 2004:169). Thus, knowledge of different cultural structures may facilitate design in Technology classes. For example, knowing how to make struts for indigenous chairs can enhance a person's knowledge of reinforcing technological products. Technology learners' IK acquired at home may assist them in acquiring technological knowledge and applying it in formal learning. According to Mwamwenda (2004:269), the greater the similarity between what has been learned and the transfer situation, the greater the transfer is. This is endorsed by Kalpana (2014:28), who states that knowledge from one place is not necessarily relevant in another. western knowledge is not always applicable to all situations.

Indigenous people do not always depend on western knowledge, but rely heavily on their IK to solve problems that arise. Contextual knowledge is constructed when people in a particular place interact with their environment (Naidoo, 2010:49). This knowledge can help Technology learners to understand why different products are needed in different regions of the world. Technology learners who have acquired the necessary contextual knowledge will be able make products that are suitable for use in their particular regions. For example, Technology

learners who know which type of soil is suitable for building a rondavel in a particular place will be able to select suitable soil for that purpose. It is therefore important to ensure that learners acquire IK that can be useful for solving some problems in local contexts. Ertmer and Newby (2013:49) concede that learning is more successful if the learning content is related to what the learners know. The use of identical elements can play a pivotal role in the acquisition of design skills. For instance, if Technology learners are taught indigenous skills to make certain products at home, any of those skills that are identical to the new skills taught in schools will be easily transferred to new learning. Technology teachers can benefit from this by using even indigenous objects such as a clay pots as teaching resources.

Svinicki (1993:3) maintains that when new knowledge is similar to existing knowledge, learning can be successful. When learners learn new things that are similar to what they know, they will easily remember them and enjoy learning, whereas if they have nothing which new information can be attached, they are obliged to resort to rote learning. This explains why technological learning activities need to be linked to the things with which the learners are familiar, i.e. things to which they can relate.

Technology teachers can start by establishing what IK and skills learners possess by using diagnostic assessment methods. Svinicki (1993:4) states that prior knowledge can be activated by starting a class with a review of what has gone before. Thus, teachers help the learners to scaffold to new learning by using the known-to-unknown teaching strategy. Establishing links between existing IK and new learning can also help to promote learning. According to Svinicki (1993:4), the introduction of new concepts by comparing them to previously learned concepts can assist in the learning of new content. Learners relate what they have already learned to what they were first taught at home and in their communities, i.e. in the primary teaching situation. Nieman and Pienaar (2006:75) concur that teachers should build bridges between learners' IK and the learning of new design skills.

2.6 THE ROLE OF INDIGENOUS CONTEXT IN ACQUIRING DESIGN SKILLS

Design skills in TE can be taught from indigenous perspectives in order to make them comprehensible to learners from indigenous communities. According to Vandeleur (2010:23), technological products are always anchored in cultural settings. That is why Veak (2000:228)

argues that technology must always be connected with culture. Both indigenous and non-indigenous learners can benefit from learning that integrates indigenous technologies, as well as the design skills that come with them. Sears (2003:14) states that learners understand new knowledge by relating it to their social, cultural and physical experiences in different places, and advocates (Sears, 2003:36) that learning should be anchored in learners' lives and teachers should motivate their learners to learn by emphasising connections between what they are asked to learn and their daily lives. As stated above, Technology learners are endowed with design skills from their varied contexts, which means that teachers should tap into those skills when they design tasks and teach learners.

Design skills can be acquired in contexts in which learners are allowed to engage in practical activities. According to Van Wyk (2002:308) and Hoadley (2010:161), constructivism can be used to accommodate other knowledge systems, such as IK, since different knowledge systems are afforded equal status. Technology teachers should understand that IK can have a positive impact on the acquisition of design skills and therefore deserves to be included in formal learning. Thinking can be located in social and physical contexts (Kalpana, 2014:28) and interaction between human beings is constant (Donald, Lazarus, & Lolwana, 1997:49). The majority of South African learners live in and interact with indigenous communities. This implies that Technology learners can learn about design in their indigenous contexts, which concurs with Jordan et al.'s (2008:59) opinion that learning can be successful if it takes place in a familiar context. It should be noted that indigenous people are constantly engaged in practical activities, which explains the role IK can play in the acquisition of design skills. Agrawal (1995:425) mentions the use of IK to solve practical problems and registers concern about the fact that modern knowledge is detached from the lives of indigenous people. The practical nature of IK can help Technology learners to acquire practical skills in the classroom. According to the Department of Basic Education (2011:9), TE teaches learners to use technological skills to design products. TE is expected to solve real problems experienced by people in their daily lives (Department of Basic Education, 2011:12). Technology teachers should always bear in mind that learners learn by doing. Design skills can be boosted by the acquisition of technological knowledge, such as conceptual and procedural knowledge from real contexts, to solve technological problems.

According to Slattery (2006:86), it is not surprising that many learners are not interested in learning because the content taught in schools is completely detached from their daily lives. This ties in with Ornstein, Pajak and Ornstein's (2011:239) statement that many ethnically diverse learners do not find school inviting as they often feel unwelcome, insignificant and alienated. Technology learners from indigenous communities may find the acquisition of design skills to be a mammoth task if the formal learning is always detached from their indigenous context. As learning becomes more difficult, irrelevant and boring, they resort to staying away from school. This clearly indicates that Technology teachers should bear in mind that the design skills taught in classrooms should be related to learners' IK. Mwamwenda (2004:184) posits that whenever possible, what is being taught ought to be related to the learners' needs and everyday experiences.

The acquisition of design skills should therefore be related to indigenous contexts in order to allow learners to apply their IK to enrich their design skills. Technology teachers can organise visits to, for example, industries, indigenous communities, businesses and the homes of indigenous elders to show learners how design occurs in various environments. Sears (2003:10) is in favour of teaching learners by exposing them to real contexts and states that learning can take place at many sites or in multiple contexts, and not only in classrooms. This is in tune with the traditional approach in many African contexts, which is that learning happens outside the classroom walls, for instance at initiation schools, or when an elder teaches young children how humans can benefit from what is provided by the natural world. Teachers could also invite indigenous experts as para-teachers and consider designing technological activities that connect with different contexts, including indigenous contexts. Ertmer and Newby (2013:55) state:

Just as learning of new vocabulary words is enhanced by exposure and subsequent interaction with those words in context (as opposed to learning their meanings from a dictionary), likewise it is essential that content knowledge be embedded in the situation in which it is used."

The TE content should reflect what Technology learners encounter in real life and should allow them to design from their contexts first. Mays (2014:118) maintains that how people understand things, and hence what they know, is strongly influenced by their cultural contexts. An understanding of cultural contexts will help Technology learners to design relevant and

user-friendly artifacts. Van Putten, Botha, Mofolo-Mbokane, Mwambakana and Stols (2014:94) state that culture-rich classrooms provide ample opportunities for learners to solve unfamiliar contextual problems and become familiar with other people's social worlds.

Technology teachers can use popular culture to facilitate the acquisition of design skills. For example, in the rural areas where learners are familiar with indigenous technologies, when discussing new developments, Technology teachers can use indigenous examples to help learners to comprehend design. Activities should be related to issues that affect their communities. For example, in rural areas where people lose their livestock due to floods, teachers can ask their learners to design a frame structure for saving livestock. They could, for example, design a cattle shed with a reinforced roof and raised foundation. Such an activity will interest learners as they will become aware of the relevance of TE to their daily lives.

Leonard, Noh and Orey (2010:12) state that social constructivists emphasise the crucial role of culture in facilitating learning. Design in TE is not supposed to be taught in a vacuum. Ornstein and Hunkins (2004:214) propose that the curriculum content should reflect and serve the learners' culture. The effective acquisition of design skills should be vested in the integration of IK in learning. Indigenous cultures can be used to promote good academic performance of learners. Moalosi, Popovic and Hickling-Hudson (2007:5) posit that human beings are influenced by culture in their decisions; designers ought to respect the cultures of the people who will use their products. Moalosi et al. (2007:7) agree that designers should design products that value the culture of the users. This means that Technology learners should be taught to consider the cultures of their potential clients in order to design user-friendly products. Technology learners should understand the value of infusing culture in their products. Moalosi et al. (2007:10) advise that designers should consider the material factors (e.g. baskets), social practices (e.g. assistance), emotional factors (e.g. kindness) and design factors (e.g. ergonomics) before commencing with new designs. Technology learners can study indigenous materials, traditional chairs, baskets, arts and crafts, sharing, respect, kindness, love, ergonomics, sustainability, technophobia and product quality to assist them in the designing of quality technological solutions. The discussion of the theoretical perspectives discussed thus far in this chapter has crucial implications for contextual teaching and learning in the TE classroom.

2.7 CONTEXTUAL TEACHING AND LEARNING

Learning should be contextualised in order to be meaningful. Technology teachers can certainly use contextual teaching to promote the use of IK for the acquisition of design skills. Hudson and Whisler (2010:54) and Davtyan (2014:1) describe contextual teaching as a way of teaching that connects academic content to real-life contexts, and Shan (2011:1) explains that contextual learning can be used to make learning relevant to learners, thereby stimulating interest. Contextual teaching can help learners to see how abstract concepts learned in school can be useful in practical life. Thus the acquisition of design skills needs to be contextualised in order to make learning interesting to Technology learners. By contextualising Technology learning, it can be made more comprehensible, which will motivate Technology learners to keep on acquiring new design skills. Sears (2003:9) and Hudson and Whisler (2010:55) mention that in contextual teaching learners understand subject matter as it is taught in a real context. The acquisition of design skills in indigenous context can inspire learners to make connections between their IK and the new learning. Teachers can use problem-based learning to promote contextual learning by engaging their learners in practical activities. According to Sears (2003:10), problem-based learning recognises that learners learn from real-world problems. Gumbo (2012:444) adds that the teaching of Technology happens through a project-based and problem-solving approach, which suggests that learners should be assigned design problems to solve. According to Gumbo (2012:445), the problem for which a solution must be designed could be a real problem existing in an indigenous set-up. Having to design a solution to such a problem will most probably motivate learners to use their indigenous skills to generate a technological solution from which even non-indigenous learners might learn. Technology learners are expected to learn to investigate problems that are found in both indigenous and conventional contexts. Gumbo (2012:445) emphasises the need for investigations that are undertaken in indigenous set-ups to target indigenous communities, thus presenting learners with opportunities to conduct research in, interact with and learn from those communities.

By addressing topical issues in the learners' communities, the TE teacher can encourage them to learn and acquire design skills and investigate important issues in indigenous communities. For example, they can identify the high cost of electricity due to the annual escalation of prices as a problem for poor rural populations. This problem may be solved by finding ways to save

electricity. Technology learners may, for example, design a house built from materials that will allow the day-time heat to be trapped inside at night. Technology learners from rural areas can use IK to make artifacts for use by rural dwellers. Technology teachers can thus use experiential learning to teach design skills. Ankiewicz and De Swardt (2001:27) state that experiential learning emphasises the linkages between the classroom and the real world; it pictures the workplace as a learning environment that can enhance formal education. According to Ankiewicz and De Swardt (2001:28), experiential learning provides opportunities for learners to practise various activities that duplicate reality in a simulated classroom environment. They can practise their design skills by making models of technological products. Ankiewicz and De Swardt (2001:28) state that through learning by doing, learners become increasingly involved in authentic practices in TE. Thus learning is then taken beyond the classroom to expert practitioners in the field. Technology learners are supposed to practise their design skills by learning from local expert designers, e.g. by basing their designs on artifacts produced by elders in their indigenous communities. This will encourage work-based assessment, which will in turn promote the acquisition of design skills in real work situations.

Ertmer and Newby (2013:52) posit that in order to retain what they have learned learners need to recognise the value of the subject matter in their own lives. The applicability of design skills in their communities will motivate Technology learners to cherish and retain those skills. According to Kalpana (2014:28), constructivist theories recommend that teachers design learning tasks that promote divergent thinking. Technology learners will be discouraged if they are expected to acquire design skills that are not related to IK. According to the Department of Basic Education (2011:9), the teaching of TE should not be restricted to classrooms. Technology teachers should use authentic contexts rooted in real situations outside the classroom to enhance learners' understanding. A Technology teacher might use an indigenous object, such as clay dish, when teaching design skills. If learning is related to familiar objects, Technology learners should find it easier to solve technological problems. Van Putten et al. (2014:94) suggest that in order to broaden learners' horizons and allow them to develop an understanding of other people's worlds, values and beliefs, learners from various cultures should be allowed to discuss their knowledge, skills and different experiences. Technology teachers can draw from different applicable teaching examples and from different cultures to optimise the acquisition of design skills.

2.8 LEARNERS' ACTIVE CONSTRUCTION OF OWN MEANING

People, learners included, can contribute towards making meaning. Skamp (2015:14) states that, according to constructivist learning, learners construct rather than absorb new ideas, and adds that learning is not simply the transferral of knowledge from teachers to learners. Ertmer and Newby (2013:55) point out that the constructivist theory holds that people are able to create knowledge by observing incidents in their environments, and Ornstein and Hunkins (2004:117) explain that although a real world exist out there about which we wish to learn, its meaning does not exist independently from us. This confirms Donald et al.'s (1997:49) view that meanings are socially constructed and are not fixed or static. Technology learners must learn to find new solutions by using unique ways of dealing with new problems. The goal of teaching, according to Ertmer and Newby (2013:56), is not to ensure that learners know specific facts, but rather that they are able to elaborate on and interpret information. This means that Technology learners should be able to analyse situations and detect real problems that exist in particular contexts. Wilson (2010:2) states that constructivism advocates active, ongoing meaning-making through authentic engagement. It is becoming increasingly important to allow Technology learners to practise design skills in TE classrooms. Technology teachers can use role-play activities to promote active learning in the process of acquiring design skills.

One of the shortcomings of the social constructivist theory in teaching, discussed under 2.3, is that teachers who are not sufficiently trained may not be able to integrate IK into their teaching of design skills. Technology teachers are expected to acquire a thorough knowledge of IK in order to be able to fairly assess learners' work. Technology teachers should be able assess projects by correctly appraising their usefulness for solving technological problems. According to the Department of Education (1997:5), Technology teachers may consider a range of possible and relevant solutions suggested by their learners as they attempt to generate different solutions to technological problems. Technology teachers should always try to encourage their learners to use their creative thinking skills when designing new products. They could also use capability tasks to promote learners' active participation in acquiring design skills when learners design and make artifacts to meet human needs. Ankiewicz and De Swardt (2001:44) explain capability tasks as tasks that are usually performed by learners themselves to acquire or improve competence, for instance by independently researching a

particular aspect of a chosen idea. Technology teachers should give their learners projects and allow them to do research in different communities, for example in indigenous communities where they can gather information about indigenous skills that can be useful for designing technological products. Technology learners should be taught to conduct investigations and construct their own meanings from the collected data, which means that they have to analyse the data and conceive mechanisms that can be used to solve the technological problems they have identified.

Technology teachers can use the inquiry approach to encourage learners to actively participate in the acquisition of design skills. Inquiry learning requires learners to solve technological problems by posing and answering questions (Ankiewicz & De Swardt, 2001:25). Most importantly, Technology teachers should ask challenging questions and suggest design scenarios that can stimulate their learners to think creatively and critically. Teachers can observe what is happening in the learners' environments and creatively design relevant scenarios. In real life new problems keep emerging, so there is a constant need for new solutions. Design skills can be adapted to suit new situations. Ankiewicz, De Swardt and Stark (2000:47) explain that in TE knowledge is created, whereas in Science it is discovered. Technology learners should construct knowledge, rather than absorb ready-made knowledge without any personal input. Mays (2014:118) advises that teachers should encourage learners to engage with multiple perspectives as knowledge is constructed and contested. This indicates that Technology teachers should also consider IK as valid knowledge in their lessons. Ornstein and Hunkins (2004:117) claim that human beings structure the world and construct reality in order to comprehend it. Learners do not receive knowledge passively, but contribute towards knowledge making. This leads to the conclusion that when Technology learners are afforded an opportunity to make meaning, they will make an immense contribution towards improving our world. According to Ornstein and Hunkins (2004:118), our understanding and view of reality are always subjective rather than objective, and knowledge is not an objective truth, but an interpretive act. This means that Technology teachers should be prepared to learn about and respect the IK constructed by indigenous people. They should also respect the new knowledge and design skills constructed by learners, which can assist in solving the problems of the world. Technology learners can construct meanings from information that they have

collected individually. The findings from different learners can be analysed and new meanings can be constructed and integrated in designs.

Technology teachers can also use the discovery teaching approach to promote active learning and motivate learners to create new knowledge. Discovery learning occurs when learners are expected to independently make new meaning (Ankiewicz & De Swardt, 2001:24). Teachers who follow a constructivist approach do not use the lecture method in teaching, but merely guide their learners in learning and allow them to create their own understanding. Learners are allowed to do things by themselves, make discoveries, undertake projects and make products to solve technological problems with minimal guidance from their teachers. Teachers who apply the constructivist theory can produce learners who take responsibility for their own learning (Kalpana, 2014:28). Technology teachers are expected to create an atmosphere that allows learners to develop design skills, rather than memorise facts without active engagement. Weegar and Pacis (2012:7) state that in constructive classrooms, learners are actively engaged in learning activities in their respective groups. Swan (2005:7) concurs by explaining that knowledge-centred learning does not rely on the memorising of facts, but requires learners to become actively involved in solving real problems in context. Technology teachers can use capability and case study tasks to promote authentic problem solving. In case study tasks, learners are usually exposed to phenomena as they appear in real-life situations (Ankiewicz & De Swardt, 2001:44). For example, Technology learners and teachers visit indigenous elders who have expertise in making indigenous technologies in order to acquire indigenous skills, which can then be utilised to design technological products in TE classrooms.

According to the constructivist theory, learners must actively apply their knowledge to solve the problems at hand (Ertmer & Newby, 2013:58), therefore learners in constructivist classrooms are expected to be more active in constructing new knowledge while teachers provide insightful guidance, rather than transfer knowledge to learners (Ertmer & Newby, 2013:58; Kalpana, 2014:28). Ornstein and Hunkins (2004:117) accept that learners are not expected to receive knowledge in its final form, but can be allowed to bring their IK and utilise it to acquire new design skills in their TE classrooms. Weegar and Pacis (2012:7) state that learners should be inquisitive in order to generate new ideas. Technology teachers should

guide their learners to construct meaningful knowledge that can contribute to human development, and Ornstein and Hunkins (2004:117) advise that learners should internalise and reshape or transform information through active consideration. Ornstein and Hunkins (2004:118) add that teachers should only furnish situations and contexts in which learners can be active, thus motivating them to understand the value of the meaningful construction of knowledge. They must understand that by creating their own meanings they may succeed in creating unique new products. According to Swan (2005:7), teachers who apply the constructivist theory concentrate on helping learners to develop a sound understanding of the subject matter. Teaching from an indigenous perspective can allow learners to construct robust meanings without fear of being penalised and discouraged from attempting to construct new meanings in the future.

According to Swan (2005:6), TE learners should express their ideas verbally so that teachers can correct any incorrect ideas. By encouraging such verbal expression, teachers will be able to diagnose misconceptions and provide remediation before learners internalise their misconceptions. Continuous assessment is useful for identifying learners' misconceptions and can encourage them to actively participate in the acquisition of design skills. Performance assessment and projects are also useful ways to engage learners. Culturally relevant assessment can stimulate all the learners, including those from indigenous backgrounds, to participate actively and individually in the acquisition of design skills. Constructivism promotes learning as a social activity, which helps teachers to free themselves from the traditional approach to teaching and to focus on learner-driven teaching.

2.9 SOCIAL LEARNING

Human interactions play a major role in learning, and according to Vygotsky, social learning is very important (Powell & Kalina, 2009:243); therefore, Technology teachers ought to encourage their learners to work cooperatively in solving technological problems. Powell and Kalina (2009:243) agree and state that when the constructivist theory is applied, learners should interact in order to promote critical thinking, for instance within the context of IK, to solve technological problems. Distinct kinds of knowledge that exist in different communities can play a role in learning and learners should be allowed to share any IK applicable to TE activities. Social constructivism is relevant to the teaching of design skills in TE as it

encourages interaction. Interaction in TE classrooms can help learners to produce useful technological products that meet human needs. People can create shared meaning when they engage in social learning (Jordan et al., 2008:59). Indigenous communities can play a pivotal role in formal learning by helping Technology learners in their communities to acquire practical skills that can be useful in TE classrooms.

According to Jordan et al. (2008:59), people's understanding and thinking are influenced by their cultures and the thinking of learners in the classroom is influenced by the knowledge acquired from their society. Interaction with parents and teachers should enable learners to help each other. Doll (1993:136) agrees that meaning is created by personal and public dialogic transactions. Interaction between learners in TE classrooms can play a crucial role in their acquisition of design skills.

Ankiewicz and De Swardt (2001:86) state that TE is cooperative in nature and requires collaboration to achieve a goal. These authors further state that in cooperative classes, learners listen, write, tell, paraphrase, read, illustrate, discuss, repeat and interact. As they interact with learners in a teaching situation, Technology teachers can guide learners towards interaction with each other. Through collaboration, Technology learners can assist one another. For example, artistic learners can show others how to draw two- and three-dimensional shapes. Mays (2014:118) explains that the constructivist theory calls for teaching approaches that emphasise interaction and dialogue. In summary, Technology learners will be motivated to share ideas in their groups as their teachers encourage discussion. Discussion provides learners with opportunities to share different experiences (Ankiewicz & De Swardt, 2001:66) and debate current issues, such as the environmental problems that affect humankind. They should critically consider the impact of their products on the environment. Technology teachers should encourage their learners to provide technological solutions that will have a minimal negative effect on the environment and should find ways to make learners aware of the danger of using certain products.

According to Swan (2005:5), the constructivist theory is supported by the distributed cognition theory, which advocates the use of cultural artifacts and tools to promote learning. This also applies to TE, and the curriculum should therefore include indigenous technologies from which

much can be learned. This supports Gumbo's (2016a:105) suggestion that, instead of including only western perspectives, the curriculum should embrace indigenous perspectives in order to accommodate indigenous learners. TE textbooks should therefore include indigenous technologies in their learning content. Turuk (2008:251) argues that cultural artifacts can simplify the learning of new concepts and can be used as teaching aids. Technology learners can also acquire indigenous knowledge and skills from indigenous people in their communities as knowledge does not reside only in people of western descent and in formal learning, but can be derived from different people and objects.

Hergenhahn and Olson (2013:271) explain that children are born with a few highly organised reflexes, such as sucking, looking, reaching and grasping, but with few schemata. The term schema is used for the potential to act in a certain way. Schemata are generally acquired through interaction with other people. Human beings' cognitive structures, and therefore also their knowledge and skills, are developed through interaction with other people. Hergenhahn and Olson (2013:34) refer to John Locke's theory that the mind is made up of ideas and ideas come from experience, and that if ideas were innate, people everywhere would possess them, but they do not. Human beings are not born with skills, knowledge and values, but acquire them through social learning. Locke points out that different cultural groups differ markedly in what they think and believe. They are not born with knowledge and design skills, but acquire both western and indigenous knowledge through interaction with people in their communities and elsewhere. During such interaction, Technology learners can learn about the properties of different materials that can be used to design prototypes in TE. For example, indigenous learners can learn about the properties of wood from trees in their environment.

According to Wertch, Rio and Alvarez (1995:190), human beings continuously learn from each other and from the objects around them. Wertch et al. (1995:191) state that while what animals learn through experience remains their own property, the creations and achievements of human beings have lasting existence and are transferred from one generation to the next. The technological knowledge and skills acquired by humans can be passed from one generation to the next through dialogue and observation. Constructivism advocates that learning occurs due to interaction between learners, as discussed in the preceding section, however learning can occur within an individual's unique mind.

2.10 CONCLUSION

In this chapter, the theoretical and conceptual frameworks that guided this study and ways in which IK can add value to teaching design skills in TE were discussed to show how IK can be used in TE classrooms to benefit learners from indigenous backgrounds. Technology teachers should include IK in the teaching of design skills. The inclusion of IK can help learners to relate new learning to their existing indigenous knowledge (IK) and promote their understanding of TE. Attention was also given to the potential role of MKOs (teachers, indigenous elders, parents and other learners) in the acquisition of design skills. Children can learn a great deal from indigenous elders. Finally, this chapter shed light on how novice learners can acquire new knowledge and design skills to become experts in the ZPD. In the next chapter, the literature that informed this study will be reviewed.

CHAPTER THREE

DESIGN SKILLS AND INDIGENOUS KNOWLEDGE

3.1 INTRODUCTION

In this chapter a review of extant literature on the role of IK in enhancing the teaching of design skills in TE classrooms will be discussed. However, this will be preceded by a discussion of the origin and importance of Technology teaching, as well as the nature and value of TE and its core knowledge areas that contribute to design in a cultural milieu, with the focus on the importance and benefits of including IK in the teaching of design skills. The disadvantages of the one-size-fits-all model that seems to dominate the teaching of Technology and design skills will also be dealt with. The chapter will further shed light on how IK can be used in the teaching of design skills and some examples will be given of indigenous technologies that may be included in the learning content. Finally, the culturally relevant pedagogy and feedback, and strategies for promoting the acquisition of design skills will be discussed.

3.2 TECHNOLOGY

Throughout history, humans have been involved in technological activities to ensure their survival and have handed their expertise in designing and making new products to their children. Since technology can be used to solve human problems to meet human needs, it plays a significant role in people's lives (Philbert, John and Cosmas, 2014:463). De Vries (2016:54) concurs that people engage in technological activities because they seek new ways to fulfil their needs and sustain their lives.

According to Gibson (2012:21), people make useful products to simplify their lives. Ancient people designed the first axe for tasks such as chopping firewood, which they could not break with their hands (De Vries, 2016:54). Other examples are spears, which could be used to kill animals from a distance, clay pots for storing food, grinding stones for grinding wheat, baskets for storing grain and wooden mallets for softening animal skins.

De Vries and Tamir (1997:3) emphasise the need for people who design products to consider social, ecological, economic and scientific factors. Indigenous people engage in making new

artifacts to provide the needs of their communities and pass their skills on to the next generation. For example, indigenous Tsonga people use leadwood beams to support the roofs of traditional huts. Liengme (1981:506) explains that the wood of a leadwood tree is very hard and durable and is frequently used in building, usually for the main supporting poles of a hut. Wood from blue gum trees is used by the South African Tsonga people to make furniture. According to Liengme (1981:504), wood from the pod mohogany is used for making furniture like chairs. IK of natural materials used to make furniture can aid design skills when learners learn about frame structures in TE.

Technological activities are practised by human beings (De Vries, 2016:53) as they constitute an integral component of people's livelihoods. People identify problems and make products to solve them (Alamaki, 2000:10). Among these are indigenous people, who have been involved in problem solving in their own settings. According to Philbert et al. (2014:463), technology is conspicuous wherever there are people, as it is needed to simplify their lives. They transform theoretical knowledge to practical applications or, as Peter (2015:2) puts it, technology is scientific knowledge used for practical ends, and technological knowledge can be used to design machinery, materials and industrial or engineering processes. The National Council for Curriculum and Assessment (NCCA) (2007:2) states that Technology promotes creative activities when people interact with their environments in their communities. While people are involved in these activities, they learn to use suitable materials and processes to make products to meet their needs. The interaction of indigenous people with their environments may lead to the acquisition of new skills needed to develop new artifacts.

People who make new products should use resources responsibly (Leahy & Phelan, 2014:384; Mukuka, 2010:4). TE is defined by the New Zealand Ministry of Education (2007:32) as a vehicle that can be used to teach the design skills needed to make technological products. De Vries (2016:54) refers to Ernst Kapp's comment that people can use technology to increase or replace their capabilities. They can use technological objects to do things that would be practically impossible for them to do themselves. Technology learners who are conversant with indigenous technologies can use indigenous artifacts to make their lives easier. Different definitions of technology lead to three approaches to technology, which will receive attention in the next section.

3.3 THREE APPROACHES TO TECHNOLOGY

The three approaches to designing technological products are discussed in the subsequent sub-sections.

3.3.1 Experience-based or handicraft technology

Experience-based technology is commonly practised in pre-industrial societies (Levin & Kojukhov, 2008:6) by indigenous people who tend to be marginalised by modern industrial technology. Indigenous people depend on technology of this kind, for example they may use sleighs to transport heavy loads. Levin and Kojukhov (2008:5) point out that in experience-based technology, learning occurs in a non-formal setting that can promote creative thinking skills, and that indigenous masters (teachers) can teach new concepts to individual learners outside classrooms. Indigenous masters help novice designers to acquire practical skills, such as designing a roof for a traditional hut. The novice designers can be taught to use purlins and rafters to reinforce a roof. Norström (2014:11) mentions that skills of this kind are easily passed on to novices and adds that non-scientific, experience-based knowledge can be justified through repeated successful use, for instance when indigenous skills and knowledge are applied to make malt sorghum. Indigenous people continue to use experience-based technology as it has proved to be reliable for centuries.

Since indigenous people do not possess scientific knowledge, they rely on experience-based technology (Levin & Kojukhov, 2008:5). Norström (2014:11) states that experience-based technology does not require any scientific knowledge. Indigenous people use their practical experience to make products. Levin and Kojukhov (2008:5) state that the knowledge is created from direct observation without making use of scientific laws, and add that designers are creative and rely on the rule of thumb, which is based on experience, and not on accurate measurements. Experience-based knowledge stems from the manufacturing practice. Technology learners can acquire knowledge and skills by designing and making technological artifacts (Sarlemijn & De Vries, 2005:19). These authors argue that experience-based knowledge is easy to acquire as teachers use real objects to simplify learning and do not teach new concepts abstractly. Technology learners may use the practical experience gained in their communities to develop technological products. According to De Vries (2012:22), examples of experience-based technologies are simple household devices and tools, such as wooden

spoons, stirring rods, meat spikes and wooden hooks. De Vries (1996:11) regrets the fact that learners do not regard the examples of experience-based technology as technology, but accept only examples of microtechnology as technology. Technology learners should be taught to appreciate and acknowledge all types of technology and endeavour to improve on them.

The science-based knowledge used in advanced solid mechanics, for example when an engineer uses written information to produce something, differs from the skills used by a blacksmith to make artifacts. A blacksmith can learn by observing a particular activity and acquire a skill, but may not be able to explain the procedure orally (Norström, 2011:4). In the indigenous context, the tacit knowledge of the blacksmith is not based on scientific knowledge like that of an engineer, but on individual discretion. This leads to the conclusion that Technology learners should also be involved in experience-based technology for solving problems that arise in their immediate environments and therefore do not only need sophisticated technology or science. This is important in the South African context where the majority of learners come from rural indigenous backgrounds. These learners are more familiar with the rustic products that were used to meet people's needs, such as the wooden ladders that were used to reach certain heights before they were replaced by steel ladders. Technology learners should be motivated to identify new needs in their communities and try to design products that will satisfy those needs.

Experience-based technologies can promote learners' understanding of the macroscopic properties of materials, such as their physical and mechanical properties, which can help Technology learners to select the most suitable materials for making artifacts. According to Laubscher (2001:19), physical properties describe the basic features of a material and include properties such weight and density, and Holdt and Richter (2005:25) explain that materials can have either high or low densities. Indigenous knowledge of the properties of cowhides, which have a low density and can be softened, can lead to people using them to make blankets and bags. Light-weight skins can be used for wrapping things in so that they can be easily carried on people's shoulders. Indigenous people also use thatch grass to construct roofs because it has a low density and soaks up rainwater, but does not allow it to pass through. Since the grass does not exert a lot of pressure on the purlins, a thatched roof can last for many years.

Laubscher (2001:19) defines mechanical properties as properties that determine how a material will react to a mechanical load or force, which implies properties such as the strength, hardness and toughness. When indigenous people select a suitable wood for making mortars and pestles, they must consider the hardness, strength and toughness of different kinds of wood. A mortar and pestle should be made from wood that is strong, hard and tough, and will not crack when maize or peanuts are being ground. The Tsonga people of South Africa use the strong, hard wood from the leadwood tree to make mortars and pestles (Liengme, 1981:506). Indigenous people also use the wood of the camel's foot tree for the apexes of their circular huts as it can support heavy loads without cracking. IK of the mechanical properties of materials can help Technology learners to select suitable materials for making technological products.

3.3.2 Macro-technology

De Vries (2005:58) defines macro-technologies as technologies that require the use of more fundamental scientific knowledge. Levin and Kojukhov (2008:5) concur that macro-technology involves the application of the fundamental and classical theories such as mechanics, thermodynamics and electromagnetics for making products. These theories can play a crucial role in assisting Technology learners to select suitable materials for designing products. For example, knowledge of the properties of thermodynamics, such as thermal diffusion, can help learners to choose the most suitable materials for making spoons, or handles for a pot used for cooking. Thermal properties indicate how a material reacts to heat, for instance whether it will contract or expand when heated (Laubscher, 2001:19). TE learners should be aware of the thermal properties of different materials before they design a new technological product for cooking. Indigenous people carve spoons from the wood from marula trees, which does not expand when the spoons are used to stir hot food. To ensure that their products will be functional, it is important for Technology learners to acquire macroscopic knowledge of material before they design products to solve some technological problems. In macro-technology, designers rely heavily on scientific knowledge when making new products (Sarlemijn & De Vries, 2005:20). De Vries (2012:22) points out that in macrotechnology the value of a new product is influenced by the designer's level of knowledge. This suggests that Technology learners can be taught to use a combination of scientific knowledge and IK to

design technological products. For instance, Technology learners may study the existing indigenous artifacts to understand the properties of materials, while professional designers may derive their understanding of the properties of materials from existing western artifacts.

In macro-technology designers usually make use of both scientific and technological knowledge (De Vries, 2016:46). Technology learners may acquire mechanical knowledge of the properties of certain materials. For example, they may learn about the properties of different materials, such as bonding (of clay soil and cow dung) and tensile strength. Technology learners should know the mechanical properties of different materials in order to be able design artifacts at the macro level. Learners from indigenous communities must, for example, know the properties of different types of soil that are suitable for building the walls of a traditional hut. They should know how different soil types react when exposed to water and have knowledge of the properties of wood from different trees that can be used to make technological artifacts. Knowledge of this kind must be acquired in their indigenous contexts. This may require collaboration with older people in their communities who can share their wisdom and knowledge, or with other learners who have already been taught these things in their homes or communities.

According to Levin and Kojukhov (2008:5), macro-technology is taught in formal education and involves learning about the properties of materials in formal institutions like schools, where teachers use formal teaching methods and theories, whereas knowledge of experience-based technology is acquired in informal settings. All teaching and learning methods used in schools are well formalised and symbolically described, while knowledge that is not formalised is inadequately presented in the curriculum. Teachers have the privilege of being able to teach their learners knowledge obtained from written documents, but restricting content and teaching to documents and formal classroom engagements downplays the value of the IK that learners bring to school.

3.3.3 Micro-technology/High technology

Levin and Kojukhov (2008:5) state that the micro-technologies are nowadays technologies, which basically form the basis of the post-industrial society. Micro-technology is based on chemical knowledge. Technology learners have to acquire knowledge of different atoms,

molecules and electrons in order to be able to design micro-level artifacts. De Vries (2016:46) explains that in microtechnology designers use knowledge of particles such as atoms, electrons and neutrons to make products, which means that, for example, learners should understand the ingredients of traditional mageu and beer. Designers therefore have to use scientific theories to help them understand particles that cannot be seen with the naked eye (Sarlemijn & De Vries, 2005:20). Levin and Kojukhov (2008:7) explain that when education becomes non-formally centred, innovative ways of designing a curriculum and imparting knowledge are required. In this technological approach, teaching and learning can be informal, which presents teachers with opportunities to allow their learners to be creative, rather than being forced to follow rigid steps to design artifacts, as seems to be the case in the current teaching of Technology. If the ultimate aim is to produce future engineers, creative industrialists, entrepreneurs, etc. who can think and apply technologies from diverse forms and contexts, learners should be free to invent new products by applying either one, or all three technological approaches to find solutions to technological problems.

According to De Vries (2016:47), designers usually use different technological approaches to make the different components of a new product. Learners should be exposed to different technological approaches as they may complement each other in the designing of new technological products. They should be familiar with existing IK so that they can use it to design experience-based technologies that can be further developed into macro- and micro-technologies. All approaches of technology that can be used to solve human problems are important. De Vries (2016:47) adds that there are some communities that still rely on an experienced-based approach, or IK, to make products such as malt sorghum (xivirisi in Xitsonga) and sorghum meal (mugayo in Xitsonga). Indigenous people in South Africa (in particular the Tsonga tribe) have been using sorghum meal for many years. They chop up the sorghum silages and allow them to dry in the sun before they are threshed by hitting them on the floor. A winnowing basket can be used to separate seeds from unwanted materials. The seeds are then soaked in water for two days, after which they are taken out and placed in a winnowing basket so that the dehydration process can take place. When the seeds are dry, they are placed in a mortar and a pestle is used to grind them. The ground grains are then sifted to make sorghum meal.

Experience-based technology is clearly still relevant today as many indigenous communities continue to depend on it to meet their needs. In addition to what they learn through formal teaching, learners should also acquire IK to facilitate an experience-based approach to the designing of technological products.

3.4 TECHNOLOGY EDUCATION (TE)

The school subject TE was designed to help learners to acquire the knowledge and skills required to apply technological approaches to design and make artifacts to solve human problems (Bondy, 2011:389). The Department of Education (2002:4) acknowledges the importance of TE.

According to Leahy and Phelan (2014:384), TE learners are expected to acquire the attitude, knowledge and skills that will enable them to solve technological problems independently. They are taught conventional design processes that promote the use of creative and critical thinking skills when they make products. Technology teachers can help learners to acquire technological skills, such as investigating, designing, making, evaluating and communicating to solve problems using technical rules for scaffolding the aforementioned skills.

3.4.1 Technical rules in TE

According to Ropohl (1997:70), there are different types of technical rules in TE that can be used by learners to design new technological products. These technical rules will be discussed at a later stage.

3.4.1.1 Socio-technological understanding of design

Ropohl (1997:70) posits that designers use resources from the natural environment to make the products people need; therefore design affects both natural resources and humankind. When making indigenous products, indigenous people always seek to maintain a harmonious relationship with nature. Technology learners need to understand that when they design products to improve people's lives, they must do so without negatively affecting nature. Socio-technological understanding is systemic knowledge concerning the interrelationship between the natural environment and social practices. Designers should understand that ecological and psycho-social contexts are also very important when they are making products and should

therefore be concerned about the effects of technological processes and new technological products. The aim should thus be to design useful products without harming the natural environment. Ropohl (1997: 70) further states that designers should not design only technical systems, but eco-technical and socio-technical systems as well. De Vries (1996:7) maintains that the success of design depends on the ability of designers to use scientific knowledge in combination with other knowledge systems. This means that scientific knowledge is not the only type of knowledge that can contribute to the designing of new products, but can, when combined with other types of knowledge, such as indigenous knowledge, lead to good, environment-friendly designs. Teachers should help learners to integrate scientific and also other knowledge systems into their design processes (De Vries, 1996:12, 13).

3.4.1.2   Structural laws/rules

Knowledge of existing technological structures may play a role in design. Structural rules prescribe how different parts of a technical system should be assembled (Ropohl, 1997:69; Norström, 2011:8). Technology learners are expected to understand the relationships between the different components of products. This will help them to identify the limitations of products to ensure a new working product. The components of a product may be connected to work together to achieve the intended goal. Indigenous hunters use flat stones balanced on sticks to which a string is attached to kill birds. Technology learners can use this indigenous knowledge to design linkages, for example to make puppets with moving parts.

Ropohl (1997:71) indicates that structural laws are appropriate in TE as they cover a wide variety of products. Since Technology learners from indigenous communities are conversant with indigenous technologies, those technologies should be included in the teaching content to facilitate the development of design skills. Ropohl (1997:69) emphasises the importance of structural rules in design and points out that design rules are often derived from non-formal learning and support the designer in creating novel realities. Therefore, learners should acquire structural rules as they can play a crucial role in design. Technology learners may be inspired by existing western and indigenous structures to think creatively about new products.

3.4.1.3   Technological laws

Designers can transform natural laws in order to solve technological problems (Ropohl, 1997: 68). The success of design depends more on practical experience than on theory. Indigenous people engage in practical experiments to make artifacts such as the deadfall trap illustrated in Figure 3.1.
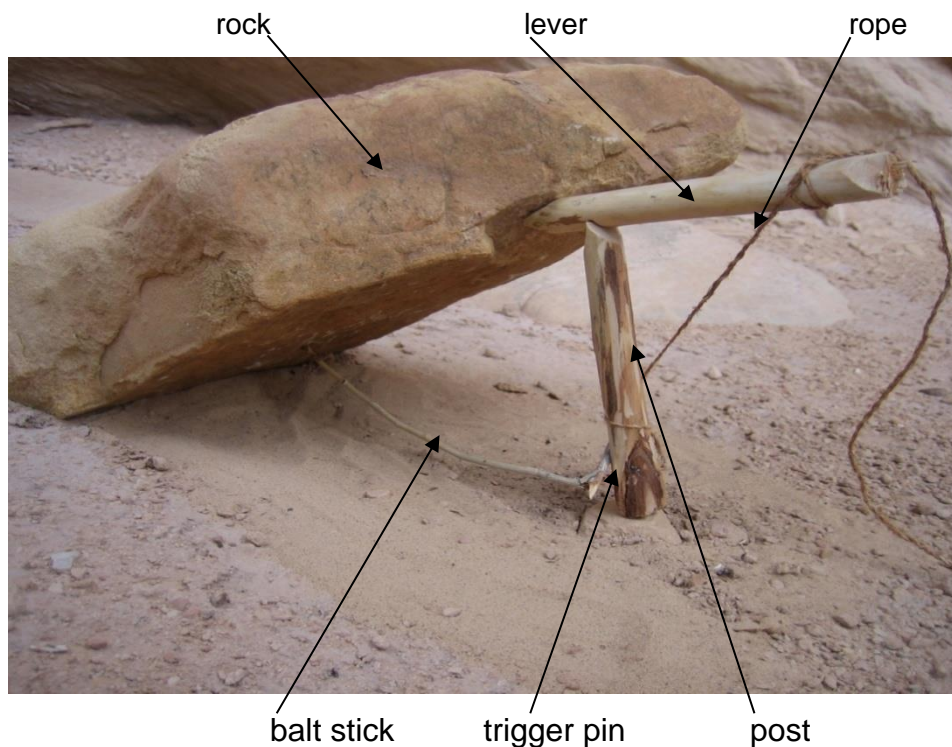
Figure 3.1: Deadfall trap / falling slab

In the above figure, the stone slab (load) is raised by the lever, which is supported by a post (fulcrum) with a trigger pin to which a string is attached. The trigger pin is held firmly in position by a balt stick. When a bird touches the balt stick the trigger pin will shift and the string will be pulled by the gravitational force exerted on the stone slab. The slab will fall and kill the bird.

Deadfall traps are made by applying Newton's law of universal gravitation. Indigenous people might not know Newton's law, but are aware of the principle. Technology learners need to know how to apply natural laws in practice in order to be able to design new technological products. According to Dixon (2013:51), Technology can accommodate different knowledge systems since insights into several established disciplines can be useful when designing new products to achieve technological goals. Scientific natural laws can play a crucial role in the

designing of new products. Ropohl (1997:68) explains that in TE classrooms teachers use not only scientific truths, but also technological laws to guide learners to design products. Compton (2004:4) concurs that technology is concerned with transforming the natural world into a technological world, thus transforming natural laws into technological laws. De Vries and Tamir (1997:8) explain that designers transform scientific concepts into technological laws when they make products and De Vries and Tamir (1997:8) confirm that the scientific concepts possessed by learners need to be transformed in order to use them in TE classrooms to solve technological problems. Compton (2004:5) concedes that technological laws are the result of the operationalisation of knowledge of other domains. Technological laws seek to optimise different kinds of knowledge, including IK; therefore, Technology learners should be able to operationalise scientific knowledge and other kinds of knowledge to design new products. In TE learners learn to use scientific knowledge in combination with other existing knowledge (Ankiewicz et al., 2000:21).

3.4.1.4 Functional laws

Technological products provide clues about how to use them when the designers are not present to explain how it should be done. Indigenous people consider functional laws when they design artifacts. For example, when they design a wooden platter, they carve a concave shape into one side of a block of wood so it can contain food. They also carve two handles on opposite sides for carrying the platter (see Figure 3.2).

Figure 3.2: Wooden platter

Technology learners should be able to design useful products to replace or compete with similar products already in use in their communities. Especially in the case of more complicated products, clear indications should be given of how new technologies should be used as the designer cannot always be present. However, complicated technological products tend to be less affordable. Ropohl (1997:71) agrees that it is important for learners to be taught technical know-how, but mentions that teaching time is often limited. Indigenous technological products, which are more affordable as they do not require complex production processes, could be clearly marked to show how they should be used. This means that the approaches and processes involved in designing and producing products will be blended.

According to Ropohl (1997:68), engineers can change technological laws into functional laws and can give clear instruction on how to use products and explains that functional rules may be written instructions and diagrams that can guide consumers' use of products, for example washing machines (see Figure 3.3) (Ropohl, 1997:71).

Figure 3.3: Washing machine

Designers and engineers usually compile user manuals to explain how products should be operated. When needed, Technology learners should be taught how to write instructions for the use of their products.

3.4.2 Technological knowledge

Professional designers cannot create new products without adequate technological knowledge (Barlex, 2007:50). This also applies to Technology learners. Owen-Jackson and Steeg (2007:172) state that technological knowledge embraces all skills and knowledge needed for making technological products. Technological knowledge is crucial as it can increase learners' ability to make products (Norström, 2011:8). Owen-Jackson and Steeg (2007:172) explain that technological knowledge consists of conceptual and procedural knowledge. Technological knowledge includes skills (technical know-how) and facts. It is often difficult to express technological knowledge in words as ideas are best explained visually in two or three dimensions. Teachers should constantly engage their learners in mind-on activities to allow them to practise design skills.

Lundgren (2006:764) defines technological knowledge as knowledge taught in workshops. TE is concerned with knowledge mostly taught in a practical way. TE learners from indigenous backgrounds may find TE easier if it is related to the more practical IK. According to Owen-Jackson and Steeg (2007:172), product design and manufacturing are generally more focused on practical than on theoretical reasoning. Alamaki (2000:12) states that many potential design solutions are found in technological reasoning; technological reasoning is the ability to make valid inferences from different technical means and systems and combine them into an optimum solution. This suggests that Technology learners with good technological reasoning ability could utilise different knowledge forms to find a technological solution. Norström (2011:4) explains technological knowledge as that which enables designers to be shrewd in designing new quality products. Technology learners should acquire technical knowledge, which is part of technological knowledge, to be able to solve technological problems.

Ropohl (1997:69) states that designers can use technical know-how and must, for example, know how to use the tools needed for making a product and further explains that technical know-how implies hidden knowledge that can be taught by way of demonstration. Since technical knowledge can facilitate design, Technology learners should acquire technical knowledge to enable them to design functional technological products. Designers rely on this hidden knowledge when they are designing technological products. Technical knowledge

facilitates design. According to Ropohl (1997: 69), technical know-how can be acquired only through direct involvement in technological activities, which means that Technology learners should be given adequate time to practise technical skills in class. Engineers are engaged in problem-solving and design using specialised technical knowledge (Travelyan, 2009:2). TE seeks to teach learners the kind of technical knowledge used by engineers to make products, but teachers must always ensure that the technical knowledge taught is appropriate for their learners' grade. Technology teachers can help their learners in different grades to acquire both conceptual and procedural knowledge in order to be able to solve technological problems.

3.4.2.1 Conceptual knowledge

This study focuses on the development of TE learners' design skills. However, since the development of skills is dependent on knowledge, this section will elaborate on conceptual knowledge and the next section will elaborate on procedural knowledge. According to Ankiewicz et al. (2000:19), invention is not a simple process of trial and error without a knowledge base. Technological problems cannot be solved without adequate knowledge; therefore designers need knowledge, in this case conceptual knowledge, to design effective products to solve technological problems (Barlex, 2007:50). Inadequate conceptual knowledge can hamper the execution of design skills. According to De Vries (2016:47), conceptual knowledge is declarative knowledge and conceptual knowledge is the knowledge of facts and theories that can easily be verbally expressed. Conceptual knowledge, for example of different shapes, plays a crucial role in designing new technological products. Technology learners should therefore acquire conceptual knowledge to enhance their effectiveness in design. De Vries and Tamir (1997:3) agree that Technology learners should be taught technological concepts and acquire conceptual knowledge in TE in order to be able to design technological products.

Dixon (2013:48) argues that the term technology does not refer only to an artifact, but also to the knowledge and processes necessary to create and operate an artifact or product. Since designers use both conceptual and procedural knowledge to solve technological problems (De Vries, 2016:48), Technology learners should be able to use combinational creative thinking to design new products. Esjeholm (2015:233) explains that in combinational creative thinking, designers use both new and existing knowledge to create new products. Technology learners

should be taught to be able to combine their IK with technological knowledge to create new products. According to Esjeholm (2015:233), designers must be able to use existing conceptual knowledge in new situations in order to produce creative solutions. His research (Esjeholm, 2015:227) revealed that learners who possess rudimentary conceptual knowledge are unable to produce creative solutions, and that teachers prescribe projects for their learners and do not promote the use of creative thinking skills. Esjeholm (2015:242) recommends that Technology teachers should try by all means to ensure that learners are equipped with the conceptual knowledge needed to find suitable solutions to technological problems.

3.4.2.2 Procedural knowledge

In addition to conceptual knowledge, TE learners should acquire procedural knowledge. De Vries (2016:47) explains that procedural knowledge is strategic knowledge, i.e. knowledge about how to solve design problems. Bongum, Esjeholm and Lysne (2014:5) concur that procedural knowledge is necessary to know how to perform processes such as design, modelling and problem solving. Technology learners should find out how existing artifacts were made and how they are used, and should gain practical experience in designing products. Their first contact point to acquire practical experience could have been in their indigenous communities. Bongum et al. (2014:5) write that procedural knowledge is practical and based on experience in relevant contexts, while Dixon (2013:48) mentions that designers use procedural knowledge (know-how) to make and use technological products. To successfully complete a technological project, Technology learners should acquire the necessary conceptual and procedural knowledge.

Van Wyk (2002:307) states that it is essential for learners to embrace conceptual knowledge, i.e. specific cultural, traditional and community facts, and to also acquire procedural knowledge, but does not specify examples of indigenous knowledge that could be included to promote effective learning. This study investigated examples of conceptual knowledge (i.e. the community facts) and procedural knowledge that can play a role in the acquisition of design skills. Alamaki (2000:12) argues that in order to be able to make valid products, learners must have adequate conceptual and procedural knowledge, and that technological, conceptual and procedural knowledge can be used as the basis for technological analysis, synthesis and

evaluation. This leads to the conclusion that Technology learners will not be able to succeed in design activities unless they possess conceptual and procedural knowledge.

3.5 DESIGN

De Vries (1996:12) argues that design is a key activity in TE that illustrates that it is possible to define a body of knowledge and skills called 'technology'. According to ITEA (2000:237), design can be described as a decision-making process that enables designers to use ideas to make technological products. Yu et al. (2010:436) and Caldecote (1995:54) concur that designers are interested in finding ways to design new products. As TE is about minds-on and hands-on activities, learners who design products in formal education should start with minds-on activities to plan what can be designed to solve technological problems. Indigenous people start with practical (hands-on) activities and then progress abstract concepts. This is confirmed by Lodhi and Mikulecky (2010:94), who state that indigenous people use practical experience acquired through observation to solve technological problems. According to Singh (2014:6), the hands-on practical experience during their learning expands their thinking. Technology teachers should therefore allow learners to use their IK to promote the generation of multiple ideas that can be used to solve technological problems. They could use their learners' existing IK to refine existing artifacts. Lodhi and Mikulecky (2010:94) define IK as the accumulation of practical knowledge learned through experience or acquired through observation. Mirian III (2012:19) argues that hands-on learning activities facilitate learning because it provides learners with a context for recalling and using knowledge and adds that hands-on, reality-based learning activities are crucial as they can help learners to internalise (abstract) concepts (Mirian III, 2012:73).

Indigenous people may conceptualise the correct steps to be followed when making a specific product after actively engaging with the concrete objects to be used. When indigenous people plan to make a product, they start with hands-on activities and eventually try to understand the procedure. This makes their knowledge practical in nature, so that it may be referred to as technology. In order to promote the effective learning of design skills in TE, learners should move from the known to unknown. Gumbo (2014:387) asserts that learning can thrive if teachers connect the subject matter with their learners' different cultures. This suggests that Technology teachers should allow their learners to use IK when they generate new ideas for

products intended to meet human needs. As mentioned earlier, they can compare their ideas for new products with existing products when they design technological products. Haik and Shahin (2011:4) emphasise the need for learners to understand the value of design in Technology. They should understand that the design is the first step in the development of all products and that the quality of products is influenced by the planning of the design. Products that are not well designed will not function properly.

3.5.1 Design process

The design process is at the heart of technology (De Vries, 1996:11). Haik and Shahin (2011:8) define this process as a sequence of events and a set of guidelines that help define a clear starting point that takes the designer from visualising or imagining a product to realising it in real life in a systematic manner without interfering with the creative process. Technology learners are expected to use the design process to plan and make a working technological model. ITEA (2000:237) describes the design process as a systematic problem-solving strategy which learners can use to generate ideas for solving human problems. The Department of Basic Education (2011:67) acknowledges that the design process is a creative and interactive approach used to develop solutions to identified problems or meet human needs. The design process encourages the development of critical and creative solutions (Department of Education, 2002:4). TE is intended to promote creative thinking through the application of the design process. Bosch et al. (2013:9) explain that TE is developed by using a well-defined design process to solve technological problems.

DeLuca (1991:2) explains the design process as ideation, brainstorming, the identification of the possible solution, deciding on a prototype and finalising the design. Bosch et al. (2013:9) give the five steps in the design process as investigate, design, make, evaluate and communicate. Indigenous people may start making traditional products without the required skills, but gradually develop them. Technology learners in the formal education system are expected to acquire knowledge about the design process so as to be able to design technological solutions. In indigenous communities, according to Awori et al. (2015:2), meaning and understanding are acquired when people observe and interact with nature, objects and other people. People can interact in different ways, for example through story-telling, dancing and singing. Indigenous people interact directly with nature to generate ideas

57

to solve technological problems experienced in their communities and rely on their spontaneous knowledge to make products that are needed. Dyson (2002:188) confirms that indigenous people learn by trial and error, and novices practising to make artifacts receive constructive feedback and guidance from their elders until they are able to make artifacts without assistance. Technology learners should also be afforded opportunities to independently identify technological problems and find ways to solve them as they see fit, without fear of failure. Technology learners should not be limited by being forced to follow routine steps. The Department of Basic Education (2011:10) states, and Gumbo (2016b:16) agrees, that the design process that drives the teaching of TE through a problem-solving approach should not be followed linearly. Potgieter (2011:76) explains that the technological process describes everything that should happen in a particular technological endeavor – from inception (of an idea) to the development (designing, making and evaluating of a product, process or system), to the conclusion (marketing) of a particular technological product. This may not always be the case from an indigenous point of view since things are made spontaneously due to the richness of the intergenerational experiential and tacit knowledge. Since in the restrictive classroom environment Technology learners are expected to solve problems by following the prescribed design process steps, Technology teachers may help learners to understand and apply the steps in the design process, which will enable them to create new technological solutions to problems, but they should not limit learners' creative thinking and abilities. De Vries and Tamir (1997:4, 6) indicate that the linear design process may not benefit learners as it requires them to think only in a particular way, which suggests that in reality the prescriptions of the linear models can be broken and that there are other ways of designing to promote the creation of new knowledge. De Vries (1996:12) advises that Technology teachers should not use linear design processes as they impede creative and critical thinking.

3.5.2 Design skills

The Department of Education (2004:221) states that the design process and skills of investigating, designing, making, evaluating and communicating form the backbone of TE (See Figure 3.4 below). Thus, these skills should be used to structure the delivery of all learning outcomes in an integrated way.
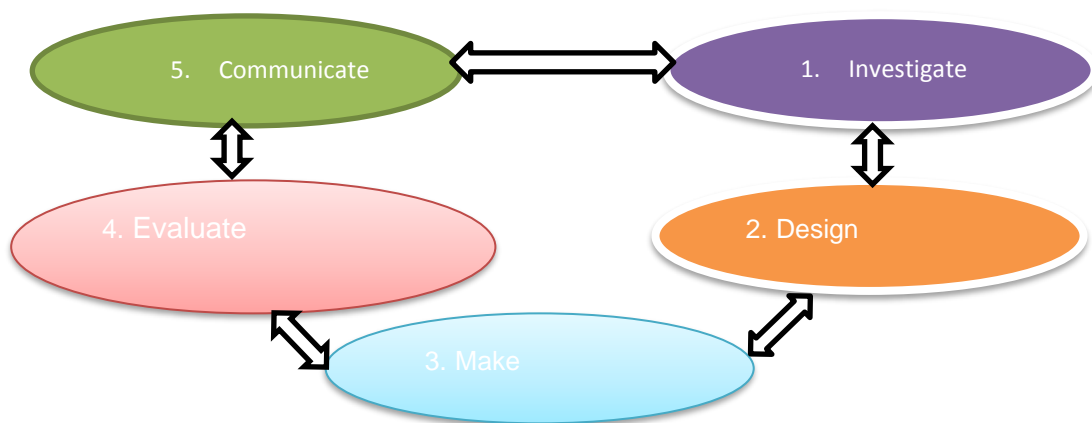
Figure 3.4: IDMEC (Technology design process)

Leahy and Phelan (2014:386) mention the different skills that designers use from the inception of an idea to the completion of the final product. Yu et al. (2010:437) agree that design skills are essential for implementing the steps in the technological process aimed at solving technological problems. Once Technology learners are able to implement the steps of the design process, they are allowed to test their design skills in the classroom to develop their understanding of the process. Learners should also be allowed to source from and apply IK. Learners may have to start with tacit knowledge shared by elders in the community to solve problems and meet human needs, and use indigenous skills learned from indigenous elders to execute the technological activities. Teachers should create an atmosphere that is conducive to the acquisition of design skills in indigenous contexts. Projects that make provision for the learners' cultural contexts will help them to acquire design skills that are similar to indigenous skills with which they are familiar. Examples of design skills include project management, communication, making, investigation, evaluation, time management, resource management, graphics, etc. Technology learners should also acquire the design skills of visualisation and modelling, generation of ideas and representation by drawing, adapting and modifying. The design process and skills should be integrated in every TE lesson. According to the Department of Basic Education (2011:67), the design skills are investigation, design (development of initial ideas), making, evaluation and communication. Indigenous people apply the following skills in solving their technological problems when producing artifacts: clay modelling, accurate bending, mixing, twisting, moulding, colouring, firing and filing.

3.5.3 Five steps in the development of design process skills in TE

In formal education, there are five steps in the development of design process skills that learners need to acquire in Technology teaching (Department of Basic Education, 2011:10). However, IK can also play a role in the acquisition of these skills, which will be discussed in the subsections that follow.

3.5.3.1 Investigate

Learners are expected to be able to complete a problem statement or scenario in writing. During their investigation they should identify needs (problems) in their communities, analyse the situation and determine what would be needed to solve it. A need may exist for a chair or any other objects, such as winnowing baskets in indigenous communities. According to Alamaki (2000:9), human survival and well-being are dependent on people's ability to use design skills to solve their problems or provide their needs. In order to conceive new ideas, they should learn to think abstractly. Learners should be allowed to discuss problems and find solutions through brainstorming. They should also collect information about the product that has to be designed and ultimately made. For example, if a chair is needed, they will investigate the different design aspects of existing chairs, such as function, values, aesthetics, ergonomics, materials and manufacturing processes without limiting themselves to one specific type, and collect information about existing indigenous and western technologies.

According to Kim and Lee (2014:2), a close examination of existing products can help Technology learners to understand design and enable them to suggest a new design and produce a new workable solution to avoid replicating an existing design. The investigation will encourage creative and critical thinking that will help them to design something new.

3.5.3.2 Design

Learners are expected to submit a written design brief with specifications for producing a suitable product. According to Ghazali, Hanim, Rashid, Dawal, Tontowi and Aoyama (2011:3), the concept of the product has to be developed according to the end-user's needs and requirements. The product should be suitable for local use and should never be designed for use by foreign cultures only. If the product is made for indigenous people, the design brief must

specify them as the end-users. Learners should state explicitly what they intend to make and briefly describe the product's functions. Esjeholm (2015:228) states that products are made to solve human problems. Technology teachers should be creative in their planning and should give learners activities that will result in new and interesting products. However, Wong and Siu (2012:471) point out that Technology teachers are not being creative, as prescribed TE projects limit learners to making similar products. They add that uninteresting design activities can limit learners' ability to generate different ideas for solving a technological problem. The result is that learners will redesign existing products.

According to Chinedu, Olabiyi and Kamin (2015:37, 38), learners should be able to execute a higher level of thinking skills in design, and they argue that all existing products were conceived by people and that learners should be able to use their imagination, pursue purpose, be original and produce a product of value. Creative and critical thinking is therefore very important in Technology classrooms and learners can use their critical thinking skills to select the best solution that offers the most advantages. The best solution chosen can be developed to make a new product. Serious problems cannot be solved by using routine steps (Chinedu et al. 2015:37). According to Rutland (2009:58), designers explore how products were developed in the past, are being developed currently and will possibly be developed in the future, and learners are expected to use the designs of others to inform their own. By doing thorough research on the type of product they intend to make, learners will discover what is already known about that product and will be able to think of ways of improving it. Chinedu et al. (2015:37) maintain that critical problems can be dealt with when a person engages in thinking creatively and critically, referring to prior knowledge.

3.5.3.3 Make
According to Ankiewicz et al. (2000: 132), this step requires a drawing of the final design plan according to which a technological product will be made. Using the knowledge already acquired from their communities about different materials and tools, learners should be able to select the materials needed. Pete, Schneider and O'Reilly (2013:103) state that indigenising teaching is about asserting the significance and application of indigenous knowledge within school subjects such as TE. Pete et al. (2013:105) suggest that Technology teachers should include IK in their curriculum choices for the benefit of their learners, but do not indicate which

indigenous ways of knowing can contribute to learning. The current study investigates the indigenous knowledge and skills needed for making indigenous artifacts. Learners from indigenous communities can use IK to select tools, materials and processes. For example, they can use suitable stones to smoothen the surfaces of clay pots. They can also fire clay pots to strengthen them so that they can withstand high temperatures when used for cooking purposes. They can ultimately evaluate this technological model.

3.5.3.4 Evaluate

Learners should be able to evaluate the new technological products against the design brief and specifications in respect of performance, strengths, weaknesses, cost and environmental and social impact. Barlex (2007:53) explains that Technology learners will have to establish the extent to which learning has been achieved, assess the success of their design briefs and examine the achievement of the goals. They can use evaluation to reflect on and justify their design decisions, determine whether their decisions were realistic or not and reflect on the usability of their imagined products.

3.5.3.5 Communicate

Technology learners should be able to explain how the whole design process unfolds in different steps. According to Gumbo (2016a:110), Technology learners are expected to be able to explain the solution to the problem and the entire design process in the form of a design portfolio and also market their solutions. Technology learners from indigenous communities should be allowed to report orally on every step that was involved in making a new product. Technology teachers should show tolerance when learners from indigenous backgrounds demonstrate their understanding from their cultural perspectives (Gumbo, 2016b:16).

3.5.4 Stages of design in technology

According to Haik and Shahin (2011:3), there are three stages of design, i.e. adaptive design, developmental design and new design.

3.5.4.1 Adaptive design

Haik and Shahin (2011:3) explain adaptive design as the improvement of a technological product by making minor adjustments, particularly in respect of size. They state that many

designers are involved in adaptive design and are interested only in making minor modifications to existing products, which does not require advanced skills and knowledge. An example of an adaptive design in indigenous technology is the traditional circular hut (rondavel). The design has remained unchanged for a long time and only the dimensions, decorations, materials, and window and door frames may have changed. Learners may use exploratory creative thinking to make minor adjustments to an existing technological product. Exploratory creative thinking, which can be executed by applying established rules (Esjeholm, 2015:233), can confine learners to thinking in a particular way that is acceptable to their culture.

3.5.4.2 Developmental design

Unlike adaptive design, developmental design requires well-trained designers (Haik & Shahin, 2011:4) who have to understand the existing product so as to be able to improve it by making major changes. Learners can use their knowledge of existing western or indigenous artifacts to design products that have been significantly modified. Haik and Shahin (2011:3) give the examples of the development of a western design from a manual to an automatic gearbox in a car, and from the traditional tube-based television set to the modern plasma and liquid-crystal display (LCD) versions. An example of indigenous development design is the stirring rod, which is a modified version of the wooden spoon and was later further developed by adding metal loops to improve stirring. Technology learners should try to improve familiar existing indigenous technologies. A developmental design product can be improved gradually over many years as there is no competition (Haik & Shahin, 2011:8).

3.5.4.3 New design

Very few designs are new. New designs are more demanding as they require a designer to master all design skills and can involve many creative and other relevant skills. These skills could be enhanced by borrowing from indigenous designs and skills. However, learners are limited by their exposure to mainly western technological designs, which include the first automobile and airplane, and even the wheel (Haik & Shahin, 2011:8). Examples of indigenous designs of long ago are sleeping mats, winnowing baskets and wooden hooks. Haik and Shahin (2011:8) posit that designers think creatively and critically when they invent technological solutions. Learners can use their transformational creativity to generate new

designs. But, as stated above, the development of creative design skills can be hampered if all that learners are required to do is to hone their design skills on inventions of western origin.

Technology learners can use their transformational creativity to design radical new technological products. According to Williams and McOwan (2016:4), transformational creativity allows learners to generate novel ideas. Boden (2009:9) explains that transformational creativity does not conform to the status quo and can challenge currently existing knowledge. Boden (2009:6) adds that transformational creative thinkers can create new ideas and stop using old ideas, even though they effectively solve human problems. Brazdauskaite and Rasimaviciene (2015:50) explain that a creative thinker who thinks transformationally can design totally new products. Learners should not be compelled to follow specific rules in order to induce creativity. Transformational creativity can beget new ideas that can produce new designs.

Some cases of creativity involve fundamental transformation that results in completely new structures (Boden, 2009:1). Esjeholm (2015:228) states that learners working in TE classrooms must learn to think creatively in order to be able to invent new technological products, and that unlike the gradual development and refinement of an existing idea involving small, incremental changes that usually take place over a long period of time, invention or revolutionary design can be rapid, ad hoc and unstructured. Revolutionary design is the most demanding type of design and requires the highest level of creativity. Real invention is therefore challenging to many learners, in particular the younger ones (Esjeholm, 2015:242). Technology learners can also use combinatorial creativity to generate new ideas. Brazdauskaite and Rasimaviciene (2015:50) define a combinatorial creative thinker as one who can use existing knowledge and skills to invent a remarkable product. Technology learners should be equipped to use the existing IK to design new technological products that will be accepted by users in indigenous communities.

3.5.5 Designing with the cultural world of the end-user in mind

Although culture can play a role in designing quality products, there is lack of research that can show designers the relationship between culture and design (Moalosi, Popovic & Hickling-Hudson, 2010:175). Culture should be considered as one of the important factors influencing

design and should, in Balsamo's (2005) opinion, be considered when designers develop technological products. Since culture can influence the way people do things and can therefore influence the use of certain products, designers should consider the cultures of potential clients. In this regard, Moalosi et al. (2010:186) emphasise the need for designers to understand the values that are important to the users of their products. Van Doorn & Klapwijk (2013:2) agree and state that designers should consider the needs and wishes of consumers in order to design products that will be accepted by them. Products will be acceptable to users if they are compatible with their cultures (Moalosi et al., 2010:186). It is recommended that designers interact with consumers in their communities to develop an understanding of their needs, values, aspirations and views. According to Reitsma, Smith and Van den Hoven (2013:84), a designer who is designing products for an indigenous community should know who the expert users are as they can inform design decisions. They add that designers who interact with expert users can design culturally relevant products that will meet the technological needs of the potential users, but fail to highlight the information about values that can be provided by IK repositories to promote learning. The current study investigates the values of IK, such as aesthetic values, which can play a role in the designing of products that will appeal to indigenous users. Technology teachers should encourage their learners to interact with the product users in order to be able to design prototypes that are likely to solve human problems.

Purao and Wu (2013:2) agree that technological products should respect the values of different societies and Moalosi et al. (2010:186) add that technological products are accepted if they promote the values of clients, and that designers need to understand how customers view their world and take their views into consideration when designing new products (Moalosi et al., 2007:37). Sun (2013:2) argues that the interaction between designers from different cultural backgrounds may help designers to design culture-sensitive products that conform to ethics and social justice in postcolonial societies. Profit should never be a designer's main concern. Technology teachers need to include indigenous technology in their teaching in order to promote the acquisition of design skills in TE.

3.6 DAILY INDIGENOUS TECHNOLOGY

Indigenous technology is defined by Kagoda (2009:117) as technology that is practised by people of a particular culture who use traditional methods to make the artifacts they need, and further explains that indigenous experts depend to a large extent on the indigenous knowledge that exists in their communities. Indigenous experts produce a variety of indigenous products, such as pottery vessels, bricks, textiles, medicine and agricultural products. Gumbo (2018:136) laments the fact that indigenous technology does not feature prominently in the CAPS. According to Hamilton-Ekeke and Dorgu (2015:32), it is imperative to include IK in the school curricula to ensure the advancement of indigenous technologies. They add that the integration of indigenous knowledge in teaching and learning may enhance learning as indigenous learners will be able to relate the subject matters to their experiences and traditions (Hamilton-Ekeke & Dorgu, 2015:35), but fail to indicate IK which can play a role in learning. The current study investigated different indigenous technologies that can play a role in promoting design skills in the subject TE.

Kim and Lee (2014:2) maintain that in daily life every person is involved in design of some kind. Solomonidou and Tassios (2007) conducted qualitative research that explored learners' understanding of daily life technologies in an investigation of Technology teaching in Greek primary schools. Sixty Greek primary school learners aged between 9 and 12 years were selected by their teachers as representative of their classes and agreed to participate in the research. The participants included 32 girls and 28 boys in Grade 4 to Grade 6. The schools were selected according to the socio-economic characteristics of the districts in which they are located in order to assure a representative sample of rural, urban and semi-urban learners. Research data was collected by means of semi-structured, personal and clinical-type interviews and the 60 learners were interviewed during school hours. The analysis of the data collected revealed that the learners represented two major categories of daily-life technologies, namely technology-oriented and human-centred technology. Technology-oriented representations focus on technological development with no connection to human activities, whereas in human-oriented representations daily-life technologies are related to the activities and needs of people as either users or inventors of technological innovations.

Another exploratory study was based on a socio-cultural constructivist epistemology that construes learning as a socio-cultural activity in which learners and teachers play specific roles and negotiate meanings through interaction. Two schools were purposively selected as per the researchers' convenience and because they were located in the same rural area. A comprehensive sampling done of science teachers at the two selected secondary schools resulted in the inclusion of five qualified science teachers. Through the lessons taught from primary school to tertiary education and their interaction with the community, the research participants were exposed to the scientific and traditional worldviews of the community. At each targeted school, two interviews were conducted with every participant. Preliminary interviews that each lasted approximately 40 minutes were followed two weeks later by in-depth interviews. The transcriptions of the ten interviews were coded using an open coding, constant-comparison process. Finally, the researchers sampled the homework and test exercise books as well as the teachers' work schemes to establish how the teachers had responded to the comments made by the learners who had revealed incidents of cultural border-crossing into IK.

The data analysis (Solomonidou & Tassios, 2007:126) revealed that the majority of learners believed that Technology includes only modern tools and appliances. They did not regard experience-based technologies as part of Technology and did not relate everyday-life technologies to human activities and needs. Hill (1998:216) states that the teaching and learning of Technology should be embedded in the real context of learners in order to simplify learning. This view is supported by Machaisa (2006:125), who points out that teachers should be aware of learners' daily experiences and the skills they bring to the class, and that learners should realise that the teacher is not a supervisor who is there to keep them quiet and in their seats, but someone who is trying to equip them with skills that will be useful in the future.

3.7 INDIGENOUS PEDAGOGIES

According to Shidza (2014:1875), pedagogies, which play a crucial role in learners' academic performance and school achievements, convey content and can be informed by indigeneity. The prevalence of indigenous pedagogies that may help with the understanding of Technology will be discussed in the following subsection.

3.7.1 Indigenous pedagogy (IP)

Technology teachers should use indigenous pedagogy (IP) to accommodate learners from indigenous communities. IP is based on practical experience and has been used for many years to teach learners how to perform tasks. Parents and experts from indigenous communities are always eager to teach the younger generation indigenous skills to contribute to the development of their communities (Singh & Reyhner, 2013:37). Gumbo (2015a:27) suggest that African leaders should promote design solutions that are developed by African experts in indigenous communities.

Indigenous elders and school teachers should work together to learn from each other instead of undermining each other's knowledge. According to Mukuka (2010:1), the differences between western and indigenous knowledge systems cause them to clash. Ntuli (1999:197) agrees that there is a serious discrepancy between the way learners acquire IK in their cultural settings and the way learning content is presented in classrooms. Singh and Reyhner (2013:38) maintain that assimilationist education regarded IK and IP as inferior and unable to add value to learning, and as a result western education interrupted the teaching of indigenous knowledge in indigenous communities. Formal education ought to value indigenous culture in order to promote the acquisition of design skills in Technology. Technology teachers need to integrate IK content to enhance learning when teaching design skills. Ntuli (1999:197) laments the fact that the current curriculum excludes learners' indigenous knowledge, which has a negative effect on their learning. The above argument is reiterated by Singh and Reyhner (2013: 38), who state that curricula that exclude cultures disadvantage indigenous learners in some countries, which leads to poor performance.

3.7.2 Culturally responsive education (CRE)

According to Singh and Reyhner (2013:38), teachers can implement IP by introducing CRE to accommodate learners from indigenous communities and thus promote learning in TE classes. Pence and Schafer (2006:1) focused their research on the use of IK in teaching new skills and knowledge and found that indigenous people mainly use story-telling to impart knowledge to their children, which means that indigenous learners are familiar with the story-method. They therefore suggest that teachers should use the story-telling method to incorporate culturally relevant pedagogy. This study does not elaborate on the kind of content that can be taught by

using the story-telling method. The current study seeks to establish teaching strategies that can be applied to implement culturally relevant pedagogy in TE classes. Singh and Reyhner (2013:38) state that CRE is based on the constructivist learning theory, which advocates that learning should occur in the cultural context of learners and should include knowledge and skills acquired by learners in their communities. They further advise that the school culture should be the same as the indigenous learners' culture to promote learning in classrooms. If IK is excluded, indigenous learners may struggle with the content of TE in the formal curriculum. CRE is intended to help indigenous learners to improve their academic performance. Biraimah (2016:52) claims that the current gap between the school culture and the learners' home culture is a major contributor to the poor performance of learners from indigenous communities. Singh and Reyhner (2013:38) agree that some learners whose cultures are largely excluded from the curriculum, which is designed to assimilate the cultures of different learners into a dominant culture, might struggle to understand the learning content. Biraimah (2016:52) believes that when the national curriculum reflects the culture of schools, learners can perform extremely well.

Mothwa (2011:8) finds it regrettable that the Department of Basic Education does not effectively assist teachers with the integration of IK in TE in a comprehensive way. This lack of guidance in the national curriculum may result in teachers teaching only western content, which is detrimental to indigenous learners. Curriculum developers should provide clear guidance to teachers on how TE content must be taught in formal education. Mothwa (2011:7), who claims that IK is comprehensible to learners as it is based on practical learning with which learners can easily associate, recommends that community members and teachers should work in harmony in order to share knowledge that can benefit learners.

Curriculum developers can use a society-centred curriculum in order promote culturally relevant education. According to Salia-Bao (1989:3), a society-centred curriculum can be defined as a vehicle that can be used to integrate the knowledge and skills acquired from learners' communities. Nixon, Martin, McKeown and Ranson (1996:41) concede that an essential aspect of education is the imparting to young people of the values, virtues, understanding and rules that it is believed they should possess. Education should re-present the learners' cultural experiences. Salia-Bao (1989:3) refers to the supporters of society-

centred curricula who believe that curricula should accommodate learners' values. Technology teachers should be allowed to teach their learners values (such as ubuntu) and practical skills that are appreciated in their communities. Ntuli (1999:196) explains that pre-colonial education in Africa was based on a system of linkages: social life was linked to production; general life was linked to practical life; and education was linked to cultural games, sports, music, dance and arts. Ntuli (1999:197) further explains that successful knowledge-gathering should involve both formal and non-informal education, which can be combined to enable learners to solve human problems. Salia-Bao (1989:4) agrees that in African indigenous education the curriculum could be used to incorporate the indigenous skills and knowledge that are transferred from generation to generation by community members. Changing the approach to the CRE can ensure a culturally relevant pedagogy.

3.7.3 Culturally relevant pedagogy (CRP)

A culturally relevant pedagogy (CRP) can play a role in solving learning problems experienced by indigenous learners in TE. Howard (2003:196) defines culturally responsive teaching as an approach to teaching that incorporates attributes, characteristics, or knowledge from learners' cultural backgrounds into instructional strategies and course content in an effort to improve educational outcomes. Biraimah (2016:52) explains that in order to provide sound education, teachers need to understand and implement culturally relevant instruction. Unless education and the methodology of teaching are jelled with the learners' culture, it will be meaningless to talk about quality education. According to Biraimah (2016:52), culturally relevant pedagogy involves the integration of the cultural experiences of learners from different backgrounds into teaching to improve their academic performance.

Richter, Van der Walt and Visser (2004:17) advise that teachers should be conversant with the cultures of their learners in order to integrate IK into their lessons and should be well-informed about other cultures in order to prepare their learners to relate effectively to other cultures in the global community. A study by Wong and Siu (2012: 471) reveals that TE projects that are not connected with learners' cultural and social contexts do not motivate them to learn. Technology teachers should therefore give their learners projects that are related to their IK in order to motivate them to learn new design skills. Howard (2003:197) states that one of the major goals of CRP is to promote teaching that allows learners to use their cultural knowledge.

The inclusion of cultural knowledge with which learners are familiar can simplify learning and improve academic performance. Howard (2003:198) argues that CRP is based on the belief that the varied cultural elements that learners bring into their classrooms can be used to promote learning.

3.7.4 Teaching strategies for promoting culturally relevant pedagogy (CRP)

3.7.4.1 The value of discussion

According to Armstrong, Armstrong and Spandagou (2010:126), the goals of educational transformation can be achieved only if the use of dialogic culture circles is considered. Dialogue encourages cooperative learning, allows learners to talk more than their teacher, discuss their experiences and add value to learning. Morrow (2002:25) contrasts dialogical education with traditional, monological education and points out that discussion is the principal way in which people are educated. This suggests that Technology learners can use discussion to learn from each other.

Morrow (2002:26) maintains that discussion has the potential to foster a spirit of social solidarity. Discussion can help Technology learners to understand their different cultures and work as a team. Venter (2004:157) suggests that teachers in South Africa should be assisted in acquiring comprehensive knowledge of local cultures. Klapwijk (2009:8) states that Technology teachers seldom encourage dialogue in class, but should in fact promote dialogue in order to encourage learners to generate different ideas. Within an Afrocentric framework, teachers should always be prepared to teach, but should also be prepared to be taught by their learners (Schiele, 1994:157), i.e. they should allow an exchange of knowledge. Technology teachers should not act as paragons of knowledge as this can cause learners to refrain from using IK to generate new ideas for solving technological problems. Schiele (1994:157) explains that an Afrocentric framework can be used to promote mutual learning in classrooms when learners from different backgrounds include IK in their discussions of design. However, during any exchange of ideas between teachers and learners, teachers should play a guiding role. The mutual sharing of ideas between teachers and learners can help to create a harmonious relationship between teachers and learners in an environment where learning can flourish. Mawson (2013:451) avers that a democratic pedagogy would require teachers to allow young children in the early years of schooling greater input into and control of

technological tasks set for them, and adds that their ownership of learning can motivate them to acquire expansive technological knowledge. Armstrong et al. (2010:126) suggest that education can be meaningful to learners only if it makes use of their own authentic experiences by using dialogue. Dialogue allows learners to discuss their cultural perspectives.

3.7.4.2 Collaborative teaching

According to Aceves and Orosco (2014:13), collaborative teaching is a broad term and can include different teaching methods, such as cooperative learning, differentiated instruction, peer teaching and reciprocal teaching. They add that collaborative learning methods are very important as they can allow learners to share and learn from each other in teams, and can be used to promote CRT. Kagoda (2009:119) accepts that team-based learning experiences can be used to foster good relationships between learners, which can in turn promote learning, and states that teachers who support the collaborative-based learning method usually involve community members in teaching the learners. Cushner, McClelland and Safford (2003:285) agree that collaborative classrooms should involve teachers, other school personnel, parents and other community members working together to set instructional goals and implement plans to achieve them.

Kagoda (2009:119) advocates greater cooperation between teachers and parents, who possess a wealth of IK. In collaborative learning, indigenous people can be accommodated to share their expertise with Technology learners and teachers. The Department of Education (2002:4) claims that in TE classrooms, teachers provide real-life opportunities for learners to interact with each other in their groups when they make products. Technology learners are also in a partnership with the members of their communities. Cushner et al. (2003:285) indicate that collaborative classrooms suggest a shift away from individualism. Technology teachers should promote collectivism in design process activities in order to allow learners to help each other in their groups. Cushner et al. (2003:285) emphasise the critical role of teachers in helping learners to attain the understanding and skills needed to live cooperatively and comfortably with others. Technology teachers should discourage individualism in their classrooms as it can suppress the acquisition of design skills. Initial ideas can emerge easily when learners work in groups and can stimulate each other to think creatively. Even engineers usually work in teams and even consult with other teams that specialise in different fields.

According to Cushner et al. (2003:285), teachers in western traditional schools do not collaborate with indigenous experts. Schiele (1994:157) maintains that Eurocentric education separates teachers and community members and learners from each other. A Technology learner who learns in isolation cannot benefit from the knowledge of other learners. According to Schiele (1994:157), one of the major disadvantages of the detached view of learning is that it promotes selfishness in learners.

Fleischmann (2015:124) states that many design programmes have moved towards a more social focus, teaching learners to become involved co-creators with others. Collaboration between learners from different knowledge systems can enhance their design skills in TE. By collaborating in a design activity, learners can produce appropriate technological models. Fleischmann (2015:124) explains that the democratisation of design will allow more non-designers to become involved in generating ideas and producing products. Travelyan (2009:3) advises that teachers should allow learners to explore possible solutions and identify needs. Technology teachers should allow their learners to work together to identify and solve technological problems. According to Travelyan (2009:2), when learners work collaboratively, they each perform their own research to fill information gaps and then analyse the alternative solutions until one solution emerges that meets their client's requirements. Schiele (1994:158) posits that in collaborative learning, learners strive to assist each other in learning in order succeed together as a team. Teachers may assist learners with learning barriers and provide support to those with high intellectual capabilities. Technology teachers are supposed to give full support to learners who are struggling with their design activities. This is corroborated by Schiele (1994:158), who states that from an Afrocentric perspective, teachers provide support to less capable learners and also allow excellent learners in design to use IK to assist those who struggle with design.

3.8 CULTURALLY RESPONSIVE FEEDBACK TO PROMOTE DESIGN SKILLS

According to Esjeholm (2015:231), teachers should always examine the learners' acquisition of design skills by testing the functionality of products in the TE classrooms. Robinson, Minkin, Bolton, French, Fryer, Greenfield and Green (1999:11) state that different types of assessment can help learners to improve their performance, and that culturally responsive formative

assessment can have a huge impact on learning. Stevens (2012:6) defines culturally responsive formal assessment as an ongoing day-by-day assessment that builds on the learners' knowledge. It is therefore important to know what a learner's understanding is based upon. Robinson et al. (1999:11) advise that assessment should not inhibit learners' creativity, and that Technology teachers' culturally responsible feedback can promote the acquisition of design skills.

Aceves and Orosco (2014:14) explain that teachers can use culturally responsive feedback to give analytical feedback to learners and add that through culturally responsive feedback, teachers provide individualised assistance, which accommodates the cultural understanding of each learner. This suggests that Technology learners should not be penalised if their correct answers are based on IK. They should be allowed to use indigenous skills and should be assessed fairly in accordance to their background knowledge. In order to accommodate indigenous learners, marking in TE should be subjective rather than objective. In order to be able to give analytical feedback, they must allow learners to be engaged in dialogue in their classrooms (Aceves & Orosco, 2014:15). Dialogue can inform teachers on the different cultural views of learners in their classes. Teachers can also use individualised teacher-learner conferences to provide analytical feedback. Aceves and Orosco (2014:15) aver that affording opportunities for individualised teacher-learner conferences can give each learner an opportunity to receive individualised teacher feedback, which has the ability to challenge them to think and can boost their self-esteem.

Thomas (1992:26) recommends that the teacher should encourage learners to discover the limits of their ideas and help them to develop more adequate ones by asking questions that activate their prior knowledge, probe their reasoning and help them to connect and integrate new knowledge with prior knowledge through the introduction of diverse perspectives. Teachers should be able to learn and to use their prior learning when assessing learners (Thomas, 1992:39). They need to acknowledge that IK exists in the contexts where they teach so that they can provide culturally responsive feedback. Thomas (1992:39) states that learners should have the ability to transfer previous learning to new situations; therefore Technology teachers should encourage their indigenous learners to use their IK and other knowledge systems when answering technological questions. Robinson et al. (1999:11) point out that one

of the roles of teachers is to create an atmosphere that is conducive to the acquisition of design skills, in other words, they should create conditions in which design skills are enhanced without alienating other knowledge systems, such as IK. They can ask open-ended questions to allow learners to use different avenues (knowledge systems) for finding the answers. According to Robinson et al. (1999:11), the development of design skills includes helping learners to acquire knowledge of their cultures. Teaching, learning and assessment should be tailored to suit specific learners in a specific place in order to promote the acquisition of design skills in TE. Technology teachers should also use IK content to teach and assess learners' design skills in order to accommodate all learners in a particular locality.

3.9 CONCLUSION

This chapter provided an in-depth discussion of the importance of using IK in teaching design skills in TE. The general concept of Technology, TE as a school subject and the three approaches to Technology were also discussed in order to elaborate the development of Technology in different cultural contexts. The literature review informed the researcher on how conceptual and procedural knowledge can play a role in the acquisition of design skills, and how indigenous technologies can be used in teaching such skills. This chapter also shed light on how design in TE can be taught from western versus indigenous perspectives. Finally, indigenous approaches to teaching and assessing design skills were discussed. According to the literature reviewed, culturally relevant pedagogy and culturally relevant feedback can play a major role in the teaching of design skills. The research design for this study will be discussed in the next chapter.

CHAPTER FOUR
RESEARCH DESIGN AND METHODS

4.1 INTRODUCTION

Chapter 4 contains a discussion of the research design, a profile of the research sites and participants in this research, and a detailed description of the research methodology and instruments used to collect data. Ethical issues are also discussed, as well as the different strategies that were employed to enhance the trustworthiness and authenticity of this research project. It concludes with discussion of the pilot study and data analysis.

4.2 QUALITATIVE RESEARCH METHODOLOGY

Knowledge of different research methodologies may help a researcher to select an appropriate research methodology to investigate a specific issue. For this study, a qualitative research methodology was employed to establish the role of IK in teaching design skills. Qualitative research aims to provide an in-depth and interpreted understanding of the social world of research participants by learning about the sense they make of their social and material circumstances, their experiences, perspectives and histories (Snape & Spencer, 2003:3; Ritchie, Lewis, Nicholls & Ormston, 2013:4). This study sought to establish how the participants viewed the role of IK in the teaching of design skills in TE. In qualitative research, the views of participants are highly valued, thus the subjective views of participants in this study were elicited and respected. The researcher employed an interpretive paradigm in order to understand the perspectives and interpretations of the participants. Thomas (2010:295) writes that interpretive researchers believe that reality consists of people's subjective experiences of the external world. For the purpose of this study, the researcher sought to obtain information on the subjective experiences of the participants by way of interviews.

Jelsma and Clow (2005:3, 4) agree that qualitative research acknowledges the strength of subjectivity and add that qualitative researchers aim to understand the particular individual/s, place/s or time, and usually do not seek to generalise or transfer the findings of their study. This study is concerned with establishing the role of IK in the acquisition of design skills in rural schools in Malamulele villages. The findings of this qualitative research cannot be regarded as objective knowledge that can be applied in all schools and will only be applicable to schools in

similar cultural settings. Savenye and Robinson (2004:1046) state that the results of qualitative research cannot be easily generalised, and that in this kind of research it is accepted that every group of participants is unique. This is also attuned to the fact that IK is unique to particular settings and can be useful for the acquisition of design skills in rural communities.

In contrast, quantitative research is concerned with objective results. Jelsma and Clow (2005:3, 4) explain that quantitative research seeks to maintain objectivity by posing hypotheses to be accepted or rejected, and by asking questions related to the generalisability of results, i.e. whether they apply to all people in similar categories. Quantitative research requires a large number of participants so that the findings can be generalised. The participants' identities are seldom disclosed and there is no direct contact with the researcher as questionnaires are sent and returned by email. In qualitative research the researcher usually conducts face-to-face interviews with the participants. This type of research is primarily subjective and exploratory in nature and is used to gain an understanding of people's underlying opinions, reasons and motives. Snape and Spencer (2003:5) write that in qualitative research, the researchers interact directly with the participants when they collect data, therefore the researcher can become a data-collection instrument.

Moriarty (2011:7) describes quantitative research as research that makes use of probability sampling, which allows data to be generalised. The samples used by quantitative researchers are much bigger than those used by qualitative researchers, which are selected in accordance with specific criteria (Welman, Kruger & Mitchell, 2010:69; Snape & Spencer, 2003:5). For this study a qualitative approach was adopted and a relatively small sample of participants was used to establish the role of IK in teaching design skills. Jelsma and Clow (2005:4) explain that quantitative researchers analyse data by using valid and reliable tests which, if used correctly, will produce the same or similar results regardless of the user. This differs from qualitative analysis, where the researcher plays a significant role in collecting the data, which can be interpreted in different ways by different researchers.

According to Roberts, Priest and Traynor (2006:42), researchers conducting qualitative research present their data in text form rather than use numbers. Ary, Jacobs and Razavieh (2002: 25) state that qualitative researchers study phenomena in a holistic way, and Gay and

Airasian (2003:163) aver that qualitative study is valuable for studying complex research areas about which little is known. It is exceptionally suitable for exploration to begin to understand a phenomenon. Since little is known about the value of IK in the teaching of design skills, the qualitative research method was chosen to determine how IK can be used to develop design skills in Technology classrooms.

Savenye and Robinson (2004:1046) explain that qualitative research is conducted in a natural setting without intentionally manipulating the environment. It typically involves highly detailed, rich descriptions of human behaviour and opinions. The current study was conducted in Technology classroom settings in order to obtain data about the integration of IK in teaching design skills. According to Snape and Spencer (2003:34), many of the methods used in qualitative research were developed to allow for the investigation of phenomena in their natural settings, and qualitative research provides data on actual behavior. The research design and methods of data collection used for the current study will be discussed in the following section.

4.3 RESEARCH DESIGN

According to Van Wyk (2012:4), a research design is the complete plan which can connect the conceptual research problems to the pertinent empirical research. Ary et al. (2002: 426) define a research design as a plan that shows the researcher how to proceed to understand a group or some phenomenon in its natural setting, while McMillan and Schumacher (2010:20), and Welman et al. (2010:55) describe it as a blueprint of how a study is conducted. Depending on the nature of the study and the demands made on the researcher by the dynamism of the research site and the participants, the flexibility of the design might be affected. In this study the blueprint factor may be violated to some degree, but the trustworthiness of the study will not be affected. A research design can be used to present a plan for gathering and analysing data (Bryman, 2012:46).

For this study, a qualitative case study was undertaken to determine how learners in Technology classes use IK to design new products, and whether IK might influence the development of the design skills of Grade 7 learners in Technology classrooms in South Africa. Research design refers to how data is collected to answer the research questions. According to Van Wyk (2012:4), the research design describes the data that is required, the methods

used for the collection and analysis of data, and how the results will answer the research questions. The flow diagram of the research design of this study is provided in Figure 4.1.

Research design

Selecting participants (purposive selection).
Participants:
- 18 parents
- 18 learners
- 9 teachers
- 3 HoDs
- 3 TE specialists

Data collection instruments and methods:
- Checklist for participant observation
- Interview guide for individual interview.
- Interview guide for focus group interview
- Tool for document analysis
- Tool for artifact analysis

Trustworthiness:
- Credibility
- Transferability
- Dependability
- Confirmability
- Authenticity

Ethical considerations:
- Protection from physical, mental or social harm
- Ensuring anonymity
- Ensuring confidentiality
- Application for ethical approval

Pilot study:
- Interview guide (questions)

Data analysis and interpretation:
- Findings
- Discussions

Figure 4.1: Research design

4.4 CASE STUDY

According to Welman et al. (2010:25), in case study research, research is directed at understanding unique cases. Gay, Mills and Airasian (2011:445) explain that a case study researcher may choose to investigate a particular phenomenon to understand a specific problem that occurs in everyday practice. The case study design was an appropriate choice for this study, which aimed to establish the unique role that IK can play in the teaching and

learning of design skills in order to arrive at a detailed description of the phenomenon (Ary et al., 2002:27).

According to Gay et al. (2011:447), every researcher uses a specific theory when conducting a study. Case study researchers should clarify the theoretical frameworks that guides their studies. Since the current study was guided by the social constructivist theory, the researcher used a collective case study to obtain the participants' perspectives and opinions. To understand the experiences of the participants, the researcher used a case study that was supported by the social constructivist theory. Social constructivists believe that individuals possess an understanding of the world in which they live and work (Creswell, 2014:8).

A case study is undertaken in order to gain an understanding of a complex phenomenon as it is experienced by the participants (Gall, Gall & Borg, 2005:311). It is defined by Wiersma and Jurs (2009:200) as a detailed examination of something. In order to obtain a variety of perspectives about the role of IK in the teaching of design skills, the researcher used a multiple case study to collect information on the perspectives of participants from the selected schools (Moriarty, 2011:16). This study included teachers, parents, heads of departments (HoDs), learners and TE specialists.

For this multiple case study, the researcher collected data from three rural primary schools with a view to determine the role of IK in the acquisition of design skills. According to Johnson and Christensen (2017:435), a collective case study that includes numerous cases increases a researcher's understanding of a research topic. Gay et al. (2011:449) explain that in educational research, case studies of the same phenomenon are often undertaken at several sites. Welman et al. (2010:193) state that in the qualitative study a limited number of units of analysis are studied intensively. The researcher collected data on the influence of IK on the acquisition of design skills from the Malamulele rural schools in Limpopo Province, which is the researcher's home province. The majority of learners and teachers at the participating schools came from indigenous backgrounds in which people rely on indigenous knowledge and skills in the execution of their daily duties, which may include teaching and learning. According to Ndlangamandla (2014:11), rural people apply indigenous skills and knowledge

to make artifacts. Many people in rural areas use their IK to make items like wooden spoons, which they sell to make a living.

4.5 SELECTION OF PARTICIPANTS

Purposive selection was used to select eighteen parents whose children attended the schools to participate in this study. According to Mason (2010:124), purposive selection means selecting participants on the basis of their ability to contribute information that would enable the researcher to answer the research questions. The eighteen selected parents had to be conversant with IK. The researcher selected parents who were skilled in making traditional products to establish whether the ability to practise indigenous skills could contribute to learners' acquisition of design skills. Purposive sampling, which is appropriate for the selection of unique cases that are especially informative (Neuman, 2011:268), was also used to select a further nine participants who were Technology teachers living in rural areas who were conversant with IK. The criteria for selection was that they had to have studied TE as a major subject at a tertiary institution and had to have at least five years' teaching experience to ensure a thorough knowledge of the subject matter. The researcher also used purposive sampling to select the HoDs and TE specialists who participated in this study. The three HoDs from three selected schools who participated in this study were considered because they could provide information about curricular and pedagogic issues, including knowledge about the integration of IK in the CAPS. They were included in this study as coordinators of the teaching and learning of Technology. This study also included three TE specialists with knowledge of the subject who were responsible for guiding the teaching of Technology and supporting the teachers and six Technology learners from each participating school. The learners were also selected by way of purposive sampling. They had to perform well in TE as the aim was to establish whether their performance could be attributed to their knowledge of IK. The researcher checked their marks to ascertain their performance.

4.6 DATA COLLECTION METHODS AND TOOLS

Research methodology focuses on the research process and the kind of tools and procedures used (Welman et al., 2010:56). Bryman (2012:46) and McMillan and Schumacher (2010:8) explain that research methods are the techniques used to collect and analyse data. Qualitative researchers employ various data collection methods. In the current study the researcher

employed individual qualitative interviews, focus group interviews, participant observations, document analysis and artifact analysis.

4.6.1 Observation

Observation alone may result in an inaccurate representation of the information obtained during interviews as teachers may not remember everything or may only report on their successful teaching strategies (Gay et al. (2011:381). For the purpose of this study, observation was used to discover how IK is integrated in the teaching of design skills in classrooms. Observation enabled the researcher to note the teaching and learning strategies that promote the incorporation of IK for the development of design skills. Gay et al. (2011:382) maintain that by observing the classes, more objective information can be obtained, which can then be compared with the information obtained from interviews. The researcher employed participant observation to collect data in the classrooms while the participating teachers presented lessons. This enabled the researcher to establish the role of IK in the acquisition of design skills. Fossey, Harvey, McDermott and Davidson (2002:727) state that researchers use participant observations to explore the naturally occurring routines, interactions and practices of a particular group of people in their social environments. Bless and Higson-Smith (1995:43), and Snape and Spencer (2003:35) concur that participant observation requires that the researcher join the group of people who are being studied in order to observe and better understand their behaviour, feelings and attitudes or beliefs. According to Gay et al. (2011:382), during participant observation the researcher participates in the situation while observing and collecting data on activities, people and the physical aspects of the setting. The researcher actively participated in the use of IK to generate ideas for producing a technological product. His participation helped him to understand how IK can assist learners in developing design skills in Technology classrooms. Snape and Spencer (2003:35) posit that participant observation affords researchers the opportunity to obtain additional insights through personally experiencing the phenomena. According to Creswell (2012:214), to truly learn about a situation one needs to become actively engaged at the research site. Wiersma and Jurs (2009:284) concur that the participant observer attempts to assume the role of the individuals under study to experience their thoughts, feelings and actions. Gay et al. (2011:382) argue that observation has some drawbacks, e.g. the researcher may lose objectivity and become emotionally involved with participants, which may hinder the simultaneous collection of data. The

researcher in this study avoided becoming emotionally involved when Technology teachers struggled to effectively integrate IK in their teaching.

Savenye and Robinson (2004:1051) state that the participant observation method usually requires the researcher to spend considerable time in the field. Researchers in the field of education are sometimes criticised for observing participants in educational setting for only a short period and then making sweeping generalisations about teachers, schools and learners. For this study, the researcher spent at least 40 minutes observing Technology teachers while they were teaching in order to avoid making wrong conclusions, and interacted with learners when they were discussing technological problems encountered during a case study. His interaction with the learners in his group enabled him to understand the kind of IK they use for developing design skills. A checklist was used to collect data during the classroom observations. *The William and Mary Classroom Observation Scales – Revised* (Van Tassel-Baska, Bracken & Drummond, 2003) were adapted for use during the current study (see Appendix 5). The researcher observed how teachers attempted to integrate IK and the role it played in the acquisition of design skills.

4.6.2 Interviews

Interviews were conducted to collect data from nine teachers, three TE specialists, eighteen learners, eighteen parents and three HoDs. During the field interviews the researcher asked questions, listened, expressed interest and recorded what the participants said (Neuman, 2011:449), and made use of the opportunity to obtain detailed information on the participants' views and experiences (Snape & Spencer, 2003:36; Blandford, 2013:23). Ary et al. (2002:434) and Moriarty (2011:8) state that interviews are used to ask participants questions about their personal opinions, beliefs and feelings. According to Neuman (2011:449), the cooperation of participants and their sharing of insights and feelings are vital components of an interview process that can reveal subjective meanings. The purpose of qualitative research is to use interviews and observations to describe a phenomenon from the participants' point of view; the researcher can listen to the voices of participants in their natural environments (Orb, Eisenhauer and Wynaden, 2000:94). Neuman (2011:450) warns against researchers forcing answers or asking leading questions.

There is a relationship between observation and interviews in the sense that interviews can provide otherwise inaccessible information through observation, while observation cannot reveal information about past experiences. Researchers can use the data obtained through observation to formulate questions for interviews – a researcher may notice something and want to ask follow-up questions for clarification (Gay et al., 2011:386). Ary et al. (2002: 434) point out that a disadvantage of using interviews as data gathering methods is that participants may not always be willing to share information, or may even provide false information.

4.6.2.1 Individual interviews

In this study, individual qualitative interviews were used to collect data from Technology teachers and TE specialists. According to Fox (2009:8), individual interviews provide rich data about the meanings that participants attach to events or situations. DiCicco-Bloom and Crabtree (2006:315) express the opinion that in an individual in-depth interview the interviewers can obtain comprehensive data about personal and social issues, whereas focus group interviews allow interviewers to obtain a variety of views. According to Creswell (2012:281), an individual interview is a data collection process during which researchers can ask questions and record the participants' responses. Mathers, Fox and Hunn (1998:3) state that personal interviews are usually preferred in studies that deal with very sensitive issues. According to Creswell (2012:281), personal interviews are more relevant when a researcher interviews participants who are reluctant to openly share information or express their views during a group interview. In the case of this study, one-on-one interviews with Technology teachers, HoDs and TE specialists who might have been hesitant to expose their views about IK in the presence of other participants were considered to be relevant. Mathers et al. (1998:3) explain that researchers use one-on-one interviews to collect high-quality data and add that personal interviews are advantageous as a researcher can explain the purpose of the interview and motivate potential participants to work together, and can also clarify questions, correct misunderstandings, offer prompts, probe responses and follow up on new ideas in a way that is not possible with other methods.

4.6.2.2 Focus group interviews

Another valuable interview technique makes use of focus groups that each includes several participants who can contribute towards the understanding of the research problem (Gay et

al., 2011:388). In the current study, the researcher used focus group interviews to collect data from six parents and six learners from each school. Neuman (2011:460) explains that a typical focus group study uses four to six separate groups. In this study each focus group consisted of six participants. Creswell (2012:281) defines a focus group interview as the process of collecting data through interviews with a group of typically four to six people and adds that focus group interviews are useful when the participants are willing to cooperate with each other. Bless and Higson-Smith (1995:113) state that focus groups allow participants to share their experiences and to reach some kind of consensus about the topic being researched. The researcher designed an interview guide with questions for this purpose. According to Bryman (2012:471), other questions not included in the interview guide may be asked when the interviewer would like more information about things mentioned by the interviewees. A focused interview is much more flexible and open in form. Ary et al. (2002:444) define this kind of interview as a way of gathering qualitative data by asking individuals questions about their beliefs and opinions and add that the participants are at liberty to respond in their own words and can either answer briefly or at length. The researcher may ask each participant different questions.

Focus groups are helpful because they allow interaction between participants with distinctive views, especially when the interaction between participants leads to a common understanding of the questions asked by the researcher (Ary et al., 2002: 435; Gay et al., 2011:388 & Creswell, 2012:218). A focus group interview method was used to obtain the views of parents and Technology learners who may have a common understanding of indigenous knowledge (IK). Mathers et al. (1998:4) state that group interviews can be used when researchers are able to select participants who share a common factor and the information on the opinions of people from within that population has to be collected. Interaction between the participants can also be a source of information.

Since group discussions allow participants to talk to each other, they offer opportunities for reflection and refinement, which can deepen the participants' insights into their own circumstances, attitudes or behaviour (Snape & Spencer, 2003:37). Gay et al. (2011:388) posit that when researchers conduct focus group interviews, they should make sure that each participant is given a chance to speak and that consensus is reached. Participants should learn

to share ideas and no one should dominate the discussion. Creswell (2012:281) advises that when conducting a focus group interview, participants should be encouraged to talk and listen to each other. The researcher motivated all the participants in this study to express their views by ensuring that each one had an opportunity to make a contribution.

4.6.2.3 Semi-structured interviews

In-depth semi-structured interviews can be conducted either with individuals or with groups (DiCicco-Bloom & Crabtree, 2006:315), and the themes and questions are planned ahead of time (Blandford, 2013:23). For this study, the researcher used semi-structured interviews for both individual qualitative and focus group interviews. The questions were planned in advance in order to avoid embarrassment when asking questions relating to IK which is alienated in formal learning. Blandford (2013:23) further states that specific lines of enquiry are followed during the interview to follow up on interesting and unexpected information that emerges. The researcher opted to use semi-structured interviews to allow the participants some freedom to express their beliefs and opinions about the value of IK. Kajornboon (2005:5) states that semi-structured interviews are not standardised and are commonly used in qualitative analysis. According to Mathers et al. (1998:2), semi-structured interviews involve a series of open-ended questions based on the topics that the researcher wants to cover, and add that the open-ended nature of the question defines the topic under investigation and provides opportunities for both interviewer and interviewee to discuss some aspects in more detail. Should an interviewee struggle to answer a question, or provide only a brief response, the interviewer may use cues or prompts to encourage the interviewee to elaborate. In this study the participants were helped to understand the questions by providing clues when necessary. Additional probing questions were used to collect detailed information about the role of IK in developing design skills.

The cues were used to encourage the participants to clarify their responses regarding the value of IK in the development of design skills. According to Van Teijlingen (2014:20), in semi-structured interviews everyone is asked the same questions, but they may be asked differently. Semi-structured interviews are useful for exploring people's views of something specific, in this case the views of teachers, among others, about the importance of IK in the acquisition of design skills. Semi-structured interviews are ideal for exploring attitudes, values, beliefs and motives (Van Teijlingen, 2014:21). According to Kajornboon (2005:6), the strengths of semi-

structured interviews are that researchers can use prompts to delve deeper into the given situation and can further explain questions that the participants do not fully understand. For example, if a participant seems to be disinterested in something raised during an interview, the researcher can probe to find reasons and ask explanations for the lack of interest. Some of the participants in this study were not interested in integrating IK in TE classrooms, which led the researcher to ask probing questions to understand the rationale behind their attitudes.

In semi-structured interviews the researcher has a list of key themes, issues and questions to be covered, but the order of the questions can be changed depending on the direction of the interview (Kajornboon, 2005:5). Van Teijlingen (2014:17) confirms that in semi-structured interviews, the order of predetermined questions can be modified to suit the interviewer's perception of what seems most appropriate, and elaborates by adding that the wording of questions may be changed and explanations given, and that questions that are inappropriate for a particular interviewee may be omitted or replaced. The weaknesses of semi-structured interviews are the invasion of the participants' privacy and that the interviewer's preferred social response (leading question as a follow-up question), prejudices, stereotypes and perceptions may influence responses (Van Teijlingen, 2014:21). The negative effect of the invasion of participants' privacy was mitigated by not referring to them by name (see 4.6). Research reflexivity (see 4.7) was used to mitigate prejudices and perceptions on the part of the researcher.

The researcher developed an interview guide for the semi-structured interviews with parents, learners, teachers, HoDs and Technology specialists. An interview guide is intended to ensure that information on the same general issues is collected from each interviewee (Valenzuela & Shrivastava, 2002:4). According to Cohen and Crabtree (2006:1), the interview guide contains a list of questions and topics that need to be covered during the conversation, usually in a particular order. The interview guide in this study was informed by mental models used by Seel (2001:408) to understand how participants felt about the integration of IK in the teaching of design skills. Johnson and Christensen (2014:79) describe mental models as deep assumptions and ideas that affect how we act. This study investigated what the participants thought and believed about the role of IK in the development of design skills and established which IK content, teaching and assessment strategies can be used to enhance design skills

(Appendices 1-4). The participants explained their assumptions on how IK can enhance the acquisition of design skills.

4.6.3 Document analysis

Savenye and Robinson (2004:1058) point out that document analysis is one of many unobstructive methods that exist for collecting information about human behaviour. According to Given, Winkler and Willson (2014:6), qualitative content analysis is another strategy for gathering and analysing data and is used for the exploration of textual data, e.g. photographs, websites and policy documents. Gay et al. (2011:389) and Ary et al. (2002:435) explain that qualitative researchers examine various types of records or written documents, including archival documents, journals, maps, videotapes and artifacts to gain an understanding of the phenomenon under study. For this study the researcher used document analysis guide to establish whether and how the integration of IK is encouraged in official documents, such as national policy documents, e.g. Curriculum and Assessment Policy Statement (CAPS), school subject (in this case Technology) policy, Technology textbooks, Annual Teaching Plans (ATPs) and question papers. According to McMillan and Schumacher (2010:361), official documents are abundant in organisations and take many forms, namely memos, minutes, working papers and drafts of proposals that provide an internal perspective of the organisation. This perception is corroborated by Snape and Spencer (2003:35), who posit that document analysis involves the study of existing documents, either to understand their substantive content or to illuminate deeper meanings revealed by their style and coverage.

4.6.4 Artifact analysis

The artifact review guide was used to collect data about traditional artifacts, e.g. clay pots, wooden spoons, and mortars and pestles from the parents who participated in this study. The artifact analysis was used to collect information on indigenous skills and knowledge that can enhance Technology learners' ability to develop design skills (Appendix 7). McMillan and Schumacher (2010:361) state that artifacts are tangible examples of people's experiences, knowledge, actions and values. McMillan and Schumacher (2010:362) add that objects are created symbols and tangible entities that reveal social processes, meanings and values. The researcher explored the use of functional laws, such as cues about how an artifact should be used. The researcher also explored the use of technological laws in different artifacts, such as

the application of natural-scientific knowledge when designing new products. The physical qualities of various artifacts, such as shape, size, weight, texture and materials used to make them, were also observed. Physical qualities can demonstrate the skills and IK possessed by indigenous people. The choice of materials, for example, may show that the indigenous people applied their IK of the properties of different materials.

4.6.5 Data collection processes

For this study, voice recordings were used to collect data during interviews as taking notes during an interview can be distracting and can alter the flow of the session (Gay et al., 2011:387). According to Fossey et al. (2002:728), a tape recorder is a useful data collection instrument that enables the analysis of the material as a whole. Audio-tapes are convenient and reliable and ensure that the original data is available at any time (Gay et al., 2011: 387). Lately tape recorders have been replaced by more advanced digital voice-recording devices. For convenience, such a recording device that could record information without any distortion was used for this study. The researcher also made field notes which, according to Ary et al. (2002: 431), is the most common method for recording data collected during observation in qualitative studies (Savenye & Robinson, 2004:1052). The researcher then analysed these notes soon after observation and interviews, noting patterns of behaviour and events. According to Gay et al. (2011:382), field notes contain two basic types of information: (1) descriptive information about what the observer has personally seen or heard on site in the course of the study, and (2) reflective information that captures the researcher's personal reactions to observations, experiences and thoughts during the observation sessions. The reflective information may include the researcher's interpretations. The above explanation is supported by Ary et al. (2002:431), who state that researchers may make brief notes during the observation and later expand on their accounts of the observations.

In this study the researcher explored the coverage of IK in different documents to see how often IK is mentioned and how much attention it is given. The scope of IK content in the documents was established (Appendix 6). This was intended to check whether IK is treasured as important knowledge that can play a role in developing design skills. The researcher also examined the documents to check the level of IK content (IK vocabulary) for Grade 7 learners.

The CAPS policy document, textbooks and question papers were studied for indications of the integration of IK in design activities.

Indigenous artifacts were examined to see if the patterns used were compatible with the culture of the community, for example decorative designs that are popular with community members. The uniqueness of an artifact showed the type of creativity used, and whether it was exploratory or transformational creativity. The researcher requested to see the old artifacts that were used before the new ones to compare them so as to establish whether the new artifacts were adaptive, developmental or new designs. The researcher also took photos of indigenous artifacts which were interpreted and analysed for research purposes.

4.7 ETHICAL CONSIDERATIONS

Hancock and Algozzine (2011:45) advise that the researcher should adhere to ethical requirements for all research involving people, and Gay et al. (2011:19) suggest that researchers should be aware of and pay heed to the ethical considerations applicable to their studies, and that research studies should be based on trust between the researcher and the participants. There are two important ethical rules: the first is that participants should be protected from risk (Wiersma & Jurs, 2009:437) and should not be harmed physically, mentally or socially. This requirement was adhered to during this study. The classrooms where interviews took place were prepared in advance to ensure that the chairs and tables were in good condition and safe for use. To prevent possible physical harm, unstable chairs and tables were put aside and the participants were advised not to use them. The learners were requested to enter and exit the classrooms in an orderly way to avoid tripping and falling. The researcher and teachers monitored the learners as they entered and exited classrooms to ensure that all were safe from any physical harm. The learners were also advised to follow safety precautions when they used tools for making technological products.

The interviewees in this study were not deceived and were protected from any form of mental or emotional injury. To ensure the protection of participants in this regard, the researcher avoided actions or utterances that could cause emotional stress, e.g. he made no comments targeting the personhood of participants. According to Welman et al. (2010:201), respondents should be assured that they would not suffer any emotional harm. Neuman (2011:146) advises

that a sensitive researcher should be aware of the fragility of a person's self-esteem, and Welman et al. (2010:201) suggest that researchers should guard against manipulating participants or treating them as objects or numbers, rather than individual human beings.

Welman et al. (2010:201) state that the researcher should obtain the necessary permission from the participants once they have been thoroughly informed of the purpose of the interview and the investigation (See Appendices 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20). All the participants were informed about the purpose of this study and the fact that participation was voluntary, and each one signed a form to consent to participate in data collection. They were also informed from the outset that since participation was voluntary, that they could withdraw at any point without any negative consequences. The participants' anonymity and confidentiality were also ensured (Hancock & Algozzine, 2011:52) by the use of pseudonyms. Welman et al. (2010:201) emphasise the importance of assuring participants of their right of privacy.

4.8 TRUSTWORTHINESS

A major concern in qualitative research, as in quantitative research, relates to the confidence that researchers and consumers of research studies can place in the validity of the procedures used for data gathering, the analysis and interpretation of the collected data, and the conclusions reached (Chilisa, 2012:164). The trustworthiness and authenticity of this study was thoroughly tested. According to Bryman (2012:717), trustworthiness is a set of criteria applied by the researcher to assess the quality of qualitative research. Trustworthiness was ensured by accounting for credibility, transferability, dependability and confirmability.

4.8.1 Credibility

Credibility is concerned with the validity of the conclusions that are drawn from the data and how these conclusions match the reality being reported on (Govender, Mabuza, Ogunbanjo & Mash, 2014:3), and Morrow (2005:252) explains that it can be achieved by prolonged engagement with participants, persistent observation in the field, the use of peer researchers, negative case analysis, research reflexivity and participant checks. The following subsections explain how credibility was achieved in this study.

4.8.1.1 Member checks

The participants were requested to verify that the collected data accurately represented their views. Chilisa (2012:166) and Billups (2014:2) both recommend that at the end of an interview, the researcher should summarise what was said and ask the participants to check the notes to confirm that they are a true reflection of their views. The researcher can conduct member checks to test the overall report with the study participants before sharing it in its final form (Gay et al., 2011:393). In the case of this study, such checking was done by way of consultation with participants to see whether they agreed with the analysis (Given et al., 2014:9). The purpose of doing member checks was to eliminate the possibility of researcher's bias during the analysis and interpretation of the results (Anney, 2014:277).

4.8.1.2 Triangulation

According to Given et al. (2014:9), triangulation is the use of several methods, research sites, data sources and participants to investigate a research problem from various perspectives. Triangulation can also be defined as the process of using various methods, data collection strategies and data sources to obtain a more complete picture of what is being studied and to cross-check information (Gay et al., 2011:393). Gay and Airasian (2003:169) advise researchers to corroborate data by using this technique. Snape and Spencer (2003:43), explain triangulation as the use of different methods and sources to check the integrity of the collected data. This can be done by using different sources of data or research instruments, such as interviews, focus-group discussion or participant observation and different informants (Anney, 2014:277). The triangulation of methods in the current study was done by using the different data collection methods discussed in section 4.5. The triangulated informants include the perspectives of teachers, HoDs, learners, parents and Technology Specialists. Fossey et al. (2002:728) concur that the triangulation of data sources and methods allows for the comparison and convergence of perspectives to identify corroborating and dissenting aspects of the research issue. Anney (2014:277) asserts that triangulation helps the investigator to reduce bias and cross-examine the integrity of participants' responses.

4.8.1.3 Prolonged engagement and observation

Gay and Airasian (2003:215) recommend that researchers extend the study by remaining in the field for a longer period to obtain additional data that can be compared to earlier data, or

to confirm the consistency of the participants' responses. Prolonged engagement in the fieldwork helps the researcher to understand the core issues that might affect the quality of data as it encourages trust between the study participants and the researcher (Anney, 2014:276). For the purpose of this study, the researcher spent approximately 45 minutes interviewing each participant during the individual interviews with Technology teachers, Technology HoDs and Technology specialists; approximately 40 minutes observing each of the participating Technology teachers while teaching; and approximately 50 minutes conducting each focus group interview for parents and learners. This translated to two months spent in the field.

4.8.1.4 Peer briefing

According to Anney (2014:276), a qualitative researcher is required to seek support from other professionals, such as members of academic staff, who are willing to provide scholarly guidance. The researcher in this study persistently sought guidance from his supervisor to ensure the integrity of the collected data. Feedback from peers also helps the researcher to improve the quality of the findings. The findings should be presented to peers for their comments (Anney, 2014:276,277). In this case the researcher sought advice from fellow master's and doctoral students at education conferences. Billups (2014:2) concurs that by inviting feedback from another researcher to compare conclusions, questions of bias, errors of fact, competing interpretations and convergence of data and phenomena can ultimately reinforce credibility. Given et al. (2014:9) states that peers may be co-investigators in the project or independent scholars with expertise in the methods being employed. Peer examination is based on the same principle as member checks, but involves the researcher's discussion of the research process and findings with impartial colleagues who have experience of qualitative methods (Krefting, 1991:219).

4.8.1.5 Negative case analysis

Data that was not compatible with the developing theory was identified in order to validate the findings of this study. Chilisa (2012:166) expounds that during data analysis, it should not be expected that all cases will fit the appropriate categories; it is thus important to document negative cases. Gibbs, Kealy, Willis, Green, Welch and Daly (2007:542) advise that researchers should search for disconfirming cases to validate their analysis. Negative case

analysis searches for opposites or disconfirming situations, data, and/or literature (Nichola, Globerman, Antle, McNeill & Lach, 2006:59). Billups (2014:3) proposes that researchers should apply disconfirming evidence to search for other interpretations in a study. The disconfirming findings in this study were identified to build a richer picture for understanding the actual role of IK in the development of design skills and were also used for refining the findings. According to Anney (2014:277), reporting negatives improves the credibility of the study as the researcher accounts for contradictions that emerged from the data, which could provide a plausible alternative explanation. Searching for negative cases and the identification of data that does not easily fit into the developing theory or the researcher's own ideas enhance the validity of the research.

According to De Langen (2009:73), negative case analysis involves addressing and considering alternate interpretations of data, especially those that are contrary to the researcher's view. Negative case analysis always presents a challenge because it is not easy to recognise discrepant data and negative or alternative cases. Booth, Carroll, Ilott, Low and Cooper (2013:127) advise researchers to only identify the disconfirming case once they have completed initial data collection and analysis.

4.8.1.6 Research reflexivity

Research reflexivity was used to ensure that the findings of this study were not diluted by the researcher's beliefs. In this context, reflexivity refers to the assessment of the influence of the researcher's background and ways of perceiving reality, perceptions, experiences, ideological biases and interests during the research (Chilisa, 2012:168). The western education to which the researcher had been exposed was not allowed to interfere with the findings of this study. Chilisa (2012:168) proposes that the researcher's thoughts, feelings and frustrations, fears, concerns, problems and ideas should be recorded throughout the study. Underlying assumptions or biases that may cause the formulation of a set of questions or present findings in a particular way should be intentionally revealed (Gay et al., 2011:393). Ritchie et al. (2013:4) maintain that qualitative research favours a reflexive approach, where the role and perspective of the researcher in the research process are acknowledged, and add that for some researchers, reflexivity also means reporting their personal experiences in the field. Krefting (1991:218) suggests that one of the ways in which researchers can describe and

interpret their own behaviour and experiences within the research context is to make use of a field journal, and posits that the most important type of information in the field journal is analogous to that found in a personal diary as it reflects the researcher's thoughts, feelings, ideas and hypotheses generated by contact with informants.

A field journal is used to write down questions, problems and frustrations concerning the overall research process. One technique for practising reflexivity is to keep a journal in which the researcher regularly records his or her reflections (Gay et al., 2011:394). To prevent the dilution of findings, the researcher recorded his beliefs about the importance of IK in the teaching of design skills. According to Krefting (1991:218), by writing down these personal thoughts and feelings about the research process, researchers may become aware of any biases and preconceived assumptions they might hold, which will give them an opportunity to enhance the credibility of the research by altering the way they collect data or approach the analysis. Gay and Airasian (2003:169) advise that researchers should always try to acknowledge their biases and preferences and to be honest with themselves in weeding them out. The researcher did not allow his beliefs and opinions regarding the value of IK to influence the findings of this this study.

4.8.2 Transferability

Applicability refers to the degree to which the findings can be applied to other contexts and settings or with other group of respondents; it is the ability to generalise from the findings to larger populations (Govender et al., 2014:3; Krefting, 1991:216; Anney, 2014:277). Krefting (1991:216) argues that the ability to generalise is not relevant in many qualitative research projects as each situation is defined as unique and is therefore less amenable to generalisation. Chilisa (2012:169) accedes that in qualitative research the transferability of research findings can be enhanced through sampling and dense description of the setting of the study. Anney (2014:277) advises researchers to provide a detailed description of the enquiry and to select participants purposively, which, as discussed earlier, was done in this study. In qualitative research, small samples are selected purposively. For this study, the researcher selected participants who were well informed on the topic under study so as to ensure a sample that complied with the research needs. Interviews were conducted with specialist Technology teachers who held qualifications in TE. The researcher also interviewed

parents who had knowledge of IK and included potters, carpenters, etc. Technology teachers from different schools (sites) who shared the same profile were interviewed to ascertain the congruency of the results and confirm the transferability of the findings.

4.8.3 Dependability

Dependability is determined by the consistency of the data, and whether the findings would be consistent if the inquiry were to be replicated with the same subjects or in a similar context (Krefting, 1991:216). This means that if the study were to be repeated by other researchers, it would produce the same results (Krefting, 1991:216). For this study, the code-recode procedure was followed to ensure dependability. Anney (2014:278) explains the code-recode strategy as one that involves the researcher coding the same data twice with a gestation period of one to two weeks between codings. If the coding results are in agreement, they enhance the dependability of the qualitative inquiry.

This study also used an audit trail to promote dependability. An audit trail is a detailed chronology of research activities and processes that can influence the data collection and analysis. According to Ary et al. (2002:436), the audit trail contains the raw data gathered during interviews and observations. Anney (2014:278) further explains that an audit trail involves an examination of the inquiry process and product to validate the data. In order for an auditor to conduct a thorough audit trail, some form of archival material needs to be maintained, such as all raw data, including interview and observational notes, documents and records collected in the field (Guba & Lincoln, 1982:10). Given et al. (2014:9) emphasise the need for researchers to make field notes during data collection and analysis. To maintain dependability, the researcher ensured that the audit trail for this research was safe. The researcher used a voice recorder to record interviews with participants so that the results could be repeated to confirm their consistency. According to Morrow (2005:252), a dependable study should be consistent across time, researchers and analysis techniques. Thus the process by which findings are derived should be as explicit and repeatable as possible.

4.8.4 Confirmability

Confirmability refers to the extent to which findings in a study can be traced to data derived from the informants and the research settings, and not to the researcher's biases (Chilisa,

2012:171). Ary et al. (2002:456) state that confirmability refers to the extent to which research is free from bias in the procedures and the interpretation of the results. External auditors may be requested to examine the processes of data collection, analysis and interpretation (Gay et al. (2011:393). To ensure confirmability, the researcher tried to avoid being influenced by his personal views and used an audit trail to ensure confirmability as explained above. Creating an audit trail is the primary technique for establishing confirmability. According to Krefting (1991:221) and Chilisa (2012:171), the audit trail strategy involves an external auditor who follows the steps in the progression of a research study to try to understand how and why decisions were made. To maintain confirmability in this study, the researcher ensured that the reasons for choosing specific data collection and analysis methods were clearly stated. Krefting (1991:221) adds that auditability suggests that another researcher given the same data and research context would arrive at comparable conclusions. The audit trail may take the form of a written description of each process and may include access to original field notes, artifacts, videotapes, photographs, etc. (Gay et al., 2011:393). The most common strategy for controlling bias in qualitative studies is reflexivity. As stated earlier in this chapter, reflexivity is the use of self-reflection to recognise one's own biases and to actively weed them out. The researcher used self-reflection to identify and deal with his biases.

4.8.5 Authenticity

Authenticity, which refers to whether the evidence is genuine and was obtained from implacable sources (Ahmed, 2010:3), was maintained throughout this study. According to Billups (2014:4), the authenticity strategy advocates that research should represent all the realities to give meaning to the findings, and Neuman (2011:214) explains authenticity as the offering of a fair, honest and balanced account of social life from the viewpoint of the people who live it every day. To ensure authenticity, the researcher used the following strategies: fairness, ontological authenticity, educative authenticity, catalytic authenticity and tactical authenticity. In this study, different constructions were solicited to promote fairness. To promote ontological authenticity, the researcher expanded and elaborated in detail on the participants' individual constructions, while educative authenticity was promoted by ensuring that the participants understood and appreciated the ideas of others. To promote catalytic authenticity, the participants were encouraged to be open to discussing reality as it was during

the interviews. During observation, the learners were requested to continue with their lessons as if the researcher was not present.

4.9 PRE-TESTING

The researcher conducted a pre-test using interview guide questions to check the feasibility of this study (Appendices 1–5). The pre-test was intended to establish areas that needed refinement. According to Johnson and Christensen (2017:211), it is a cardinal rule in research that research instruments must be tried out or pilot-tested to determine whether they operate properly before using them in a research study. Ary et al. (2002:111) explain that a pilot study can help researchers to decide whether a study is feasible and whether continuing with it would be worthwhile. It provides an opportunity to assess the appropriateness and practicality of the research methodology. Unexpected hitches may emerge and be dealt with at this stage, which may save time and effort later. Bryman (2012:262) suggests that questions in the pilot sample that appear to be difficult to understand should be identified and rephrased. This research was preceded by a pilot study to assess the appropriateness of the questions.

Mathers et al. (1998:13) posit that in order to ensure that all the relevant issues have been covered, that pre-codes are correct and that the researcher has not forgotten or omitted any issue that might be important to the respondent, a pilot study should be conducted using the draft instruments. Feedback from the pilot study participants can be very helpful for reviewing the methods.

Mathers et al. (1998:13) state that ideally the instrument should be tested on a small number of participants who meet the same criteria as those in the sampling frame. Gay et al. (2011:387) and Johnson and Christensen (2017:211, 212) concur that, to ensure that the questions are understood, researchers should do a pilot test with a group of between five and ten people, for example colleagues or friends who share similar characteristics with the research participants. Mathers et al. (1998:13) state that it is essential that the interview question be phrased in plain, clear language. The participants' feedback can quickly confirm or challenge the assumptions made while formulating the questions (e.g. about the use of appropriate language) (Gay et al., 2011:387). Researchers should use the feedback from the participants in the pilot study to revise the questions before they start interviewing the

participants in the actual study. In the case of the current study, the participants were afforded an opportunity to review the questions to make sure that they were comprehensible. They also made recommendations regarding the language(s) to be used for interviewing, i.e. English only or English and Xitsonga.

4.10 DATA ANALYSIS TECHNIQUES

In qualitative research, data analysis involves summarising the data that was collected accurately and in a dependable manner to ensure that the findings can be presented with an air of undeniability (Gay et al., 2011:465). The data collected for this research was analysed inductively, using content and thematic analysis. The data obtained from the individual interviews, focus group interviews and participant observations was analysed using thematic analysis. Bryman (2012:517) and Johnson and Christensen (2017:579) explain thematic analysis as the identification of themes in the qualitative research data, and Johnson and Christensen (2017:579) describe a theme as a word or a set of words denoting an important idea that occurs repeatedly in the data. Content analysis, which was used to analyse the data obtained from documents and artifacts, is defined by Bryman (2012: 290) as an approach to the analysis of documents and texts that seeks to express content (of text) in terms of predetermined categories. Content analysis was also used to record the number of times a phenomenon occurred and to retain important data. According to Saldana and Omasta (2018:66), content analysis can be used for scrutinising the manifestation of narrative and visual texts. Neuman (2011:360) states that when content analysis is used, the researcher gathers and analyses the content of a text (visual or spoken medium for communication). The content can be words, meanings, pictures, symbols, ideas, themes or any communicated message. Texts include official documents, books, photographs, works of arts and indigenous artifacts.

Data analysis involves several steps, namely getting to know the data, focusing the analysis, categorising information and identifying patterns and interpretation (Taylor-Powell & Renner, 2003:2). The researcher followed the following process to analyse the collected data:

a) Get to know your data

The researcher carefully transcribed the collected data in order to be able to easily read and analyse it. Taylor-Powell and Renner (2003:2) advise that in qualitative research a researcher should read and re-read the text and write down all useful impressions, and Lacey and Luff (2007:22) concur that researchers should listen to their tapes, read and re-read the data, write memos and make summaries before they start the final data analysis. For this study, the researcher carefully read the notes made during individual and focus group interviews, document analysis, artifact analysis and lesson observation numerous times in order to gain a clear understanding of their content.

b) Focus the analysis

To find out how the participants answered the questions, the researcher used the focus-by-question approach which, according to Taylor-Powell and Renner (2003:2), means that a researcher focuses the analysis to look at how all the individuals responded to each of the questions asked. For the current study, the researcher organised the data according to the questions to carefully consider all the participants' responses to each question in order to identify consistencies and differences.

c) Categorise information

Qualitative content analysis involves a process designed to condense raw data into categories or themes based on valid inference and interpretation (Zhang & Wildemuth, 2009:2). This process uses inductive reasoning by which themes and categories emerge from the data through the researcher's careful examination and constant comparison. Categorising information involves reading and re-reading the text to identify coherent categories (Taylor-Powell & Renner, 2003:2). Lacey and Luff (2007:22) state that researchers need to organise data in such a way that it can be easily retrieved in sections. Each interview should be given a code or number. A researcher may assign a code to a section of text of any size, provided that that chunk represents a single issue of relevance to the research question (Taylor-Powell & Renner, 2003:2). According to Smith (2002:69), coding refers to naming and categorising phenomena through a close examination of the data that has been broken down into discrete parts, which are then compared. Smith (2002:68) explains qualitative data analysis as the selection and categorisation of bits of data.

Codes were assigned to sections of the transcribed data. According to Johnson and Christensen (2008:534), a researcher may use segmenting to divide the data into meaningful analytical units. When text data is segmented, the text is read by line to establish whether a segment of text has a specific meaning that might be important for the research study. Codes were organised into categories or themes. Johnson and Christensen (2008:534) define coding as the process of segmenting and labelling text to form descriptions and broad themes in the data. This is an inductive process used to narrow data down into a few themes. The researcher used constant comparison to analyse the collected data. Constant comparison is a process during which the researcher is continually searching for both supporting and contrary evidence about the meaning of the category (McMillan & Schumacher, 2010:377). Creswell (2012:434) concurs that constant comparison is an inductive data analysis procedure during which categories are generated and connected by comparing incidents in the data to other incidents, incidents to categories and categories to other categories. Throughout this process, the researcher constantly compared indicators to indicators, codes to codes and categories to categories.

d) Identify patterns

According to Taylor-Powell and Renner (2003:5), as a researcher categorises the data into categories, he or she will begin to see patterns and connections both within and between categories. In this study the data was coded into different themes that correlated with the main research questions. Qualitative data analysis is primarily an inductive process during which data is organised into categories and patterns and relationships are identified in and between the categories (McMillan & Schumacher, 2010:367). The researcher used a constant comparison process to form themes, after which similar themes were grouped together to discover patterns. According to Wiersma and Jurs (2009:238), a researcher searches for patterns of thinking or behaviour, words or phrases and events that appear with regularity or for some reason appear noteworthy, and make generalisations about the findings. Ary et al. (2002:470) state that in an inductive process, a researcher makes generalisations based on the connections and common aspects that are identified in the different categories and patterns, as was the case in this study.

e) Interpretation

The researcher explained and interpreted the qualitative patterns of thinking or behaviour and events in terms of words by explaining the role that IK can play in assisting Technology learners to acquire design skills. Taylor-Powell and Renner (2003:5) suggest that researchers should use themes and connections to describe their findings. According to Zhang and Wildemuth (2009:5), qualitative research is fundamentally interpretive, and interpretation represents the personal and theoretical understanding of the phenomenon under study.

4.11 CONCLUSION

This chapter presented a detailed description of the differences between qualitative and quantitative research, which confirmed the relevance of qualitative research for this study. The research design, sampling and data collection methods used for this study were discussed in detail. The triangulated data collection methods and techniques used facilitated the collection of relevant data to answer the main research question. Ethical considerations, the need for trustworthiness and the importance of a pilot study were also discussed. Ethical considerations ensured that the participants were treated with respect for their dignity, and compliance with the demand for trustworthiness ensured the value and validity of the findings of this study. Finally, the researcher described the data analysis techniques that were used to establish the role of IK in the teaching of design skills.

The findings of this study will be presented in the next chapter.

CHAPTER FIVE

FINDINGS AND DISCUSSIONS

5.1 INTRODUCTION

Chapter 4 presented a detailed discussion of the research design and methodology for this study. The main goal of this chapter is to present the findings of this study, based on the content analysis framework as referred to in Chapter 4 (section 4.9), in order to answer the main research question: What is the role of IK in developing Senior Phase learners' design skills in TE? and the sub-questions as stated in Chapter 1 (section 1.3). The analysed data was obtained from interviews, participant observation, indigenous artifacts and documents. The researcher maintained the confidentiality of the participants (see section 4.6) by using codes instead of their real names, e.g. TT1S1 (Technology Teacher 1 School 1); THS1 (Technology Head School 1); TS1 (Technology Specialist 1); P1S1 (Parent 1 School 1); and TL1S1 (Technology Learner 1 School 1). The findings of this study are presented under the following main themes and categories:

- The value of indigenous knowledge (IK) in teaching design skills
  - o The understanding of IK
  - o The evidence of IK in local communities
  - o Technological indigenous designs in local communities
  - o Design skills that can be acquired from technological indigenous designs
  - o The importance of the integration of IK in teaching design skills
- IK as content
  - o The content of design skills included in the CAPS
  - o The inclusion of the aspects of indigenous design skills in the CAPS
  - o The relevance of design skills to the learners' cultural world
  - o The integration of IK in the content of design skills
  - o The reaction of learners to the integration of IK
- Teaching strategies
  - o Methods for teaching design skills
  - o The relevance of CRP in teaching design skills

- o Transforming the dominant design-make-evaluate method
- o The use of indigenous artifacts to teach design skills
- o The use of the inquiry teaching approach to promote the use of indigenous knowledge
- o The use of the discovery teaching approach to promote the use of indigenous knowledge
- Learning strategies
  - o The use of the experiential learning strategy to promote integration of IK
  - o The use of the cooperative learning strategy to promote the co-construction of knowledge
- Assessment strategies
  - o Assessment methods that can contribute to the development of design skills from an indigenous perspective
  - o The learners' reaction to assessment tasks that integrate indigenous knowledge
- The role of more knowledgeable others (MKOs)
  - o The role of indigenous experts in teaching design skills
  - o The indigenous ways of teaching design skills

Within the themes and categories, the findings are integrated across datasets/sources and participants.

5.2 PRESENTATION OF FINDINGS

5.2.1 The value of indigenous knowledge (IK) in teaching design skills

5.2.1.1 The understanding of IK

The first research question related to the understanding of the value of IK in teaching design skills, therefore the participants were asked to describe IK and its value according to their understanding. The responses of the majority of participants suggested that IK still exists in some communities in South Africa, particularly in rural areas. TS3, for example, stated: *"Indigenous knowledge is informal knowledge which is commonly conspicuous in rural areas. This knowledge is used by indigenous people to meet their needs."* P2S2 stated that, unlike the school knowledge that is fetched from far, indigenous knowledge originates from villages. By "from far", this participant meant knowledge external to indigenous context. Other

participants' responses regarding this matter pointed to the colonial influence that is evident in the content packaged in the curriculum: *"Indigenous knowledge is a knowledge which is not written in books like western knowledge, therefore it is not taught in schools"* (TT2S3). According to this participant, *"indigenous knowledge helps us to deal with problems that we face"*. TL4S3 saw IK as the solution because *"indigenous knowledge is a cultural knowledge that is taught orally without writing. This knowledge is practical and can help to solve problems at home"*. The participants regarded IK as informal knowledge as it is generally not taught in schools, since they indicated that IK is not documented and is generally taught outside classrooms at home. According to P2S2, this knowledge is accumulated and stored in people's heads. The textbooks provide clear evidence that WK is better documented than IK.

The participants further described IK as traditional knowledge, and indicated that it is mainly the older people who are the custodians of this knowledge. According to TL3S1, *"indigenous knowledge is possessed by old people in our communities. If you can visit our local communities, you will see how they use it"*. P1S3 concurred by stating that *"indigenous knowledge is a traditional knowledge which is found and established in local communities using practical experience. Majority of people in our rural communities rely on this type of knowledge"*.

From the above views it is clear that IK still exists in local rural communities. It has its roots in indigenous contexts as it was established by indigenous people to assist communities to sustain life and solve problems. The many descriptions of IK given by the participants indicate that they know and own this knowledge and hold common views about it, i.e. that IK still exists, that it is valued by indigenous people and is commonly used in indigenous communities, and is therefore still relevant to the lives of people, particularly in rural areas. The above finding goes against De Vries' (1996:11) view, which is that learners do not regard the examples of experience-based technology as being technology. The participants appeared to view the informality of IK as an indication of inferiority. The questions that ring in the researcher's reoriented mind, unanswered during the engagements, are: does the fact that IK is mostly shared orally suggest that it is informal? Does the documenting of school knowledge dismiss the undocumented IK?

5.2.1.2 The evidence of IK in local communities

The participants were very clear in the confirmation of the conspicuous role of IK in indigenous communities. They pointed out that their local communities used IK and skills to produce a variety of products. The participants believed that IK plays a pivotal role in the daily decisions taken by indigenous people living in rural areas. In this regard TS2 stated that: *"Knowledge and skills are highly required to design a product. Indigenous people use their indigenous knowledge to make their products for their community members. Products are not made accidentally without knowledge and skills."* According to this participant, indigenous people rely on their expansive indigenous knowledge and skills to make their products.

No useful product can be made without knowledge and skills. This is attested to by TT1S2, who stated: *"Indigenous experts should possess factual knowledge and practical knowledge in order to be able to make indigenous artifacts."* This indicates that expert indigenous people who make artefacts needed by their communities rely on perambulating between tacit knowledge (practical knowledge acquired through experience, which even the knowledgeable person might not be able to explain) and explicit knowledge (factual knowledge, which can be explained to someone). This finding does not support Nostrom's (2014:11) assertion that experience-based technology does not demand any scientific knowledge. Indigenous people who rely more on IK than on specialised scientific knowledge can in fact use both types of knowledge. They use scientific and technological knowledge to make products. The indigenous artifacts that were studied confirm that the manufacturers of products use their knowledge to make them. For instance, the analysis of indigenous sifter (see Figure 5.1) shows that indigenous people possess a sound knowledge of different shapes, such as rectangles, squares and triangles, which is also taught at school, as well as design knowledge of different structures, such as shell, frame and solid structures, which enabled them to make this sifter with its shell structure. It is evident that the designers of this square sifter used for grinding peanuts were able to measure accurately as all the sides are of equal length. It is also clear that the making and the choice of materials combine IK and conventional knowledge and skills, which supports the idea of a dual approach to teaching.

Figure 5.1: Sifter

The participants indicated that the application of IK in their communities can be attested to by the indigenous artifacts made by local people without any formal training. TS1 asked: *"If you say indigenous people are blank, how can they be able to make all those products that we see in our communities?"* and TT2S3 said: *"If the western knowledge is regarded as important because it can be used to make products, the indigenous knowledge, which is used to make indigenous products, must also be regarded as important knowledge."* The participants believed that IK is important as WK, as it can also be used to make valuable products. According to these participants, in order for indigenous experts to make valuable artifacts, they must have both conceptual and procedural knowledge, i.e. knowledge of facts and practical knowledge based on experience.

Indigenous experts harbour knowledge of the physical and mechanical properties of different trees that they use to make new indigenous products. The participants mentioned the mechanical properties of four trees, which are needed by their communities, namely the jackalberry (Toma), mopani (xanyati), marula (nkanye) and leadwood (mondzo) trees (the Xitsonga names are given in brackets). Three of these trees can be seen in Figures 5.2 to 5.4. The useful properties of these trees were explained as follows by the participants: *"Do you know that toma can be used to make yokes as it is very strong, it cannot break easily"* (P1S1); *"Xanyati tree can be used to make roof material because it is hard and durable. The roof should be strong to withstand strong wind"* (P3S2); *"We use nkanyi to make bowls, wooden spoons, mortars and pestles because it is durable"* (P2S1); *"Indigenous experts prefer mondzo to make poles for fencing a yard because they are strong and durable. The poles should be put underground, they should be durable"* (P3S3).

The above comments show that indigenous Vatsonga people are knowledgeable about different trees that grow in their environment and their uses. The classroom observations revealed that the learners also possessed conceptual knowledge of the properties of different indigenous trees. The participants believed that conceptual knowledge can help a manufacturer to select appropriate indigenous materials for making different products. They mentioned that inadequate conceptual knowledge might lead to the use of unsuitable materials to make products which are less useful to achieve intended goal.

Figure 5.2: Mopani tree   **Figure 5.3: Leadwood tree**   **Figure 5.4: Marula tree**

5.2.1.3 Technological indigenous designs in local communities

The participants were requested to describe indigenous designs used in their communities. They indicated that indigenous communities use a wide variety of indigenous designs. P2S3 said: *"We are pleased by the fact that we have plenty of our indigenous designs in our local community. It shows that indigenous people are also wise as they can make things which can be used by majority of people in our community"*. According to this participant, it is rare to find a home without any indigenous artifact. The participants indicated that the ownership of indigenous artifacts is an indication that one belongs to the Vatsonga tribe, and participant TL3S2 explained that *"in our community, if you do not have some indigenous designs such as a xibelani (*traditional skirt) *you are regarded as a foreigner, particularly if there is a special gathering"*. According to this participant, the indigenous designs are cherished as they symbolise belonging to a community.

The participants believed that western designs are favoured by wealthy people, while many poor indigenous people still rely on indigenous designs to make a living. For instance, TS3

said: *"Our indigenous designs can be used to fight poverty in a country like ours which is affected by high rate of unemployment. Indigenous designs can be sold at minimal costs. They are affordable for people with low income."* This was confirmed by P2S1, who said: *"In our community, we have many people who cannot afford to buy the western products which are extremely expensive as they are manufactured far away from us."* The participants believed that indigenous designs are cheaper because they are locally manufactured from readily available indigenous materials, such as clay which is used to make pots. According to TL1S2, *"we have a variety of indigenous designs which are predominantly used by our local communities, such as mud houses, wooden spoon, clay pots, calabash, traditional sandals and winnowing baskets".* The participants also claimed that indigenous people have their own unique ways of dealing with local problems by manufacturing indigenous artifacts needed in their communities. In this regard, P2S3 said: *"Our people here heavily rely on indigenous designs, any person who lives in our community cannot deny this truth."* This participant explained that indigenous people are actively engaged in manufacturing indigenous products for their local communities, e.g. sculpted (carved) articles, pottery, textiles (weaving), buildings, medicines and food.

a) Sculpting

The participants stated that sculpting is still a major activity in their communities. P2S3 said: *"… sculpted products are important commodities in the lives of many rural people. The common sculpted artifacts which are found in our community are stirrer, wooden spoon, sifter, calabash, hoe handle, mortar and pestle."* The participants mentioned that some of these products, such as wooden spoons and stirrers (see Figure 5.5) are used daily by rural and urban people.

Figure 5.5: Stirrer

The participants believed that sculpted designs are valuable in their communities. The following excerpts attest to this belief: *"Some of the sculpted products, such as a wooden spoon and stirrer, are highly needed daily for cooking porridge and relish"* (TT1S3). TH1 confirmed this by stating that even though she now lives in a town, she uses a wooden spoon almost every day.

The participants mentioned that some sculpted products, such as mortar and pestle (see Figure 5.6) are no longer being regularly used by indigenous people. They explained that the mortar and pestle can be used to grind peanuts into a powder, which can be mixed with pumpkin leaves to make a relish. P1S1 said: *"These days we are no longer using mortar and pestle to grind a large quantity of maize. We can grind little amount of maize for making a kind of samp* (tihove in Xitsonga). *We also grind peanuts so that we can cook it with pumpkin leaves which makes our relish delicious."*

Figure 5.6: Mortar and pestle

The participants were of the opinion that calabashes (see Figure 5.7) are no longer used regularly as they have been replaced by cups. Calabashes are however still often used for traditional beer due their hygienic value, as THS2 explained: *"The calabashes are hygienic as they have long handles which prevent users from touching the heads which are used to scoop traditional beer."*

Figure 5.7: Calabash

b) Pottery

The participants were of the opinion that pottery is still practised in their communities for making articles like clay pots and plates. A potter (muvumbi in Xitsonga) knows the properties of clay that is suitable for making clay pots. They know that clay products are strong: *"The products made of clay do not have cracks like the other products made of other types of soil such as loam soil"* (P3S3). They indicated that clay pots play a very important role in their communities, and TL3S2 said: *"Clay pots can be used as refrigerators to cool water as some people in rural areas cannot afford to buy refrigerators. Clay pots can also be used to preserve food to last longer before becoming rotten. The food stored in clay pots can last longer."*

c) Textiles

The participants showed that they have acquired explicit indigenous knowledge about different plants that can be used to make indigenous artifacts. This was confirmed by P1S3, who said: *"I know that creepers (tinxotso in Xitsonga) can be used to weave conical baskets. I have learnt that from my parents."* (See Figure 5.8.)

Figure 5.8: Conical basket

The participants further explained that indigenous experts can use reeds (called mihlahlu in Xitsonga), which grow next to rivers, to make sleeping mats. According to the participants, sleeping mats (see Figure 5.9) are in high demand in their local communities. P1S2 explained: *"During summer, as Limpopo Province is one of the provinces which experience high temperatures in South Africa, majority of people, women in particular, prefer to sleep on sleeping mats under shadows of trees."*
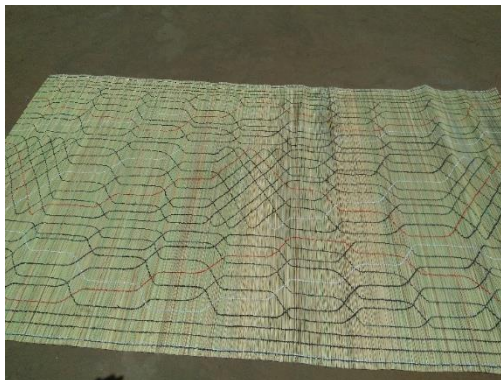
Figure 5.9: Sleeping mat

According to the participants, indigenous experts can use reeds (called majekeje in Xitsonga) to manufacture winnowing baskets (Rihlelo in Xitsonga) (see Figure 5.10).

Figure 5.10: Winnowing basket

The participants also mentioned that many indigenous people use lala palm leaves to make brooms. P1S2 confirmed this by stating: *"I can tell you without any doubt that majority of people in our villages rely on lala palm plants to make their brooms for sweeping".*

Figure 5.11: Broom

d) Architecture

The participants mentioned that different indigenous structures are still prevalent in their local rural settlements. In this regard TL2S1 said: *"The indigenous carpenters and bricklayers are engaged in the process of planning, designing and constructing traditional rondavel houses, gates and many other structures."* The *Grade 7 Via Africa* textbook contains illustrations of different types of houses, such as the Ndebele houses, cone-on-cylinder, domed grass and Xhosa huts. The participants expressed the opinion that indigenous people are able to use recycled materials to make products such as gates (see example in Figure 5.12). The gate was constructed from tree branches and discarded wire, which also helped to clean the environment.

Figure 5.12: Recycled materials used for gate

e) Medicine

Figure 5.13: River bushwillow

The participants explained that a river bushwillow tree may be used as a medicine for the treatment of certain illnesses. The leaves of the river bushwillow is steeped in boiling water, which is then given to patients to treat flu. It can also be used to heal sexually transmitted diseases. P3S2 stated: *"Do you know that this river bushwillow can heal sexual transmitted disease? Even if you are not a traditional healer you can get the barks and leaves of the river bushwillow and boil them in water. The patient who has the sexually transmitted disease can drink that water and get healed."* However, the participants warned that one should not eat the fruit of the river bushwillow, which is very poisonous and therefore deadly.

5.2.1.4 Design skills related to technological indigenous designs

The findings revealed that indigenous experts possess numerous indigenous skills, such as reinforcing, brewing, food preservation and pottery skills, which are useful in the manufacturing of new products.

a) Reinforcing skills

TT2S3 and TT1S2 stated that indigenous people use indigenous skills to reinforce the roofs of their indigenous rondavel houses. For instance, carpenters use small poles to strengthen the roofs to withstand strong wind. Grass mats are also tied to the purlins at the bottom of the roof to strengthen it against strong wind (see Figures 5.14 and 5.15). This illustrates that indigenous carpenters know how to reinforce structures, as confirmed by P3S1: *"Our carpenters are skillful in designing traditional roofs. The roof of my rondavel house has been made more than ten years ago, but it is still fine; but the carpenters with rudimentary knowledge can spoil your roof".* Rondavel roofs last longer if they are designed by an expert.

Figure 5.14: Support structure for a roof seen from outside

Figure 5.15: Inside view of thatched roof

Reinforcement was also related to the making of chairs and benches, because *"the chairs should withstand the weight of different people"* (TL1S2). Figure 5.16 shows how wooden blocks were used to reinforce a bench.

Figure 5.16: Bench

b) Brewing of marula beer

The participants explained how indigenous people use their skills to process food. For instance, P3S2 explained: *"The indigenous people use their skills to make beer. The indigenous people do not rely on those modern technological machines to make their own beer".* Beer from the fruit of the marula tree (see Figures 5.17 and 5.18) can be made by indigenous people in their homes in the traditional way. A kitchen fork is used to open the marula fruit (Figure 5.17), after which the juice is squeezed into a clay pot or a bucket. The juice is left in a closed container for about three days so that fermentation can take place, after which it can be tasted and bottled for consumption (see Figure 5.18). It is therefore clear that

indigenous people possess the scientific (chemical reaction) knowledge needed to brew their traditional beer.

Figure 5.17: Marula fruit

Figure 5.18: Marula beer

c) Food-preservation skills

The participants indicated that some vegetables, such as cowpea, pumpkin and jute mallow are plentiful during the rainy season (summer months) in Limpopo Province, and should be preserved for use during the dry winter months. The jute mallow (see Figure 5.19) can be dried straight after being picked and no cooking is required. Indigenous preservation skills are also demonstrated by the gathering of mopani worms, as THS2 explained that mopani worms, which can be boiled and sun-dried to preserve them for later consumption. P1S2 stated: *"The indigenous people can also preserve the traditional leafy vegetables like cowpeas (tinyawa), pumpkin leaves (tinwembe) and jute mallow (guxe). They can harvest cowpea and pumpkin leaves and boil them until they are edible and thereafter, they can take them out and put salt and dry them so that they can last longer."* Knowledge of these indigenous skills can motivate learners to find new ways of preserving food in Technology classrooms.

Figure 5.19: Dried jute mallow

d) Pottery skills

The findings revealed that indigenous pottery manufacturers are skillful in making strong clay pots. The participants believed that a person with only a rudimentary knowledge of making clay pots will not be able to design strong and beautiful clay pots: *"The clay pots made by a novice may be characterised by cracks. A potter should have acquired mixing skills. They should be able to mix clay and water so that it is soft to make a new clay product. They should be able to apply different techniques such as modelling, ring and clod method"* (P3S2). In addition, P1S1 stated: *"In a modelling method a potter makes a formless piece of clay ball and makes a hollow with the fingers. In a ring method the potter makes rolls with clay and these rolls are used to make a needed product. The last method used to make clay products is called clod method. In clod method a potter uses small pieces to make a product."* Potters use their finishing skills to enhance the aesthetics of a product. A smooth stone can be used to smoothen the surface. Once the finished products have dried completely, they are strengthened by firing them.

Figure 5.20: Clay pot

5.2.1.5 The importance of the integration of IK in teaching design skills

a) IK can simplify learning and make it more meaningful to learners

Teaching learners design skills in Technology can be challenging. This refers to the finding that IK can play an integral role in assisting learners' acquisition of design skills in Technology classrooms. IK has the potential to benefit learners, whose prior knowledge can be determined through assessment. The participants indicated that when learners learn things that are related to what they know, they are likely to comprehend them better than learners with no prior related knowledge. TL3S3 said: *"It is very difficult to learn something for the first time. When you learn things which are related to what you know, it makes learning easier."* TL1S2 concurred by saying: *"When we are taught things which are related to the things we were taught in the lower grades we can easily understand them, but when we are taught new topics which we have never seen before, the learning is challenging".* According to THS3, *"That is why there should be progression of learning in the Technology subject and other subjects so that learners do not start new things in every topic. When learners learn something that they are familiar with they can understand it better".* The findings suggest that learners should be taught content that is related to what they know, which will improve their retention of information.

The participants lamented the fact that the current teaching of Technology is not relevant to learners, which makes it difficult for them to comprehend. *"We really do not understand why there is a big wall between our traditional knowledge and that technology which our learners are taught. In that technology, our children are taught to make things and in our technology we also make things to be used by people"* (P1S1). However, the participants did not dismiss the possibility of mixing different knowledge systems, as attested to by THS1: *"There should be a bridge between different knowledge systems in order to make learning meaningful to our learners."* It was felt that interaction between knowledge systems could promote meaningful learning. The implication is therefore that IK should be linked with WK in the teaching and learning of design skills. The classroom observations revealed that learners who are conversant with indigenous skills can relate to technology in meaningful ways and contribute ideas inspired by technology from their own contexts. In design projects, these learners can also be asked to analyse technology from different cultural contexts and suggest solutions that would suit different contexts.

b) IK can enhance academic performance

With reference to a), this study further revealed that the integration of IK can enhance the academic performance of learners. The observations made during interviews showed that learners who were conversant with indigenous knowledge were able to select appropriate materials for making new artifacts and were also able to make products that resolved an existing problem. It was also observed that learners who lacked IK struggled to make technological artifacts in their classes.

c) IK can motivate learners to learn

The participants indicated that the alienation of IK in current education system makes learning unstimulating for learners who are conversant with it. TL1S3 said: *"The schools teach Technology which is very difficult for us, sometimes I do not feel like going to school as teachers keep on repeating foreign things which are outside our reality."* According to this participant, the continued teaching of western design skills can discourage learners from acquiring design skills. THS3 commented: *"Success may lead to another success. If learners can succeed in making indigenous products, they will be motivated to succeed in technological activities in their classrooms."* This statement shows that the integration of IK can play a significant role in motivating learners to acquire design skills. Technology teachers should therefore try their best to integrate IK when teaching design skills in order to motivate their learners to learn.

5.2.2 IK as content

5.2.2.1 Design skills content in the CAPS

The *Via Africa* textbook for Grade 7 shows the Technology design skills content for this grade. The participants (teachers, HoDs and learners) could describe the design skills content in the CAPS. They indicated that the CAPS expects learners to be able to investigate, design, make, evaluate and communicate. They could also elaborate on the concepts that are taught in a particular design skill. TT1S1, for instance, said: *"When learners are taught investigation skills, they should learn to identify problems from the given scenarios. They should be able to use their critical thinking skills to analyse the scenario."* According to the participants, when learners are taught design skills, they should learn to investigate the existing need or problem: *"The learners should find out how problems similar to the new identified ones are solved by*

experts. The learners may investigate the shapes, colours, patterns and materials used to make those existing products" (THS1). TT1S3 agreed with THS1 in stating that learners may visit the marketplace, libraries and the internet, and consult books, magazines, encyclopedias and newspapers to conduct investigations. They may collect information without any limitation as they have not yet decided which product they will make to solve a technological problem. It was expected that the participants would include elders and/or experts in their communities among the sources that learners could consult.

The participants further indicated that learners who are being taught the skills required for making products to solve problems should also be taught how to use the appropriate tools and should be aware of the safety measures to be taken when using them. TT1S1 stated: *"During making stage we teach our learners to use tools safely."* The participants further indicated that learners learn to evaluate the functioning of the artifact. TT2S2 said: *"The Technology learners should evaluate their products in accordance to the design specifications."* With reference to communication skills, the participants explained that teachers have to teach their learners to explain all the stages that have to be followed to arrive at a solution to a technological problem. TS2 said: *"Technology learners should be able to give information about technological processes and skills that they have followed to make a product".* As is evident from the above, it was mainly the teachers who related the design skills content in the CAPS and their expectations of learners who are acquiring those skills. While the findings this far show that participants were forthright in stating their views of IK, the teachers seemed to be focused wholly on the design process.

5.2.2.2 The inclusion of aspects of indigenous design skills in the CAPS

The findings of this study revealed that CAPS seeks to promote the inclusion of local contexts in learning. The CAPS document indicates that the incorporation of local knowledge can make learning more meaningful to learners. A statement by the Department of Basic Education (2011:4) reads: "… children acquire and apply knowledge and skills in ways that are meaningful to their own lives'', which indicates the promotion of the inclusion of local contexts in learning. According to above quotation, teaching and learning should include IK in order to make learning meaningful to learners. This shows that Technology teachers are given latitude to integrate IK in their teaching of design skills in order to simplify learning. However, the

participants (teachers) indicated that there is only minimal inclusion of indigenous design skills in the CAPS, which might partly explain the reason why it has been underplayed, as related to 5.2.1.1. They do not deny the fact that the curriculum advocates the inclusion of IK, but their concern is that very little IK is included as content. TT1S1 stated: *"The inclusion of indigenous knowledge is not sufficient. The indigenous design skills are only included in the topic of bias in and impact of technology".* The analysis of the *Grade 7 Via Africa* textbook and the Annual Teaching Plan (ATP) confirmed that the use of IK is limited as it is only included in "processing/bias in and impact of technology". TT1S3 confirmed this by stating: *"Learners are only taught about indigenous technologies when they are taught about properties of materials which can be used to make shelters in rural areas. IK is treated unfairly in the CAPS document."* The participants also criticised the CAPS for its vagueness with regard to indigenous skills such as weaving, carving, food processing, moulding, reinforcing and clay modelling, which are used by indigenous experts to solve problems in their communities. This is reflected quite well in THS1's response: *"CAPS document does not specify which indigenous skills to be attained in Technology subject. CAPS document has just included one topic to represent IK".* It appears as if it is up to Technology teachers to decide which IK content can be included in the teaching of design skills, which may be why they do not make an effort to ensure such integration.

This finding revealed that IK is marginalised in the CAPS and in Technology textbooks. The analysis of Grade 7 Platinum textbook showed that indigenous technology is included only in Term four, which is not sufficient. The participants suggested that the inclusion of indigenous design skills should also be found in the core content areas of Technology subject in order to make learning meaningful to all learners throughout the year. TT2S1 stated that: *"…indigenous design skills should also be included in the CAPS and Technology textbooks in order to help Technology teachers to integrate them".*

5.2.2.3 The relevance of design skills to the learners' cultural world
The participants believed that it is important that the content of design skills be related to the real-life world of the learners. According to them, Technology teachers should be conversant with the cultural world of their learners in order to be able to create scenarios that are related to the learners' daily lives. Learning that is relevant to the learners' cultural world can make

learning an enjoyable experience. Consider the following responses in this regard: *"Sir, I prefer to learn things which are related to what I know"* (TL4S1), and *"You know, when teachers give us examples which we know, we can understand a concept better"* (TL2S2). The participants indicated that Technology learners should be taught to solve real problems that are experienced in their communities. THS3 stated: *"Technology teachers should teach their learners to design products which are targeting consumers' culture in their communities in order to be acceptable."* This suggests that Technology teachers should teach their learners to design products that are culturally acceptable to users. TT2S3 provided an example: *"When one makes a hoe stick for ploughing it should not be heavy as it is commonly used by old people with less strength."*

5.2.2.4 Integration of IK in design skills content

The participating teachers indicated that they had attempted to integrate IK in teaching design skills in their lessons. TT2S1 stated: *"I have integrated IK in the teaching of investigation skills in the past. The learners were given a project of making a technological product. The learners were supposed to understand the skills used by indigenous experts to make products so that they can understand how to make a new product. I advised my learners to interview elders who are expert in indigenous knowledge."* TT1S2 said: *"Technology learners were requested to collect information in their communities. They were supposed to investigate how indigenous artifacts are made. They investigated shapes, colours, patterns, techniques and materials used by indigenous experts and investigated reason for using each one, for example why a material was preferred."* The above responses show that an understanding of techniques and materials used in local communities can facilitate learning in the subject Technology and can provide Technology learners with ideas about new ways of making artifacts. Indigenous experts have valid reasons for choosing a particular shape, technique or material for making a product. The learners' investigations should help them understand that they must have valid reasons for their decision to make a product in a certain way.

The findings revealed that Technology learners should be allowed to use their spontaneous thinking, which is based on their experience, and must be allowed to use their practical knowledge when writing a design brief. They should be able to explain how they plan to solve a problem identified in their community. According to TT1S1, *"Technology learners should*

provide reasons for choosing a particular technological solution", and TT2S3 stated: *"I teach my learners to consider the age of users in their communities. For example, if a mud house will be used by old people and children, it must have many steps to assist them to enter or exit the house."* The participating teachers also indicated that they teach their learners to design products using readily available resources, as indigenous experts do. Indigenous experts use environment-friendly materials. In this regard, THS1 said: *"Indigenous people use biodegradable materials such as clay soil which is cost free and readily available to make their products."* These findings oppose Mothwa's (2011:7) view that IK is cognitively less demanding than WK. It is surprising that Mothwa, an African scholar, should make a statement that negates the value of IK. In fact, from an explicit and experiential knowledge point of view, the making of indigenous products demands more thinking as one has to, among other things, be conversant with certain procedures in order to select appropriate materials, follow the correct steps and apply one's critical knowledge.

The participating teachers indicated that they integrated IK in teaching their learners about the skills required to make products. They believed that knowledge of the use of indigenous tools, such as smoothening stones, can help learners to design valuable artifacts in Technology classrooms. They suggested that learners should be allowed to bring indigenous tools and materials into Technology classrooms. They further explained that when they allow their learners to use indigenous tools, they easily grasp the skills taught in Technology classrooms for making products. Technology learners should also observe the same safety measures as those observed by elders when producing indigenous artifacts. TS1 stated that Technology learners who can use indigenous tools correctly can master making skills and work safely in Technology classrooms.

The participants further indicated that they believed that the indigenous ways of evaluating the functionality of products can assist learners to understand evaluation in Technology classrooms. For example, TT1S1 stated that Technology learners should be able to test a completed artifact to establish whether it serves the intended purpose. This can help them to improve its functionality. Indigenous experts evaluate their products before they offer them to consumers. The participating teachers also mentioned that they teach their learners about indigenous ways to evaluate new products. TT1S1 said: *"For example, after finishing to make*

a clay pot the indigenous experts can use it to cook a soft porridge in order to establish its strength. This can also help them to detect leakages before they recommend it for usage by consumers." The participants indicated that the projects should be evaluated against the specifications as noted in the proposal and expressed the opinion that indigenous ways of evaluation can help them to evaluate the products they make in the Technology classroom. However, TT1S3 stated: *"Technology learners who do not know indigenous ways of evaluating functionality of products do not value evaluation skills taught in Technology classrooms."*

5.2.2.5 Learners' reaction to the integration of IK

The participating learners pointed out that the inclusion of IK in teaching design skills can be conducive to learning as Technology learners show more interest when IK is integrated in teaching. This is confirmed by TL1S1's response: *"I enjoy Technology when my teacher includes indigenous technology."* TL4S2 substantiated this view by stating: *"The day I had a wonderful experience in learning Technology is when our Teacher explained the indigenous way of reinforcing frame structures to help us understand reinforcement in Technology."* These responses are an indication that the integration of IK can improve learners' concentration.

TT1S3 stated: *"I was very surprised that the first day when I integrated IK almost all my learners listened attentively. They really wanted to understand what I was explaining."* TL2S3 substantiated this view: *"Whenever our teacher mentions indigenous technology all of us want to know if it is related with the Technology that they teach us here in the school. It is so strange that even learners who always misbehave during learning periods they keep quiet when our teacher uses indigenous technology to demonstrate some skills."* The researcher probed the participants to explain why learners tend to concentrate more when IK is included in learning. The response was that *"the relationship between indigenous technology and western technology helps us to understand the Technology that we learn here in the school"* (TL2S2). The integration of IK also enhances interaction between teachers and learners. TT2S2 emphasised this point thus: *"Learners are always asking me questions when I include IK in my teaching, I think because they want to know more, become inquisitive."* The researcher's observation also confirmed this as learners constantly raised their hands to ask questions seeking clarity.

125

5.2.3 Teaching strategies

5.2.3.1 Methods for teaching design skills

The participants believed that Technology teachers should use a combination of teaching methods when teaching design skills as this could enhance the acquisition of those skills. According to THS2: *"It is not helpful to use only one method when you are teaching design skills. I think you know that learners are not the same. I do not believe in using one method when I am teaching design skills."* TT1S2 agreed by stating that the use of various teaching methods can help all learners in a Technology classroom to acquire design skills. The participants criticised the use of a one-size-fits-all method and recommended that Technology teachers should use different teaching methods. The most favoured methods and strategies for teaching design skills that were mentioned by participants included discovery, inquiry, cooperation, dialogue and brainstorming.

The participants understood discovery to be the opposite of rote learning. It can be used to promote active learning and learners can share what they know in order understand what they do not yet know. TT2S2 said: *"Technology teachers can use discovery teaching methods if they want learners to use their prior knowledge to make new meaning. For example, Technology learners can use their understanding of how the past problems were solved to understand how they can solve a current problem innovatively."* The participants indicated that teaching methods that encourage inquiry can be used to enhance learners' eagerness to learn more during the teaching of Technology. Technology teachers should provide their learners with opportunities to practise their investigative skills. Learners should be able to ask valid questions about the status quo and should seek to understand why things are done in a particular way. TS1 said: *"Technology learners should be able to enquire about the rationale behind the technological laws which were used to make different products; they can use their understanding of the existing technological laws to create new ones which can be used to solve technological problems."* To be able to do this, Technology learners should be taught how to investigate existing things with a view to creating new ones. They should also be able to work cooperatively to detect shortcomings in existing products in order to make the changes necessary to improve them.

In the light of the above, Technology teachers can use brainstorming to promote cooperation between their learners. They may put a question to the learners and ask them to discuss it in their groups and suggest different possible solutions. Individual learners should all be allowed to present their ideas to the group. In this regard, TT1S3 said: *"During brainstorming all ideas are important. All learners should be given an opportunity to generate their own individual ideas."* All ideas are important and should be respected. Brainstorming necessitates dialogue, which can promote creative thinking. According to the participants, Technology teachers could use dialogue to promote cooperation between learners. TT2S1 stated: *"In a dialogue, learners listen to each other in order to have common understanding which is meaningful to all learners."* Dialogue makes it possible for learners to consider different ideas in order to find the best one for solving a technological problem.

5.2.3.2 Relevance of CRP in promoting meaningful learning

The participants were concerned about the fact that many indigenous learners struggle to comprehend design skills and were of the opinion that the use of pedagogies that exclude the cultural experiences of learners may contribute to the poor performance of Technology learners, in particular those from indigenous communities. THS1 expressed this concern thus: *"It seems as it is so difficult for indigenous learners to understand western technology, which does not include what learners have learnt at home."* This was corroborated by TL2S1: *"I always understand Technology in my school if our teacher includes what my grandmother taught me at home."* The above comments show that a teaching method that takes the experiences of learners into account can help to heighten Technology learners' interest in the subject.

According to some of the participants, CRP may offer a lasting solution for many learners who struggle to comprehend design skills in Technology classes since indigenous learners experience enormous challenges in acquiring western design skills. These participants believed that this problem can be solved by teaching design skills with which learners are familiar in their socio-cultural contexts. For example, TS2 said: *"I believe that the usage of culturally relevant pedagogy may allow teachers to ensure that the cultural experiences of learners are reflected and honoured in teaching design skills."* The findings revealed that

127

participants were convinced that CRP can promote the inclusion of IK in the teaching of design skills.

The participants advised that Technology teachers should always acknowledge and show respect for the cultural experiences of their learners in order to enhance the learning of design skills. The inclusion of cultural experiences may inspire learners to learn. However, some participants had contradictory views. This is confirmed by TT2S3 response: *"To be honest with you I do not know a culturally relevant pedagogy and I do not think it can help learners to understand design skills. I am also not sure if that indigenous knowledge can help learners to acquire design skills."* TT1S3, who also confessed that he had never heard of CRP, stated that he always struggles to integrate IK but his learners understand design skills when he gives them familiar examples. He expressed the opinion that if teachers could be trained on CRP they would be able to teach from an indigenous perspective.

5.2.3.3 Transforming dominant design-make-evaluate method
The participants held the view that the current dominant design-make-evaluate method needs to be revisited in order to accommodate all learners. They advised that the people responsible for curriculum design should consider ways of approaching their task from the points of view of different cultures. P1S3 said: *"Hi Xitsonga vari ku na tindlela to tala to dlaya ximanga, leswi vulaka kuri kuna tindlela to tala leti nga tirhisiwaka ku fikelela xikongomelo xin'we"* (In Xitsonga we say there are many ways to kill a cat, which means there are many ways to achieve the same goal). The participants believed that curriculum design should make provision for learners from different cultural backgrounds.

Technology learners should be taught that cultural product can be made in many different ways, some of which have not yet been discovered. TT1S1 warned against relying on western ways of designing products only as *"our own elders have their own ways which are also effective in making quality products"*.

The participants indicated that knowledge of indigenous ways of designing might stimulate creative and critical thinking in learners. According to the participants, indigenous experts do not really follow 'prescribed' steps in the design process. P3S1 stated: *"There are no particular*

steps which are taught to be memorised by initiates. The novices are just allowed to observe the experts when designing new products". According to P2S3, the observers can practise designing new products according to their own understanding. The learners are not instructed to follow five design steps, i.e. investigate, design, make, evaluate and communicate, but are given the latitude to find new solutions by using their own steps. This can lead to the constant regeneration of the design process that is attuned to teaching Technology in indigenous contexts.

The participants also indicated that indigenous people learn to design through experience and only contemplate the steps they had followed after designing a product. P2S3 explained: *"We practise how to make products and from practice we acquire skills."* P3S1 concurred with P2S3 and said: *"In our design we learn by experimentation. We try out different ideas."* The findings showed that the indigenous people concentrate on experimentation rather than on the process. Technology learners should therefore be introduced to designing through experimentation. This shows that in indigenous contexts, designing is not formally taught, but develops through practice.

5.2.3.4 Indigenous artifacts for teaching design skills

Although some of the participating teachers had never used indigenous artifacts to teach design skills, they agreed that the use of indigenous artifacts could boost learners' design skills. However, they indicated that they were not keen to use indigenous artifacts due the stigma attached to them and commented: *"Do you know, sir, that many people believe that indigenous artifacts are for the people who are uncivilised?"*(TT2S1) and *"… if you teach using indigenous artifacts some people may make a joke of you, saying that you are teaching pagan things in a school"* (TT1S2).

Participants who had used indigenous artifacts in the past were positive about their use and stated that it has a tremendous positive effect on the teaching and learning of the subject Technology. In teaching learners about different indigenous structures, TT2S3 had used clay pots to demonstrate shell structures. According to this participant, the use of indigenous structures as teaching resources can help learners' understanding of the different types of structures. However, some participants indicated that the use of indigenous artifacts can be

hindered by factors such as the unavailability of indigenous artifacts in schools and teachers' inability to use concrete objects, particularly indigenous artifacts. There are teachers who can only rely on the textbook and teach abstractly, which does not promote quality learning in Technology. TS1 expressed the following concern: *"Some of our teachers are not able to use practical examples which are in the context of learners to teach Technology. This makes the Technology subject to appear like an abstract subject. This type of teaching makes Technology subject to be difficult subject in our schools."* Participants also indicated that Technology teachers should learn to teach Technology as a subject that combines theory and practice, and to use both western and indigenous artifacts to facilitate learning.

5.2.3.5 The use of the inquiry teaching approach to promote IK

The participants were of the opinion that inquiry teaching can play a pivotal role in promoting the inclusion of IK in the teaching of design skills. Through inquiry teaching, Technology learners can investigate problems and ways to solve them, e.g. by using indigenous skills and knowledge. Teachers could ask relevant question to stimulate learners' interest. TS1 indicated that the inquiry teaching method mainly seek to develop learners' investigative skills. TT1S1 stated: *"I use inquiry teaching methods if I want to stimulate my learners to learn things on their own. This method can enable my learners to understand products in their local communities".* Learners should be encouraged to investigate structures in their communities and gather information that can help them to make new technological products. For this the Technology learners should be taught how to gather information about the different properties of raw materials such as soil and trees.

The participants indicated that Technology learners should be inquisitive and should ask questions about things that puzzle them. They must be curious about things in the technological world and should ask questions in order to promote their understanding of different phenomena. TT1S1 said*: "I do not think that Technology learners should expect their teachers to spoon-feed them."* TT2S3 agreed and stated: *"Learners must not be provided with knowledge without thinking for themselves. They should not absorb knowledge in its current form without asking questions. For example, they should ask why certain indigenous materials are preferred to make a certain product, why certain indigenous techniques are used to make products*". According to these participants, learners who are eager to learn more are more

likely to know how to choose appropriate materials for making products. Technology learners should be challenged to investigate the materials used for making indigenous artifacts and to find out why those materials are preferred. In this regard, TT1S2 said: *"The learners should understand the reason(s) for using certain materials. The material may be chosen due to its availability or strength, or because it is environmentally friendly."* THS3 contributed the following: *"They can investigate a texture of an indigenous artifact and provide the reason for preferring that texture. If it is a spoon, a handle should be smooth so that it does not hurt hands when cooking*".

The inquiry teaching method will also help learners to retain the knowledge and skills that they have acquired. According to TT2S3, *"it is not easy to forget something that you have chosen to study"*. TS1 agreed, stating that he remembered most of the things he had been eager to understand.

5.2.3.6 The use of the discovery teaching approach to promote IK
The findings based on this research indicate that discovery teaching can promote the integration of IK in the teaching of design skills. According to the participants, Technology learners can use IK to understand new problems dealt with in Technology classrooms. TT2S1 said: *"The learners' knowledge of indigenous technology can help them to understand that technology can be manifested in different forms."* P1S1 concurred with TT2S1 by stating that *"in our communities we have different types of technology, such as food, pottery, baskets and clothing technology".* This knowledge can help learners to understand the type of technology taught in Technology classrooms. IK can help Technology learners to find out new ways of solving problems by using indigenous techniques. THS2 stated that when the discovery method is used, learners are able to try new ways of doing things and designing new product by using their prior knowledge such as IK.

The participants indicated that in discovery teaching methods learners are provided with minimal guidance and are allowed to use their IK, which they acquired at home, to solve technological problems. They can be provided with basic knowledge only, which will enable them to discover new things. According to the participants, learners can use the trial and error method to make discoveries while dealing with any new problems they might face. Problems

are not always similar and learners can use their IK as a starting point for solving new technological problems. Technology learners should be able to recognise the advantages and disadvantages of their initial ideas. With regard to this, TT1S1 said: *"The advantages and disadvantages of initial ideas should be based on learners' IK."*

Technology teachers should guide learners on how to study a given scenario to detect a problem on their own without being given any clues. With reference to this requirement, TT2S2 said: *"Technology learners should not be told what product to make, they must use their creative and critical thinking skills to find out what they can make individually."* The classroom observations revealed that the learners in the participating schools were all given similar projects, which means that they were told what product to make. This suggests that Technology teachers do not encourage creativity in their learners. While Technology teachers may guide learners on how to write a design brief, learners' must take responsibility for writing their own individual design briefs, which must contain brief explanations of how they intend to solve the problems they have identified. They draw from IK to either improve an existing design or produce a new one.

5.2.4 Learning strategies
5.2.4.1 The use of experiential learning strategy to promote IK

The findings revealed that experiential learning can be used in the teaching of design skill to relate learning to the learners' contexts. The participating teachers described experiential learning as learning that allows learners to learn outside their classrooms. TT1S3 stated that experiential learning is learning that takes place in the real world. According to TT2S1, experiential learning occurs when teachers take learners outside the classroom to experience real situations. It can occur in different settings, such as a laboratory, a place of work (factory), a library or a home. Learners are taught by allowing them to observe a phenomenon in reality. This kind of learning is crucial in Technology, which is mostly a practical subject. Seeing how certain products are actually made can help learners to acquire the necessary making skills. P3S2 recommended that learners should visit their elders to see how they produce indigenous artifacts. The above findings contradict Lundgren's (2006:764) assertion that technological knowledge is knowledge that is taught only in workshops. Technology learners do not have to be taken to a conventional industrial environment only. Given that teaching in indigenous

settings happens spontaneously and mostly in an open environment, the idea of confining technology to the conventional industrial environment is a blunder that denies the vibrancy of IK.

The learners can have first-hand experience of making products, which will help them to understand different processing techniques such as welding, grinding, sawing and moulding. P1S1 remarked: *"Our children may learn a lot from us. They can observe us when we are engaged in manufacturing activities."* TS2 agreed with P1S1 and stating that learners can learn the skill of moulding by observing their elders while they are making bricks from mud to build a house. They can acquire indigenous processing techniques at home and apply them at school. This type of learning, which connects formal learning to learning outside the classroom can inspire learners to learn. According to THS1*, "experiential learning can motivate learners to use their design skills in Technology classroom".* Technology teachers should avoid teaching only abstract concepts as Technology is a practical subject. The abstract teaching of technological concepts may result in learners memorising learning content without understanding, which is detrimental to learning. The participant indicated that if you teach learners technological concepts that are related to what they know, you promote understanding.

The participants indicated that in order to retain knowledge longer, learners should gain a thorough understanding of technological concepts and should also be able to apply their knowledge in real-world situations. In the subject Technology, learners should learn by doing. TT2S2 expressed the following opinion: *"You cannot say you are teaching Technology if you are only relying on the textbooks and curriculum policies. Sometimes learners should be taken outside their classrooms in order to see and practice how products are made in reality"* and *"Experience can be a good teacher in Technology subject. Technology learners should be given a chance to learn by seeing and doing."* Learning by doing enables Technology learners to solve problems, and the participants believed that experiential learning is the key to enabling learners to solve real problems in their communities. They also pointed out that when teaching, Technology teachers should use examples with which their learners are familiar. This idea was expressed as follows by TT1S1: *"Do you know that good teaching should start from known to*

unknown. If Technology teachers can always start by reminding their learners about familiar things, learning can be successful."

It was further suggested that Technology learners should use role-play activities to practise what they have seen in the field. TT2S1 said: *"I believe that practise makes perfect. If learners can be given a chance to practise the indigenous skills from their communities, they will master them and ultimately they will be able to understand design skills which we teach in Technology".* Technology learners should be afforded opportunities to observe indigenous experts while they are making products and should then practise duplicating what they have seen. The participants believed that if they keep on practising those skills, learners will eventually be able to master the design skills taught in their Technology classrooms.

5.2.4.2 The use of the cooperative learning strategy to promote the co-creation of knowledge
This study revealed that Technology teachers can use the cooperative learning strategy to teach learners to co-construct knowledge. The participants indicated that Technology learners should learn to work together in groups to solve technological problems and achieve learning goals, which could be advantageous to all the group members. Cooperative learning can also help learners to acquire social skills. They felt that Ubuntu can play a pivotal role in teaching learners to work together in order to co-create knowledge in Technology. P3S3 said: *"You know, our local community is rich with values which can be reinforced in schools. We possess Ubuntu principles which we teach our learners at home."* P2S1 shared similar views about Ubuntu: *"The following Ubuntu principles may help our children to work together: teamwork, solidarity, sharing and respect".* According to the participants, the principles of Ubuntu can be used as a catalyst to promote cooperative learning in Technology classrooms.

The observations showed that working together in groups promotes the development of higher-order thinking skills, such as critical thinking skills. The learners can discuss their different interpretations of technological concepts, which will challenge them to think deeply. This may encourage them to create new knowledge in their groups. According to TT1S2: *"When learners are challenged to solve a technological problem, they may discuss about the existing technological laws. They may end up co-creating new technological laws which will help in designing new products."* Technology learners should not rely on existing knowledge

only, but should be challenged to develop higher-order thinking skills through involvement in group work.

According to the participants, learners who work in groups perform better than those working on their own. In a teamwork, learners who are intellectually more advanced can help those with learning difficulties. It was observed that all learners can learn something from each other. In this regard, TS2 remarked: *"… average learners can also teach the group members something."* Technology learners should therefore always strive to have a symbiotic relationship with each other. The participants indicated that it is very important to promote the spirit of teamwork by guiding learners. THS2 said: *"In order to ensure that learners cooperate well in their groups in the beginning of each year I tell my learners that each one of you is very important in your groups. There is no any learner who is better than other learners. I tell my learners that each idea is very important when they are engaged with a particular task."* Technology learners should learn to respect the ideas of other learners in their groups, particularly during brainstorming sessions.

The learners should not undermine each other so as to allow different ideas to emerge. P2S2 said: *"Our children should be taught to respect indigenous knowledge in their classes. My child once told me that his classmates laughed at him when he suggested that some problems may be solved by using indigenous ways."* The participants felt that Technology learners should never discourage the use of IK and should learn to accommodate each other in their groups. The participants indicated that learners working together in groups and respecting the different views of other learners may be more successful in solving technological problems than those who work alone. TL4S1 said: *"You know sir, when we work in groups with other learners, we challenge each other to think. We are able to have better technological solutions than when I am working alone".* TL3S2 concurred with TL4S1 and stated: *"When we use different knowledge systems, we learn from each other and the solution is better than when I am working alone."* Teamwork can be beneficial to all the learners in a group as it helps them to generate many different ideas that can be considered to find the best idea for solving a technological problem.

5.2.5 Assessment strategies

5.2.5.1 Assessment methods for the development of design skills from indigenous perspectives

The participants felt that Technology teachers should refrain from using only one assessment method when assessing design skills as this may prevent learners from demonstrating their understanding of design skills and emphasised the vital importance of ensuring that assessment caters for learners with different abilities. The use of only one assessment method can be detrimental to learning. TS3 said: *"I think, you know, sir, that learners are not the same, some learners are shy to talk in class, when a teacher uses only oral presentations those learners will fail dismally. They will not fail because they have not mastered the concept which was taught, but they will fail because they are not familiar with the assessment method which was used."* THS3 pointed out that *"some learners are good in oral presentations and poor in writing, whereas some are good in writing and poor in oral presentations".* This suggests that Technology teachers should know which assessment method is most appropriate for each learner and should not use the same assessment method for the entire class. According to TT1S3, the use of various assessment methods allows all learners to demonstrate their design skills from different perspectives. They can also answer questions according to their indigenous perspectives. The participants mentioned a range of assessment methods that Technology teachers could use to include IK, namely tests, examinations, projects, performance assessment, individual conferences, dialogues and oral presentations.

a) Projects

Several participants indicated that the best way to allow learners to use their indigenous knowledge is to give them projects that require them to solve technological problems in their indigenous milieu. Such projects can help learners to use a variety of the skills they have acquired, including indigenous skills. The participants regarded a project as a good assessment method to integrate IK. Projects may not limit learners to use only WK, which dominates in Technology classrooms. Learners are free to use all the knowledge and skills at their disposal. This was confirmed by TT1S3, who said: *"When I give my learners a project, I do not restrict them to use only western knowledge or skills. I tell them that they can use whatever knowledge and skills which they possess to solve a given problem."* The participants believed that a project can create a platform for learners to work independently.

b) Oral presentations

According to the findings, the written assessment may disadvantage some learners who possess knowledge not known to the teacher. Teachers can give learners poor marks because they do not understand the knowledge or skills used by the learners. TL1S2 said: *"Sometimes teachers mark us wrong when we answer questions using our indigenous knowledge and we feel demoralised".* Learners can therefore be negatively affected if teachers assess their written work without understanding the knowledge on which it was based. Oral presentations may give learners a chance to clarify their answers.

The participating teachers also indicated that they use oral presentations to accommodate learners who are not shy to speak in front of other learners. Such learners may be asked to act as spokespersons for their groups during cooperative learning. Those who are shy may be given other roles, such as scribes, time-keepers and chairpersons. Oral presentations may be used to allow learners to explain the steps they followed to make their products. TT2S2 said: *"Learners are not the same and they will never be the same. When I assess learners in their group work, I give them roles according to their potential."*

c) Dialogue

The majority of participants indicated that they use dialogue to allow learners to freely express their views. Dialogue can stimulate Technology learners to use and refine their IK and skills, and can be used to promote creative thinking skills. The classroom observations revealed that learners generated different ideas when they were involved in a dialogue and were able to defend their use of IK and skills. TT1S1 said: *"I allow dialogue so that my learners can explain why they think that a particular skill or knowledge is valid in Technology subject."* Klapwijk (2009:8) seems to be unaware of the use of dialogue in classrooms as he states that although teachers ask learners questions, one can hardly speak of mutual dialogue. The current study found that Technology teachers use dialogue to encourage learners to think. The participants indicated that any knowledge should be questioned and debated, and if knowledge is found to be lacking, it should be developed.

d) Performance assessment

During performance assessment, Technology learners are allowed to do practical work in class. The teacher observes and assesses the learners while they are working and demonstrating the skills and knowledge they have acquired. The observations revealed that Technology teachers encourage their learners to use different knowledge systems. The participating teachers indicated that they allow their Technology learners to use any knowledge and skills when making a model. In this regard, TS2 said: *"Demonstration is the best assessment as learners are able to show the skills and the knowledge they possess."* The participants regretted the fact that many children are embarrassed to use IK and prefer to use only western skills and knowledge. TT2S3 said: *"Technology teachers should always encourage learners during performance assessment to use knowledges and skills that they are acquainted with in order to excel and get higher marks."* The participants indicated that Technology teachers can assess the design skills demonstrated by learners by using rubrics that are suitable for the assessment of design-related skills, regardless of whether they are western or indigenous.

e) Individual conferences

The participating teachers indicated that they prefer to use individual conferences to help learners who perform poorly in design skills content and to correct their misperceptions. They said that they coach learners to use all the knowledge that they possess. TT2S1 explained: *"During individual conferences I tell my learners to use any knowledge which can help them to understand a technological concept that I am teaching them."* The participants indicated that they emphasise that all knowledge systems are important and that no knowledge system is inferior to another. TT1S2 stated: *"I tell my learners that they should not be afraid to use even indigenous knowledge when they are acquiring new design skills. Some learners think that indigenous knowledge is inferior to western knowledge, hence individual conferences may be used to boost their self-esteem to use all knowledge systems."* However, some participants indicated that individual conferences are often difficult to manage due to overcrowding and time constraints. TT2S3 emphasised this point: *"In the morning learners are not punctual, during break time they want to have enough time to eat and after school teachers attend workshops. We have many learners who need individual conferences."* According to this participant, Technology teachers are willing to conduct individual conferences, but due to practical issues they are not able to do so.

5.2.5.2 Learners' reaction to assessment tasks that integrate IK

The findings revealed that assessment tasks that integrate IK help to improve learners' performance. The participants recommended that Technology teachers should also include IK in the assessment of design skills. TT1S2 stated that Technology learners should be given investigative tasks to encourage them to explore indigenous ways of making products. TT1S3 concurred with TT1S2 by stating that, to improve learners' performance in Technology, *"The indigenous ways of making products should also be recognised as valid and therefore should be awarded marks."* The observations revealed that when learners were required to answer questions relating to their IK, they were quick to respond.

The question papers that were analysed showed that Technology teachers relied more on closed-ended questions that required only one answer. However, the participants were of the opinion that subjective marking would be better as it would promote the use of different knowledge systems. TT2S1 explained: *"Subjective marking can enable learners to use different prior knowledges that they possess which ultimately will improve the performance of learners. Subjective marking can allow divergent ideas to emerge during design."* The participants therefore believed that subjective marking, which takes learners' personal opinions into account, can help them to obtain higher marks.

The participants mentioned that by taking learners' cultures into account when assessing their work, Technology teachers can help them to improve their performance. THS1 said: *"Accepting learners' culture can help learners to use whatever prior knowledge at their disposal. This will stimulate learners to use indigenous knowledge and skills in answering questions."* According to this participant, when Technology teachers accept their learners' culture they will boost the learners' confidence to use IK for future assessments. The temporary shelter shown in Figure 5.21 below shows that learners used IK to join different parts.

Figure 5.21: Temporary shelter

The analysis of the mark lists showed that Technology learners performed well in the project that required them to make a temporary shelter by using their prior knowledge. The majority of learners were able to use IK and skills for this project. Technology learners were also able to use readily available materials, such as mealie meal bags and wire.

5.2.6 More knowledgeable others (MKOs)

5.2.6.1 Role of indigenous experts in teaching design skills

Several participants indicated that although they had never invited indigenous members to come and demonstrate their technological knowledge, they believed that indigenous elders, whose knowledge they respected, could help their learners to acquire certain practical skills. TT1S1 said: *"I understand that our indigenous elders are knowledgeable, they possess a lot of knowledge through experience."* These participants stated that they were willing to invite them to teach the learners, but were afraid that they might expect to be compensated. TT1S2 confirmed this concern by stating: *"Who will pay them if they can demand some payment. I do not think it is a right thing to ask someone to come and work for nothing; they must be compensated".* They seemed to have forgotten about the potential of Ubuntu and the possibility that some elders might be prepared to help for free.

Only three participants indicated that they had invited community members to visit their classrooms and stated that the elders had been able to demonstrate their knowledge and skills in the Technology classrooms. They emphasised the relevance of the knowledge of the indigenous elders in the teaching of design skills. According to these participants, the elders

140

taught the learners practical skills that can support them in the execution of the design skills that are taught in the Technology class. TT2S1 reported: *"You know on that day my learners have learnt a lot of practical skills, I was not expecting that. Hey! You must never undermine the elders in our community."* It is evident that these participants believed that indigenous elders can make an important contribution to education in Technology classrooms.

The participants who had invited members of the indigenous community indicated that this was done when they were teaching the learners about making technological artifacts as they felt that the elders' expertise would make a valuable contribution to their own teaching. TT1S1 stated: *"I know that the indigenous elders are good in making because I always see the products that they have made with their hands"*. TT1S2 said: *"I sometimes buy indigenous artifacts; their artifacts are beautiful and user friendly. You can really see that they possess making skills."* It is evident that the elders were invited because the teachers knew that they were skilled in making artifacts and trusted them.

5.2.6.2 Indigenous ways of teaching design skills

This study revealed that indigenous experts use scaffolding strategy to teach novices new skills. The majority of participants who had invited indigenous experts indicated that they were scaffolding the making skills during their lesson presentation. TT2S1 explained that the indigenous elders showed the learners how to use indigenous skills to make indigenous artifacts: *"The elderly expert was showing learners how to hold and use tools to make a wooden plate. He started by explaining that learners should take precaution measures before they start using tools to make any product. He showed them how to handle an axe and how to cut a wood. The learners were given an opportunity to practice cutting a wood with the support of the elderly expert. The learners were showed how to use an iron scoop to make a hollow in a bowl and the learners practised that with the supervision of an elderly expert. Finally, the learners were shown how to use an adze for shaping and sandpaper for smoothening the wooden bowl. At the end of his lesson learners were afforded an opportunity to make a bowl on their own without any assistance of indigenous expert and surprisingly all the learners were able to make a wooden bowl."*

The participants suggested that Technology teachers should also learn how to teach indigenous design skills and should guide their learners during design activities. They believed that Technology teachers can learn from the practical way in which the elders taught, for instance by demonstrating how tools should be used. Technology teachers should teach learners by showing them so that they can acquire practical experience. Practical teaching can accommodate learners with different learning capabilities.

5.3 DISCUSSION OF FINDINGS

In this section the findings pertaining to the six main themes will be discussed. These themes are: the value of IK in teaching design skills; IK as content; teaching strategies; learning strategies; assessment strategies; and the role of more knowledgeable others (MKOs).

5.3.1 The value of IK in teaching design skills

The findings confirmed that IK is actively employed in South African indigenous communities, even though it is treated by some as inferior to western knowledge. IK is practical knowledge that is effectively used to solve problems in indigenous communities, as sufficiently attested to by the findings of this study. According to Lodhi and Mikulecky (2010:94), indigenous people use practical skills acquired through observation and experience to solve technological problems. The study established that IK is valuable in the lives of indigenous people as they depend on the availability of indigenous artifacts to meet their needs. Indigenous experts use both conceptual and procedural knowledge to make products designed to solve problems. It transpired from this study that IK is developed through observation and experimentation. This finding is consistent with the view of Lodhi and Mikulecky (2010:94), who state that IK is the accumulation of practical experiences and is learnt through experience or acquired by observation.

The findings revealed that IK is evident in different creative activities, such as pottery, sculpting, weaving and building, and in the preparation of medicine and food. Kagoda (2009:117) states that a variety of local knowledge and technology is found in each cultural group. The indigenous artifacts discussed in the findings attest to the wealth of IK and skills demonstrated by indigenous people. The indigenous people rely on tacit and explicit indigenous knowledge for making their products. In support of the above, participant TS2

stated that products are not made accidentally, and indigenous people cannot make products without any knowledge and skills. Ankiewicz et al. (2000:19) agree that invention is not a simple trial-and-error process undertaken without a knowledge base. The researcher is of the view that IK can make an important contribution to the teaching and learning of Technology and that learners should acquire both tacit and explicit indigenous knowledge in order to be able to design artifacts that are informed by their contexts.

This study established that indigenous communities have a wide variety of indigenous designs in the form of wooden spoons, stirrers, clay pots, mortars and pestles, calabashes, conical baskets, sleeping mats and winnowing baskets, among others. The current use of some of these products in many households prove that they are not obsolete, as many claim.

This study found that indigenous experts possess skills that enable them to manufacture new products. According to De Vries (2016:48), a combination of procedural knowledge and conceptual knowledge is always necessary in order to solve a design problem. Various skills that can be learnt from indigenous technological designs include reinforcing, food processing, weaving, measuring, mixing, moulding (pottery) and finishing, and many other practical skills such as sawing, carving, joining and sanding. The findings of this study and the literature consulted agree that IK can be useful in aiding the teaching and learning of design skills in the Technology classroom. Indigenous or prior knowledge can be applied when learners learn design skills. According to Bryant (2010:25), constructivism utilises learners' prior experiences and perspectives for the self-construction of learning. This study found that the indigenous skills with which learners are familiar can assist them with their acquisition of new design skills embedded in IK. Hence, the synergy that exists between indigenous skills and design skills can promote learners' understanding of the design skills taught in the Technology classroom. De Beer and Mothwa (2013:453) concede that the rich IK and cultural practices can help to improve learning.

The researcher's observations revealed that IK can make learning more meaningful to Technology learners who are being taught design skills. This means that when learning is related to the daily lives of learners, they will see the value of IK as it is applied in their communities. This study also established that IK is valuable as it can help learners to use

resources that are readily available in their environment to make models. This finding is supported by Gray and Macblain (2012:21), who state that young children's experiences are of great immediate value in that they affect future experiences and learning. Based on the researcher's observations and the participants' responses, it can be concluded that IK is valuable as it can assist learners with the acquisition of design skills.

5.3.2 IK as content

Although the document analysis and interviews revealed that the Department of Basic Education has attempted to integrate IK in CAPS in TE, this study found that the CAPS is not at all clear about the inclusion of IK content to promote the acquisition of design skills. The document analysis revealed that the integration of IK with a view to promote design skills is very minimal and is mentioned only rarely, for example as part of the third learning outcome. According to Gumbo (2018:136), the CAPS does not give serious attention to indigenous technology and it is also not correctly explained. Mothwa (2011:8) states that the official curriculum and policy documents provide very little guidance to teachers on how IK could be taught in a technologically sound manner. Western knowledge is prioritised in the teaching and learning of Technology and the integration of the IK content is often frowned upon. The CAPS and Technology textbooks do provide teachers with guidance regarding the indigenous content that can be taught to learners in different grades. Such guidance should be provided through pre-service and continuous professional development.

This study revealed that the most important indigenous skills that can assist learners in the acquisition of design skills are excluded. The CAPS should be revised to acknowledge indigenous design skills such as weaving, curving, food processing, moulding, reinforcing and clay modelling skills. This, by implication, suggests that the content should also be reviewed. Indigenous skills are commonly used by indigenous experts to make products in order to meet the needs of indigenous people. Pete et al. (2013:105) suggest that Technology teachers should include indigenous ways of knowing in their curriculum choices to enrich their teaching practice. Technology learners could have IK and skills acquired through observing their elders. Such knowledge and skills can enrich their design ability. Hamilton-Ekeke and Dorgu (2015:35) agree that the inclusion of IK in teaching often enhances the effectiveness of teaching and learning for indigenous learners and teachers.

The findings suggest that the design skills taught in Technology should be relevant to the daily lives of learners, in other words, they should be related to their socio-cultural world or their experiences in their communities. The content of design skills should also be geared towards teaching learners to make products that are acceptable to their communities. It transpired from the findings of this study and related literature review that Technology learners should consider the culture of indigenous people when they make their prototypes. According to Purao and Wu (2013:2), designers should design products that add value to society. Moalosi et al. (2010:186) agree that products can be successfully marketed only if they resonate with the users' values, attitudes and behaviour. This implies that Technology learners should be aware of the values of indigenous people in order to be able to make products that are acceptable to them. The design skills content should therefore also include the values of indigenous people. The participants indicated that products that are not culture driven are not always appreciated in some communities.

The findings of this study and the literature review indicated that Technology learners should not only rely on western sources of information, such as libraries and factories, but should also investigate ways of making indigenous artifacts by consulting indigenous sources. This can be done by interviewing elders and studying indigenous artifacts in order to understand how they were made. This will help Technology learners to plan their designs to meet existing needs in their cultural contexts.

It is evident from the findings that the design skills content should include information on the environment-friendly materials used by indigenous people. Since indigenous people live in harmony with the natural environment and have a spiritual connection with it, their designs take into account the careful manipulation of the physical environment. This research has indicated that Technology learners should be taught how to use indigenous tools to master indigenous skills, and should also be taught the precautionary measures applied by indigenous experts to prevent injuries.

This study further established that Technology learners respond positively and pay attention when teachers integrate IK in the teaching of design skills. The observations revealed that the

integration of IK can stimulate learners' interest and encourage learning. This finding is supported by the finding of Singh and Reyhner (2013:38), who found that if a one-size-fits-all curriculum that leaves out too much of the learners' world and culture is implemented, learners will struggle to connect with the learning content. The interviews and observations revealed that the integration of IK can promote active learning, which will ultimately enhance the acquisition of design skills.

5.3.3 Teaching strategies

The use of different teaching methods in the teaching of design skills is beneficial to all learners. However, the methods used should be varied to accommodate learners from different backgrounds. Technology teachers should therefore be exposed to varied methods to avoid clinging to one conventional method when teaching design skills as this can disadvantage learners who do not understand that. Pedagogies that are removed from the experiences of learners may negatively affect their academic performance. According to Biraimah (2016:52), it is anticipated that when the learners' school cultures and curriculum, and their teachers' pedagogy are built upon their own culture, marginalised learners' achievements will skyrocket. Singh and Reyhner (2013:38) confirm that when the culture of the school is too different from the home cultures of indigenous learners, they face severe identity issues and learning difficulties.

The findings also show that Technology learners sometimes do not understand Technology lessons that do not integrate their indigenous knowledge, which suggests that Technology teachers should use pedagogies that allow them to include IK with which the learners are familiar. CRP is singled out as the most relevant method for including IK that will enable learners to acquire design skills that resonate well with their environments. According to Howard (2003:2), CRP is situated in a framework that recognises the rich and varied cultural wealth, knowledge and skills that diverse learners bring to school. The current study revealed that the CRP can be used as a vehicle for teaching learners in their socio-cultural contexts in order to promote the smooth acquisition of design skills. The findings are consistent with those of Biraimah (2016:52), who states that culturally relevant teaching insists that all learners will achieve greater educational outcomes when teaching includes and reflects their own cultural experiences. Technology teachers can use CRP to include the customs, traditions and beliefs

146

of all the learners for the benefit of indigenous learners. In similar vein, Moalosi et al. (2007:5) state that people are cultural beings and the process of integrating cultural factors in their practices should be emphasised. Technology teachers should therefore use CRP to ensure that the cultural experiences of learners are reflected when they teach design skills. The learners can acquire design skills when their cultural experiences are included in learning. Veak (2000:228) argues that technology cannot be separated from its cultural context.

One of the problems experienced with the use of CRP is a lack of knowledge. This study showed that certain teachers struggled with the use of CRP due to their lack of relevant knowledge, which resulted in negative attitudes towards CRP and IK. They believed that IK is useless and did not advocate its use to assist the incorporation of IK in the teaching of design skills. However, it is a fact that an understanding of IK and CRP can help teachers to develop a positive attitude towards the inclusion of IK by using CRP. Venter (2004:157) suggests that teachers in South Africa should be encouraged and assisted to broaden their cultural perspectives in their practice.

This study established that the current dominant design-make-evaluate method needs to be overhauled in order to accommodate all learners in Technology classrooms. De Vries (1996:12) advises that Technology teachers should avoid the naive use of generalist design prescriptions. The findings based on the interviews show that there are alternate ways of promoting the acquisition of design skills, such as the use of CRPs. The participants believed that indigenous ways of design should be acknowledged as they can facilitate the acquisition of design skills. Dyson (2002:188) elaborates that indigenous people learn by trial and error. This study revealed that indigenous people start by designing a product before establishing the steps that should be followed, they learn through experience. Nostrom (2014:11) states that non-scientific, experience-based knowledge can be justified by repeated successful use, and Lodhi and Mikulecky (2010:94) explain that indigenous people use practical experience, acquired through observation, to solve technological problems. The findings also support Dyson's (2002:188) claim that the learner gradually comes closer to the ideal through a series of increasingly refined approximations, unguided by teacher corrections. Indigenous people use a trial-and-error method to establish new ways of making new products, whereas in the Technology classroom learners are taught the technological design steps first, and thereafter

practise following them. When learners learn by using the trial-and-error method, they may generate new ideas, which can cause spontaneous thinking to thrive when they solve technological problems.

The study revealed that knowledge of indigenous artifacts can inspire learners to acquire design skills. However, the use of indigenous artifacts may be hindered by a negative attitude towards IK. The interviews and observations revealed that indigenous learners in the Technology classroom understand lessons in design skills better when their teachers use indigenous artifacts as teaching aids. A lack of indigenous artifacts in schools and the inability of teachers to use concrete objects in the teaching of design skills can hinder their use as teaching aids. The researcher is of the view that Technology teachers should move away from teaching Technology from the abstract to the concrete. They must be able to teach Technology the other way around as it involves minds-on and hands-on activities. This study found that Technology teachers should be taught to use both indigenous and western artifacts as teaching aids in order to help all the learners in their classrooms. This supports Gumbo's (2016:105) idea that the curriculum should also include indigenous perspectives in order to accommodate indigenous learners, instead of embracing only western perspectives.

This study found that the inquiry method of teaching, which involves the use of investigative skills, can play a crucial role in promoting the integration of IK for the acquisition of design skills. Technology learners can develop their investigative skills by investigating the skills and knowledge used by indigenous experts to make their products. Fraser (2006:16) posits that a more formal understanding of the subject matter should be built on the learners' conceptions of the world around them.

Technology teachers can use the inquiry method by asking learners to investigate the indigenous materials and techniques they will use to make their products. Rutland (2009:58) agrees that designing explores how products were developed in the past, are currently being developed and will possibly be developed in the future, and learners are expected to study the designs of others to inform their own. This study found that indigenous learners are curious about IK and the skills used to make indigenous artifacts. It is evident from the findings that learners retain knowledge and skills longer if their learning had been inspired by curiosity.

According to Green (2010:137), it is much easier to recall things that fit within one's schema as they are easier to retrieve.

Participants believed that the discovery teaching approach can be used to incorporate IK in the teaching of design skills. Technology teachers can use discovery to allow learners to use their prior knowledge to understand and solve new technological problems. According to Ankiewicz and De Swardt (2001:24), discovery learning takes place when learners are not presented with subject matter in its final form, but are required to design and organise it themselves. An understanding of existing indigenous technology can help Technology learners to understand how they can solve technological problems in an innovative way. According to Esjeholm (2015:228), learners working in Technology classrooms are supposed to be creative and to design novel artifacts. This study found that Technology learners should be provided with minimal guidance about IK so that they themselves can collect relevant data that will enable them to create new designs for solving the identified problems. Weegar and Pacis (2012:6) advise that the primary role of teachers should be to motivate learners to construct their own knowledge through their personal experiences. Technology learners can use IK as prior knowledge to determine the advantages and disadvantages of their initial ideas.

5.3.4 Learning strategies

From the findings discussed thus far, it is evident that as experiential learning allows learners to learn outside classrooms, it can be used to incorporate IK in the teaching of design skills. Since learners can learn at home, experiential learning allows them to acquire knowledge and skills from their elders. Sears (2003:10) proposes that learning should take place at different sites or in multiple contexts, and not only in classrooms. This finding is in line with Lemus et al.'s (2014:9) claim that learners' evaluations are strongly supportive of the cultural field trip. This study suggests that Technology learners should visit their elders to learn more about the various skills they use to make artifacts.

Technology learners should not rely only on the skills and knowledge taught in their classrooms, but must understand that some things learnt outside classrooms may be helpful when they design new products. The Department of Basic Education (2011:12) state that Technology learners must be able to identify and explain a problem or opportunity from a given

real-life context. Experiential learning can be used to help learners to learn by observing and practising skills outside their classrooms. In support of the above, Weegar and Pacis (2012:7) state that learning activities in constructivist settings are characterised by active engagement, inquiry, problem solving and collaboration with others. Technology learners may acquire design skills through interacting with real objects outside their classrooms.

This study revealed that Technology learners can use ubuntu principles to promote cooperative learning. According to De Beer and Mothwa (2013:453), the rich IK and cultural practices in many areas in the country provide learners with a good entry point into learning. The learners should be taught to understand the principles of ubuntu, which can help them to work together when they design products in Technology classrooms. According to Powell and Kalina (2009:243), social constructivism is based on the social interactions of learners in the classroom, which can promote critical thinking. Cushner et al. (2003:285) agree that teachers play a critical role in helping learners to understand and develop the skills needed to live cooperatively and comfortably with others.

This study revealed that Technology learners can work together to identify and solve technological problems in a symbiotic relationship. They should respect each other's ideas and work together to achieve a common goal. They should also respect indigenous ways of designing products in order for cooperative learning to thrive. Schiele (1994:158) posits that the role of the learner should be that of a cooperative learner who is concerned with the collective survival of the class. Ankiewicz and De Swardt (2001:86) also maintain that Technology is cooperative in nature and requires collaboration to achieve a goal. Technology teachers should teach learners to understand that all learners are equal and every idea is significant. Jordan et al. (2008:59) conceive that interacting with teachers should allow learners to help each other. When learners work together they can help each other, and cooperative learning that acknowledges different knowledge systems can lead to the creation of designs that can solve technological problems.

5.3.5 Assessment strategies

The study found that the use of only one assessment method can have a negative impact on learners' performance. Technology teachers should use culturally responsive assessments to

ensure that learners with different abilities are catered for. According to Stevens (2012:6), culturally responsive formal assessment is an ongoing day-by-day form of assessment that builds on the learner's knowledge. Technology learners should be assessed by using different modes of assessment and Technology teachers should understand which mode is most suitable for each individual learner. Aceves and Orosco (2014:14) add that through culturally responsive feedback, teachers supply individualised support in a manner that is sensitive to learners' individual and cultural preferences.

Technology teachers may give learners projects that reflect their home environments to allow them to use the skills they have acquired in their communities. In a study conducted prior to this study, Robinson et al. (1999:11) advised that assessment should support and not inhibit creative and cultural education. This study revealed that Technology projects should not limit learners to using only certain knowledge and skills, but should allow them to use any knowledge that they possess, including IK. Wong and Siu (2012: 471) found that because Technology projects seldom relate to the learners' social and cultural backgrounds and seem to be totally unconnected with their lives, they do not perform well.

This study showed that performance assessment may be used to allow learners to demonstrate any knowledge and skills they possess. The participants indicated that some learners are reluctant to use their IK, which they perceive to be inferior, during performance assessment and prefer to use western knowledge. This study suggests that Technology teachers should encourage their learners to use different knowledge systems. Based on the findings of this study and the literature reviewed, Technology teachers should use rubrics to assess skills and knowledge. However, rubrics should not be Eurocentric, but must assess the all kinds of skills and knowledge as of equal value. According to Von Glasersfeld (1995: 4), there will always be more than one way of solving a problem or achieving a goal. Technology learners should be allowed to use IK to answer questions.

The study established that dialogue allows learners to share and discuss their knowledge and skills with others in the class, as well as the teacher, and learn from each other. During dialogue, learners may also be able to refine their knowledge and skills to make them suitable for solving a technological problem. Mays (2014:118) explains that the constructivist theory

151

calls for a teaching approach that emphasise interaction and dialogue and according to Doll (1993:136), meaning is created by public dialogic transactions. The findings suggest that Technology teachers may use individual conferences to assist learners with learning problems. Aceves and Orosco (2014:15) state that individualised teacher-learner conferences allow learners to receive individualised teacher feedback and may be used to remedy learners' misconceptions. During individual conferences, Technology teachers should encourage learners to use their IK to solve technological problems. This study found that although Technology teachers are keen to use individual conferences to help learners who struggle with design skills, they are inhibited by overcrowding in schools and time constraints.

The findings further revealed that Technology learners perform well when Technology teachers integrate IK in their assessment tasks. The participants suggested that learners should be rewarded and not penalised for using IK to answer questions. According to Aceves and Orosco (2014:15), in order to engage in critical feedback exchange, teachers should create many opportunities for the learners to respond. This study established that Technology learners are eager to answer questions when assessment tasks integrate IK. From the participants' point of view, open-ended questions and subjective marking can be used to promote the use of IK. Ornstein and Hunkins (2004:118) state that our understanding and view of reality are always subjective. This study showed that objective marking, though it may not be ruled out, may disadvantage some learners as the correct answers are predetermined. According to the Department of Education (1997:5), Technology teachers should consider a range of possible and relevant solutions and should not confine themselves to accepting only the answer suggested in the memorandum. By making use of subjective marking, teachers can promote the use of IK when learners make technological artifacts. This study revealed that Technology learners feel demoralised when their answers informed by IK are marked as incorrect.

5.3.6 The role of MKOs

This study highlighted indigenous adults' knowledge and skills in product design and the significant role they can play in the teaching of Technology. This finding is consistent with the that of Mothwa (2011:7), who states that members of the school community, such as parents, learners, teachers and departmental officials need to work together to ensure a smooth

exchange of knowledge among these stakeholders. The findings established that indigenous experts with their vast knowledge and skills can help Technology learners to acquire the skill of making artifacts. These findings are supported by Gumbo (2015a:27), who states that African leaders should prioritise design solutions devised by indigenous Africans. Indigenous elders can be invited to act as co-teachers to demonstrate their skills to Technology learners.

The participants indicated that indigenous experts use scaffolding to teach making skills, which reflects Singh and Reyhner's (2013:37) finding that family members, elders and other community members pass on their knowledge from generation to generation. The findings established that indigenous experts allow their apprentices to first observe them while they make products, after which they are allowed to copy the process independently. This study recommends that Technology teachers should learn to use indigenous ways of teaching design skills, i.e. by demonstrating their design skills to the learners, which could help them to master the design skills needed in the subject Technology.

5.4 THE RELEVANCE OF THE SOCIAL CONSTRUCTIVIST THEORY IN THE TEACHING OF DESIGN SKILLS

The findings of this study agree with the principles of social constructivist theory in many ways. The classroom observations showed that Technology learners are more interested in solving technological problems if IK is acknowledged. This supports Turuk's (2008:247) finding that the constructivist theory emphasises the importance of what the learner brings to any learning situation as an active meaning maker and problem solver. In this instance, Technology learners come into a learning situation endowed with IK and ready to apply it in problem solving situations. From a constructivist perspective, IK plays an important role as learners can use it to construct new ideas and make sense of technology as it relates to their contexts. It appears as if teachers can enjoy a Technology class in which they affirm the value of IK and encourage the learners to use it. The analysis of the question papers showed that teachers had included a few IK-based questions, but assessment should include more IK-informed questions. Social constructivism also includes culture, and the findings showed that culture plays an important role in learning. Learners' IK is informed by their cultural context as it is represented by the artifacts. Participants in the study spoke passionately about their culture and how it contributed to their knowledge. IK-based designs are evident in the artifacts that represent a culture. This

153

is in agreement with Leonard et al. (2010:12), who state that social constructivists emphasise the importance of culture in the learning process. It is in that light that Ornstein and Hunkins (2004:214) propose that the curriculum content needs to reflect and serve diverse cultures of learners.

Technology learners should be challenged to acquire higher-order thinking skills such as critical and creative thinking skills by being asked thought-provoking questions that promote active learning. Challenging the learners can make them operate at the level of the zone of proximal development (ZPD), which is a much-needed performance level in a subject such as Technology. According to Kalpana (2014:28), constructivist approaches recommend that teachers should provide complex real-life learning situations where multiple solutions are possible. Ertmer and Newby (2013:58) agree that as one moves along the behaviourist to the constructivist continuum, the focus of education shifts from teaching to learning, from the passive transfer of facts and routines to the active application of ideas to problems. IK provides a fertile platform for multiple solutions informed by learners' different contexts and cultures. In addition to this, combining IK and western knowledge can promote such multiple solutions.

The findings of this study revealed that indigenous elders use scaffolding to assist their children's learning. This teaching strategy could be a building block in a Technology classroom, especially when explaining new concepts which learners find difficult to understand. The classroom observations showed that the majority of learners struggled to understand certain new concepts, such as reinforcement and food preservation (see section 5.2.1.4). This means that Technology teachers are supposed to start by checking the level of learners' prior knowledge, i.e. what and how they were taught at home to scaffold their learning. According to Galloway (2010:48), Vygotsky believed that when a learner is at the ZPD for a particular task, providing the appropriate scaffolding will give him/her an opportunity to succeed in learning. The scaffolding can be removed when the learner has acquired the desired skill.

5.5 CONTRIBUTION OF THIS STUDY

The design process, which includes a range of design skills, was explained in line with the CAPS prescription (investigate, design, make, evaluate and communicate) and other conventional ways discussed in the literature review. It was shown to be both the dominant

content and method in the teaching of Technology. However, the findings highlighted a different view of design that is inspired by how designers in indigenous contexts design and make artifacts in response to local problems. The design process that flows from this hinges on the key aspects of analysis, culture, materials, apprenticeship, make and evaluate, which are intertwined and are centred more on the elders' and local designers' guiding roles. They should therefore be understood in a holistic and interactive manner. Hence, the indigenous conceptualisation of design suggests an IK-informed design process, which the researcher decided to call an indigenous knowledge-based design process (IKBDP) (see Figure 5.22). The IKBDP can be used in Technology classrooms to integrate indigenous knowledge in teaching design skills. The steps of IKBDP can be briefly summarised as follows:

- Culture: Learners first investigate the cultural dynamics informing knowledge and other values in their context. This helps them to understand the needs of the end user for a suitable design and to design appropriate artifacts for the end users. The elders are conversant with important cultural practices in their communities and are therefore able to make relevant indigenous artifacts. The elders adhere to the customs, values and traditions of their communities, which could also guide Technology learners' learning about indigenous technological knowledge and skills.

- Analysis: As a second step, the learners can investigate the existing problems and needs in their communities and society as whole. They should clearly understand a problem and its cause in a socio-economic cultural context. Elders can (collectively) identify real problems in their communities, which can provide pointers towards what could be helpful in the teaching and learning of Technology, i.e. teamwork and collaboration in identifying and tackling problems. The elders thrive on their experience-based knowledge, which helps them to design and make products in a cooperative manner. It is not surprising to see a group of men discussing or working together on something – a practice that is informed by the Lekgotla principle (tribal men meet for discussions about matters concerning the village). Some ideas are not generated by individuals, but by groups of learners working together. Partnering with community members such as indigenous experts and users of indigenous products could enhance learners' design ideas and skills.

155

- Materials: Learners now investigate the materials in their environment. They consult, especially with elders, to understand the types and properties of the available indigenous materials, such as trees (Section 5.2.1.2). Technology learners can learn about the extraction and preparation of indigenous materials such as clay. There is a strong relationship between the elders and the environment, which they respect as it provides them with the materials they need. In a time when the environment is under threat, the knowledge of elders could contribute to steering learning in the Technology classroom towards ensuring sustainable development.

- Apprenticeship: Apprenticeships are common in indigenous communities. As part of their investigation, the learners observe local designers who are knowledgeable and skilled in making artifacts so that they can acquire the skills for use in their school project. The elders mostly draw from their tacit knowledge and skills to design and make products. As tacit knowledge cannot be transferred through talking, they use observation and experimentation to teach novices. Partnerships with communities could ensure that learners learn design and making skills from elders through observation and experimentation.

- Make: Learners make artifacts by applying the skills that they acquired by observing the experts, as well as skills learnt at school. In some rural communities people still use traditional tools for working on materials and making artifacts. Unlike the motorised tools that are harmful to the environment (e.g. diesel-operated tools that emit smoke), traditional tools do not affect the environment. Furthermore, conventional tools promote an individualistic approach to problem solving as technology cuts out labour on the job. Traditional tools, on the other hand, encourage team work as they are labour intensive. These may help learners a great deal in the making of artifacts, e.g. carving a tree trunk with a traditional axe to make benches.

- Evaluation: Learners test their artifacts to ensure that they are suitable for the intended purpose. If an artifact does not work properly, the learners should take a close look at their decisions and choices, starting at the beginning, to identify an area where improvements can be made. They could also seek advice from the designers and elders in their communities. In indigenous communities, the designers can conveniently consult with end users about the suitability of their products and use the feedback to

156

rectify their designs if necessary. If the community is involved in teaching, teachers and learners may request community members to evaluate the learners' artifacts.
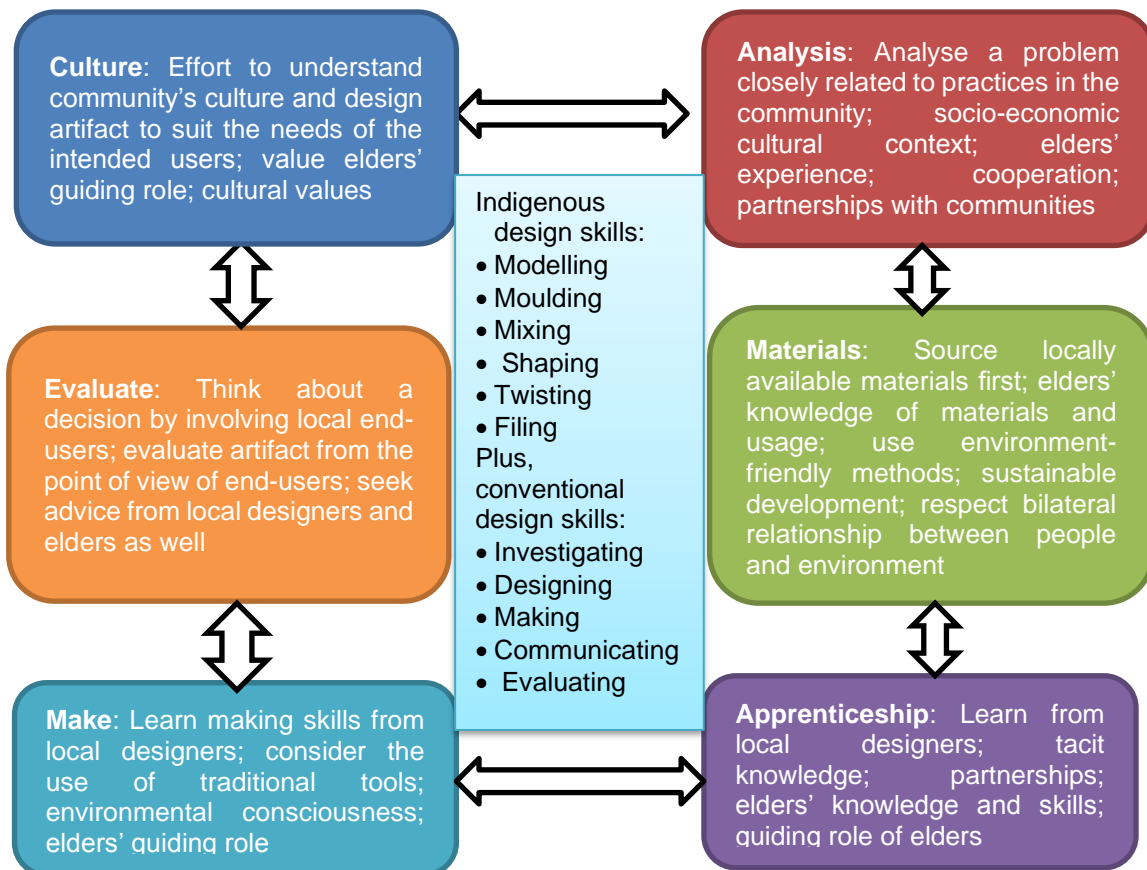
Figure 5.22: Indigenous knowledge-based design process (IKBDP)

5.6 CONCLUSION

Chapter 5 presented a discussion of the findings of this research study. It was established that IK exists and is highly valued by indigenous communities, and therefore its inclusion in the teaching of Technology is warranted. This resonates with the educational transformation project on which South Africa is currently working. The CAPS addresses the transformation agenda in line with the preamble of the National Constitution. Most interestingly, the indigenous knowledge system represents one of the seven principles undergirding the CAPS to ensure such transformation. The findings also revealed that IK can increase learners' acquisition of design skills, as attested to by the participants. Furthermore, this study established that the integration of IK can be effected by using CRP. The integration of IK in the teaching of design skills can, however, be hindered by factors such as the inability of teachers to use the indigenous artifacts, the use of only one assessment method for all learners, a negative attitude towards IK and CRP, and Technology teachers' inability to implement CRP in teaching

design skills. The chapter concluded with a discussion of the findings in relation to the theory that guided this study, which led to the formulation of IKBDP. In the next and final chapter, conclusions will be drawn and recommendation for future related studies will be made.

CHAPTER SIX

SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

In the previous chapter, the researcher discussed the findings of the study in detail. This chapter concludes the study with a brief summary, a discussion of how, and the extent to which the research objectives were achieved, the limitations of the study and recommendation for future related research. The researcher then wraps up this research project by reflecting on his scholarly journey during the study.

6.2 AIM AND OBJECTIVES OF RESEARCH

The main goal of this study was to examine the role of IK in developing Senior Phase learners' design skills in TE. The objectives of this study were:

- To describe the value of IK in developing design skills in TE.
  To this end the importance of IK in the teaching of design skills was investigated. In order to establish the value of IK, the researcher examined evidence of the existence of indigenous designs and indigenous design skills in the communities where the study was conducted.

- To identify the IK that can be integrated in TE to promote the acquisition of design skills by Senior Phase learners. In order to establish the IK content that can be used to promote the acquisition of design skills, the researcher investigated the use of IK content in the CAPS, textbooks, annual teaching plans (ATPs) and question papers.

- To examine the teaching and learning strategies that can be used to promote the incorporation of IK for the development of the Senior Phase learners' design skills. The researcher investigated suitable teaching and learning methods that can be applied to include IK in the teaching of Technology in order to promote the acquisition of design skills.

- To explore the assessment strategies that can be used to accommodate IK in the assessment of the Senior Phase learners' design skills. The researcher investigated

the assessment methods that can be effectively used to develop design skills from an indigenous perspective.

6.3 SUMMARY OF STUDY AS A WHOLE

This section provides a summary of the six chapters that comprise this research study.

Chapter 1 introduced the study and provided background information and a discussion of the research problem, the aim of and rationale for the study, and the objectives that the researcher hoped to achieve. The motivation for the study was also discussed and a clarification of key words used was provided. The chapter concluded with an explanation of the structure of the thesis.

Chapter 2 dealt with the theoretical and conceptual frameworks that informed the study. Since this study was based on the constructivist theory, the value of prior knowledge (IK) in learning TE and the principles of the social constructivist theory in relation to the use of IK in the teaching of design skills were discussed.

Chapter 3 consisted of a review of existing scholarly literature dealing with IK and design skills as they relate to TE. The role of IK in the acquisition of design skills was explored, as well as ways in which indigenous technologies, Ubuntu (humanism) and the connectedness of indigenous people can contribute to the teaching of design skills in Technology classrooms. Literature on the incorporation of IK in the teaching and assessment of design skills was also reviewed.

Chapter 4 dealt with the research design and the profiles of the research sites and participants. The qualitative method was used to establish the views of participants regarding the role of IK in the teaching of design skills. The purposive sampling that was used to select the participants was discussed and the research methods and instruments used for data collection were described in detail. The ethical issues that were considered were discussed and a description was given of the different strategies that were employed to enhance the trustworthiness and authenticity of this study.

Chapter 5 presented a detailed discussion of the findings based on the analysis of the interviews, participant observations, documents and artifacts. The findings, which were grouped into six themes, helped to answer the research question, which sought to establish the role of IK in the development of learners' design skills in TE.

Chapter 6 contains a summary of the research, focusing on the findings, and a discussion of how the research questions were answered. Recommendations are also made for future related research. It concludes with the researcher's reflections on his journey towards the completion of this study.

6.4 MAIN RESEARCH FINDINGS OF THIS STUDY

The findings of this study seem to be largely compatible with the findings reported in the literature reviewed in the theoretical framework in Chapter 2 and the literature review in Chapter 3, which indicated that prior knowledge may play an important role in learning. This study showed that IK plays a crucial role in the teaching of design skills, specifically in the South African context. The findings suggest that the current teaching of design should consider IKBDP, which integrates the culturally informed IK of learners. The IKBDP can enable Technology learners to use their IK first as prior knowledge in the acquisition of design skills. More generally, the findings revealed that IK can play a role in the teaching of design skills in TE. Technology teachers should be conversant with indigenous pedagogies, which can be used to integrate IK in their teaching of design skills. It was also found that the use of indigenous pedagogies may help Technology learners to use their IK as it can enhance the acquisition of design skills. The conclusions reached in respect of the different themes that emerged during the analysis of data will now be briefly discussed.

6.4.1 The value of IK in the teaching of design skills

The study showed that IK can make a valuable contribution to the promotion of the acquisition of design skills. Technology learners who possess IK are better able to comprehend design skills in Technology. The study showed that IK still exists in indigenous communities and from the views expressed during the interviews it was clear that indigenous learners are conversant with IK. IK can be used to the advantage of learners, especially when Technology learners learn design skills. The study established that the indigenous communities possess a wealth

of indigenous designs. Adults use their knowledge to make indigenous products that are needed in their communities and their children learn some of the skills, such as the preservation of food, for example the drying of jute mallow. The elders use their tacit and explicit IK to make products. Technology learners may acquire some of the skills used by experts to make indigenous products. This study found that IK plays a pivotal role in promoting the acquisition of design skills and can motivate learners to learn, which in turn can lead to the improvement of their academic performance. In general, it may be concluded that IK is valuable in TE as this study confirmed that it promotes the development of learners' design skills.

6.4.2 IK content

This study revealed that in the CAPS, the indigenous content that can be taught to Technology learners is not clearly defined; therefore Technology teachers are not able to include IK content in their teaching of design skills. The findings indicated that the indigenous skills that can assist learners to acquire design skills are not included in teaching. The findings further showed that content that is relevant to the daily lives of learners promotes understanding, in other words, content that relates to prior knowledge may facilitate learning.

This study suggested that Technology teachers should teach their learners that when they make prototypes, they must consider the culture of the users to ensure that their products will be acceptable to their clients. Knowledge of indigenous materials is useful when selecting appropriate materials for making technological products, and procedural knowledge of how indigenous tools are used may help learners to use tools safely in Technology classrooms. It was found that the integration of IK may encourage learners to concentrate when teaching and learning is taking place, which means that the integration of IK can promote active learning.

6.4.3 Teaching strategies

This study showed that the use of different teaching methods may help to accommodate learners with different abilities in Technology classrooms and that Technology teachers should not over-emphasise western pedagogies at the expense of alternative pedagogies. Instead, indigenous pedagogies such as a CRP can be used to accommodate the cultural experiences of learners. The CRP can be used to integrate IK in the teaching of design skills. The study

established that Technology learners acquire design skills more readily if their cultural experiences are included in learning. This means that Technology teachers may use CRP to include learners' cultural experiences, which can facilitate the acquisition of design skills. It was evident that one of the obstacles preventing the integration of IK is the teachers' poor knowledge of IK and CRP.

This study found that the current dominant design-make-evaluate method needs to be reconsidered and adapted to fully accommodate indigenous design skills. The use of alternative design methods applied by indigenous people can help Technology learners to think more creatively. This study contributes the IKBDP, a new indigenous process that can be used to integrate IK in the teaching of design skills in Technology classrooms. By using IKBDP when teaching design skills, Technology teachers can draw from indigenous knowledge (skills). They can use the elders' knowledge and skills to guide their learners' acquisition of design skills. This can help learners to design artifacts that can enhance their understanding as this process requires them to consider the cultural values of the users. IKBDP can also conscientise learners to use resources in a more sustainable manner, which would be in keeping with indigenous people's respect for the environment.

This study found that indigenous artifacts can be used as valuable teaching aids in the teaching and acquisition of design skills. Learners who are able to investigate indigenous skills and knowledge will be able to make suitable products to solve technological problems. The findings revealed that skills and knowledge acquired through investigation are retained for a longer period. The discovery teaching approach can be used to integrate IK when teaching design skills. Technology learners can use IK to solve technological problems on their own with minimal guidance from their teachers. This study is congruent with the constructivist view, which can be used to promote IK as prior knowledge and integrate it throughout teaching to facilitate learning. According to the constructivist theory, the knowledge acquired by learners through experience supports the effective learning of design skills. IK can help Technology learners to generate new ideas for solving contextual technological problems.

6.4.4 Learning strategies

The findings further revealed that an experiential learning strategy can be used to integrate IK in the teaching of design skills. Technology learners should make use of opportunities to learn design skills in their communities and Technology teachers and learners should visit expert elders in order to learn the practical skills used by them for making indigenous artifacts. Experiential learning can help Technology learners to learn though observation and to practise skills outside their classrooms.

This study also found that Ubuntu may play a pivotal role in promoting cooperative learning. Many learners from indigenous communities are familiar with the principle of Ubuntu, which can help them to work together in a symbiotic relationship in which they respect each other's ideas when attempting to solve technological problems to achieve a common goal. Cooperative learning can help learners in the Technology classroom to accept different knowledge systems as they will learn to respect the views of learners from different backgrounds.

6.4.5 Assessment strategies

It became apparent that the use of a single assessment method that limits learners to one knowledge system can have a negative effect on their performance, and as a result Technology learners refrain from using IK and other knowledge systems. The study suggested that Technology teachers should use different assessment methods in order to allow learners to use their IK when answering questions or completing projects. Projects should allow learners to integrate their design-related IK to make new products.

This study further established that performance assessment can also be used to promote the use of IK in Technology classrooms. During performance assessment, Technology learners may demonstrate indigenous knowledge in the making of products; therefore Technology teachers should formulate rubrics that make provision for the assessment of different knowledge systems. It was determined that Technology teachers could use dialogue to promote the integration of IK in the teaching of design skills, which will allow learners to use their IK to support their views on design. This study also found that Technology teachers must use individual conferences to promote the integration of IK and thereby help learners to acquire

design skills. During individual conferences, Technology teachers can coach learners to use their IK to solve technological problems.

It was found that Technology learners are eager to answer questions that relate to their IK, and that the use of subjective marking allows them to use different knowledge systems, which can improve their performance in Technology assessments as there will not be only one correct answer.

6.4.6 Role of MKOs

This study found that indigenous adults are thoroughly acquainted with design activities and could make a valuable contribution if they are invited to share their knowledge with, and demonstrate their skills to learners in Technology classrooms.

Indigenous elders use scaffolding to teach making skills. They start by only allowing their apprentices to observe them while working. After adequate observation they are eventually allowed to make their own indigenous artifacts. In general, it may be concluded that indigenous ways of teaching practical skills may help Technology learners to acquire design skills.

6.5 LIMITATIONS OF STUDY

Several limitations to this study are acknowledged, as discussed below.

6.5.1 Sampling

This research was limited by the use of the purposive sampling method, according to which participants have to comply with specific criteria. Only participants who were familiar with IK were selected. The inclusion of people who possessed only limited knowledge of IK could have added value to the findings of this study.

6.5.2 Sites

The findings may not be applicable to all schools in South Africa as the research was conducted in only one district and was qualitative in nature. The findings of qualitative studies are not generalisable. All the participants in this study resided in the same district (Vhembe District in Limpopo) and the participating schools were all rural schools, which means that the

findings cannot be generalised to other districts and provinces, or to urban schools. The sample was also not representative of the entire South African population as it targeted indigenous people only, specifically Vatsonga.

6.5.3 Unavailability of participants

This study was limited due to the withdrawal of some participants for personal reasons. They were replaced by other participants in the last week before the fieldwork commenced.

6.5.4 Participant observation

The learners and teachers who participated in this study may have felt intimidated by the presence of the researcher in their classrooms. They may have felt that their space had been invaded, or may have acted differently to impress the researcher. The teachers may also have felt intimidated by the active participation of the researcher.

6.5.5 Bias

The researcher's commitment to dealing with bias (see subsection 4.7.1.6) helped him to avoid being influenced by personal bias while conducting this study. However, his positioning as an IK scholar might have compromised his determination not to be affected by bias. The researchers' knowledge of IK may also have affected the interpretation of the collected data, which he undertook on his own.

6.6 CONCLUSION

The aim of the current research was to establish the role of IK in developing Senior Phase learners' design skills in TE. The main research question guiding this study was: What is the role of IK in developing Senior Phase learners' design skills in TE?

The following four secondary research questions were also addressed:

- What is the value of IK in developing design skills in TE?
- Which IK can be incorporated in TE to promote Senior Phase learners' acquisition of design skills?
- Which teaching and learning strategies can be used to promote the incorporation of IK for the development of the Senior Phase learners' design skills?

- Which assessment strategies can be used to accommodate IK in the assessment of Senior Phase learners' design skills?

The findings of this study provided the answers to the research questions. The following conclusions were drawn from the findings:

- Although the indigenous skills that can assist learners' acquisition of design skills are not currently included in teaching, IK could help learners to understand design skills, which in turn could help them to improve their academic performance in TE and motivate them to acquire design skills.
- The knowledge of materials that *have* been traditionally used for making objects is useful when selecting appropriate materials for making technological products, and procedural knowledge of how indigenous tools are used can help learners to design new technological products.
- CRP can be used to integrate IK in the teaching of design skills. Technology learners acquire design skills more easily if their cultural experiences are included in learning. It became evident that the current dominant design-make-evaluate method is not effective in helping Technology learners to acquire design skills.
- The findings of this study showed that an experiential learning strategy can be used to integrate IK in the teaching of design skills, and that cooperative learning can help learners in the Technology classroom to accept other knowledge systems, such as IK. It can help learners to respect the views of learners from different backgrounds.
- Performance assessment can also be used to promote the use of IK in assessing design skills and may allow learners to demonstrate different knowledge and skills that they possess. Dialogue in the classroom can stimulate learners to use IK when they are designing new prototypes, and individual conferences are useful for promoting the incorporation of IK when learners are acquiring new design skills. This study contributed the IKBDP which may be used to integrate IK in the teaching of design skills.
- The pivotal role that IK can potentially play in the teaching of design skills was confirmed by the findings of this study. The following section discusses the recommendations for possible future related research.

6.7 RECOMMENDATIONS

6.7.1 Empowering technology teachers

This study found that some Technology teachers are not conversant with indigenous knowledge (IK) and CRP. It is therefore recommended that the Department of Basic Education should provide Technology teachers with training in IK content to enable them to use IK to

assist learners with their acquisition of design skills. They should also be trained in CRP to understand how IK can be integrated in their Technology lessons, and should familiarise themselves with the properties of the materials used in the making of indigenous artifacts, for instance trees (wood) and clay.

6.7.2 Motivating learners to accommodate different knowledge systems

Technology learners should be encouraged to acknowledge the value of IK and to bring materials to school that can be used to make indigenous technological products. Technology teachers should give their learners projects that require the inclusion of IK in order to motivate them to use it. To demonstrate the value of IK, the Department of Basic Education should include it in all school subjects.

6.7.3 Inclusion of indigenous content in the CAPS

In order to decolonise the education system, the CAPS should be revised to include IK so that it can be equivalent in status to western knowledge. The Department of Basic Education should be clear about the IK content that will be useful in Technology classes. Currently this is not clearly defined in the CAPS and Technology teachers are unsure of how to integrate IK in their lessons. The findings of this study offer ideas about IK that can be used in the CAPS.

6.7.4 Using indigenous ways of design

Indigenous methods used for designing artifacts should be valued, taught and used in Technology classes. There should be no prescribed design processes and Technology learners should be taught that design can be done in different ways. Technology teachers should therefore allow learners to use different design processes according to their individual preferences. This means that Technology teachers can also use IKBDP to teach design skills.

6.7.5 Creating harmonious relationships between schools and community members

Members of the indigenous community should be regarded as partners who can make a vital contribution to the teaching of design skills and should be invited to visit schools often in order to share their skills and knowledge with teachers and learners.

6.7.6 Provision of indigenous artifacts as part of LTSM resources

Learning and Teaching Support Materials (LTSM) committees should include indigenous artifacts when they do requisition for LTSM resources. These articles can be displayed in the library or stored on the school premises and Technology teachers should be encouraged to use them as teaching aids to facilitate the acquisition of design skills.

6.7.7 Further studies

Since the integration of IK is still in its embryonic stage in South Africa, the researcher recommends that future research should be conducted to confirm the findings of this study. Such further studies could be undertaken to:

- fully establish the effects of teachers' IK in teaching the subject Technology;
- fully establish the impact of Technology teachers' knowledge of culturally relevant feedback;
- establish the presence and/or absence of IK and the impact it has on the acquisition of design skills and/or other content in urban areas, particularly in the former Model C schools; and
- investigate the role of TE specialists in promoting the integration of IK in the teaching of design skills.

RESEARCHER'S AUTOBIOGRAPHICAL REFLECTIONS

Although this intellectual journey presented me with a herculean task with many challenges that demanded great effort and wisdom, it was exhilarating as I enjoyed discovering new knowledge and skills along the way. The journey was a mixture of sadness and joy.

Finding a theoretical framework that was a good fit for this study was problematic. When I wrote my initial theoretical framework I was convinced that it was compatible with the research title, and was devastated when the feedback from my supervisor informed me that it did not comply with the requirements. This led to a lengthy meeting with my supervisor, during which the weaknesses of the theory were explained to me. I felt totally demoralised, but understood that it was necessary to change the framework if I wanted to continue with my research. This experience taught me that all the chapters in the thesis should be compatible.

The regular feedback received from my supervisor was always loaded with challenging questions that forced me to think deeply about this study. Quite often the questions were difficult to answer and I was stimulated to think critically about contemporary scholarly issues. I learnt that everything I wrote had to be substantiated, and that thorough research could contribute to the solving of human problems. I often felt like giving up after receiving feedback, but once I had studied the comments, I could see that they were not meant to dishearten me, but rather to improve my study and initiate me thoroughly into the academic world. The motivation received from the supervisor helped me to keep on moving forward despite the many challenges.

Balancing my time to study, work and take care of family responsibilities was complicated and initially I was convinced that it would be impossible to complete my research on time. As time passed, I realised that the best time for studying was late at night and very early in the morning. I became a nocturnal person and mostly did my research at night when everyone else in my family was sleeping and it was quiet. I discovered that my mind functioned very effectively in a quiet environment and started making good progress. Soon ideas about this study were emerging spontaneously and I realised that the human mind can create amazing things if it is used correctly in an atmosphere that is conducive to intellectual pursuits.

I now understand that innate abilities are like plants – they need pruning, in this case by studying – and I will always strive to enhance the skills I have acquired during the course of this study. I will jealously guard those skills by studying continuously in order to keep abreast of new developments in the field of education.

The main lessons that I have learnt during my academic journey are:

To get good things in life one must persevere. Through hard work and perseverance it is possible to complete daunting projects. Things that are worth much are not easy to achieve.

When the going became tougher on this intellectual journey, I persevered as I understood that this study would change my life for good. I also understood that the higher you go, the colder it becomes. As I attempted to attain this highest degree, I could expect it to require more effort than my previous degrees. This study taught me that better quality demands more energy.

I have acquired academic writing skills. While I was involved with this study, my supervisor and I collaborated in the writing of two conference papers. The feedback received from the conference reviewers helped to hone my academic writing skills, which in turn helped me to complete this thesis. This study also helped me to improve my skills in collecting and analysing data gathered during fieldwork. The study taught me how to select appropriate research methodologies for a research study. I am happy that I have reached my goal and can now confidently conduct research on my own. I will always use my research skills to find ways to improve teaching and learning.

I have learnt to apply critical judgements in different contexts in order to create new knowledge. This study taught me to formulate problems for research purposes. I have also learnt to review the publications of other scholars and acknowledge their work by citing them correctly. I have learnt to work independently, guided by my supervisor who continued to pose intelligent questions that demanded the use of analytical thinking skills, which will serve me well when facing future challenges.

When I started my research, I knew very little about CRP. As I progressed, I learnt more about it and about how it can play a role in the teaching of design skills. I have also acquired more practical knowledge about IK and a sound knowledge of indigenous design skills, which can play a role in the teaching of those skills, and I learnt how culturally relevant feedback can be used to promote the use of IK.

The findings of this study will be of immense benefit to Technology teachers, HoDs and TE specialists as it will help them to integrate IK in their teaching of design skills. The theme of this study is topical and relevant as the decolonisation of education is currently a burning issue in our country, and the findings will be useful to the Department of Basic Education, which has been challenged to completely decolonise the curriculum to reflect the cultures of the majority of school learners. These findings can also help other countries that were colonised to decolonise their education systems by using the IKBDP to teach design skills. This is the first study to elaborate on the content of indigenous design skills and provide new indigenous design process that can be used to teach design skills in TE. The Department of Basic Education may find this study useful for including more IK content in the CAPS as part of the decolonisation of TE. This can help to enhance design skills, which are in great demand in the Fourth Industrial Revolution.

LIST OF REFERENCES

Abejuela III, R.B. (2007). Indigenous knowledge systems and higher education in the Phillipines. *Studies of Tribes and Tribals*, 1: 205-213.

Aceves, T.C. & Orosco, M.J. (2014). Culturally responsive teaching. Available At: www.ceedar.education.ufl.edu/tools/innovation-configurations/. Assessed 25 June 2017.

Adams, K. (2005). The sources of innovation and creativity. Paper commissioned by the National Center on Education and the Economy for the New Commission on the Skills of the American Workforce. Washington, USA.

Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge. *Development and Change*, 26(3): 413-439.

Ahmed, J.U. (2010). Documentary research method: New dimensions. *Indus Journal of Management and Social Sciences*, 4(1): 1-14.

Alamaki, A. (2000). Technological reasoning as a human side of technological innovation. Paper presented at the PATT-10 Conference. Available at: www.teaconnect.org/conference/PATT10/Alamaki.pdf. Accessed 30 March 2017.

Ankiewicz, P.J., De Swardt, A.E. & Stark, R. (2000). Principles, methods and techniques of Technology Education Module 1. Johannesburg: RAU.

Ankiewicz, P.J. & De Swardt, A.E. (2001). Technology Education: Principles, methods and techniques of Technology Education II. Johannesburg: University of Johannesburg.

Anney, V.N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, 5(2): 272-281.

Armstrong, A.C., Armstrong, D. & Spandagou, I. (2010). Inclusive education: International policy and practice. London: Sage.

Ary, D., Jacobs, L.C. & Razavieh, A. (2002). Introduction to research in education. Belmont: Wadsworth.

Awori, K., Vetere, F. & Smith, W. (2015). Transnationalism, indigenous knowledge and technology: Insight from the Kenyan diaspora. Paper presented at 33rd Annual ACM Conference on Human Factors in Computing Systems. Seoul, Republic of Korea.

Bada, S.O. (2015). Constructivism learning theory: A paradigm for teaching and learning. *IOSR Journal of Research & Method in Education*, 5(6): 66-70.

Balsamo, A. (2005). Taking culture seriously: Educating and inspiring the technological imagination. Available at: www.academiccommons.org. Assessed 19 May 2016.

Barlex, D. (2007). Assessing capability in Design and Technology: The case for a minimally invasive approach. *Design and Technology Education: International Journal,* 12(2): 49-56.

Bettencourt, A. (1993). The construction of knowledge: A radical constructivist view. In Tobin, K. (Ed.). *Constrctivism: the practice of constructivism in science education*. Lawrence Erlbaum Associates. Hillsdale.

Billups, F. (2014). The quest for rigor in qualitative studies: Strategies for institutional researchers. *The NERA Researcher*, 52(1): 1-5.

Biraimah, L.B. (2016). Moving beyond a deconstructive past to a decolonised and inclusive future: The role of ubuntu-style education in providing culturally relevant pedagogy for Namibia. *Internationally Review of Education*, 62(1): 45-62.

Blandford, A. (2013). Semi-structured qualitative studies. In Soegaard, M. & Dam, R. F. (Eds.). *The Encyclopedia of Human-Computer Interaction. Aarhus: The Interaction Design Foundation*. Available at: www.interaction-design.org/encyclopedia/semistructured_qualitative_studies.html. Assessed 14 January 2018.

Bless, C. & Higson-Smith, C. (1995). Fundamentals of social research methods: An African perspective. Cape Town: Juta.

Boden, M.A. (2009). Creativity: How does it work? In Krausz, M., Dutton, D. & Bardsley, K. (Eds.). *The idea of creativity*. Boston: Brill.

Bondy, A. (2011). Indigenous knowledge, intellectual property and Technology Education. *The International Journal of Learning*, 18(1): 389-399.

Bongum, B., Esjeholm, B.T. & Lysne, D.A. (2014). Science and Mathematics as part of practical projects in Technology and Design: An analysis of challenges in realizing   the curriculum in Norwegian schools. *NorDiNA*, 10(1): 3-5.

Booth, A., Carroll, C., Ilott, I., Low, L. L. & Cooper, K. (2013). Desperately seeking dissonance: Identifying the disconfirming case in qualitative evidence synthesis. *Qualitative Health Research*, 23(1): 126-141.

Bosch, D., Hendrics, H. & Tarling, I. (2013). Technology learner's book Grade 7. Northlands: Macmillan.

Bransford, J.A., Brown, A. & Cocking, R. (2004). How people learn: Brain, mind, experience and school. Washington, D.C.: National Academy Press.

Brazdauskaite, G. & Rasimaviciene, D. (2015). Towards the creative university: Developing a conceptual framework for transdisciplinary teamwork. *Journal of Creativity and Business Innovation*, 1: 49-63.

Bryant, D. (2010). Technology resolved: An ethnographic approach in instructional design within urban middle school debate. Georgia: Georgia State University.

Bryman, A. (2012). Social research methods. New York: Oxford University Press.

Caldecote, T.V. (1995). Investment in new product development. In Roy, R.& Wield, D. (Eds.). *Product design and technological innovation*. Philadelphia: Open University Press.

Chilisa, B. (2012). Indigenous research methodologies. Los Angeles: Sage.

Chinedu, C.C., Olabiyi, O.S. & Kamin, Y. (2015). Strategies for improving higher order thinking skills in teaching and learning of Design and Technology Education. *Journal of Technical Education and Training (JTET)*, 7(2): 35-43.

Cohen, D. & Crabtree, B. (2006). Qualitative research guidelines project. Available at: www.qualres.org/HomeSemi-3629.html. Accessed 18 February 2018.

Cole, M., John-Steiner, V., Scribner, S. & Souberman, E. (1978). Mind in society. The development of higher psychological processes. Cambridge: Harvard University Press.

Compton, V. (2004). Technological knowledge: A developing framework for Technology Education in New Zealand. Paper presented at the New Zealand Ministry of Education Curriculum Project. Unpublished.

Creswell, J.W. (2012). Educational research: Planning, conducting and evaluating quantitative and qualitative research. Boston: Pearson.

Creswell, J.W. (2014). Research design: Qualitative, quantitative and mixed methods approaches. Los Angeles: Sage.

Criticos, C., Long, L., Moletsane, R., Mthinyane, N. & Mays, T. (2009). Getting practical: About classroom-based teaching for National Curriculum Statement. Oxford University Press, SAAIDE. Cape Town.

Cushner, K., McClelland, A. & Safford, P. (2003). Human diversity in education: An integrative approach. Boston: McGraw-Hill.

Davtyan, R. (2014). Contextual learning. Paper presented at the ASEE 2014 Zone I Conference.Bridgeport, USA.

De Beer, J. & Mothwa, M. (2013). Indigenous knowledge in the science classroom: pseudo-science, or a missing link. Paper presented at the ISTE International Conference on Mathematics, Science and Technology Education. Phalaborwa, South Africa.

De Langen, A.N. (2009). Nurses' opinion of pain in patients who suffer from dementia. Unpublished dissertation. Pretoria: University of South Africa.

DeLuca, V.W. (1991). Implementing Technology Education problem-solving activities. *Journal of Technology Education*, 2(2): 1-10.

Department of Education. (1997). Senior Phase (Grade 7 to 9): Policy Document. Pretoria: Government Printers.

Department of Basic Education. (2011). Curriculum and Assessment Policy Statement Grades 7 – 9: Technology. Pretoria: Government Printers.

Department of Education. (2002). Revised National Curriculum Statement GradesR–9 (Schools) Technology. Pretoria: Government Printers.

Department of Education. (2004). Revised National Curriculum Statement Grade 7–9 Schools: Senior Phase. Pretoria: Government Printers.

Department of Higher Education and Training. (2013). National skills development strategy III, progress report 2011-2013. Pretoria: Government Printers.

Department of Labour. (2003). State of skills in South Africa. Pretoria: Government Printers.

Department of Presidency. (2011). National development plan (NDP): Vision for 2030. Pretoria: Government Printers.

Department of Science and Technology. (2004). Indigenous knowledge systems. Pretoria: Government Printers.

De Vries, M.J. (1996). Technology Education: Beyond the technology is applied science paradigm. *Journal of Technology Education*, 8(1): 7-15.

De Vries, M.J. (2005). Teaching about technology: An introduction to the philosophy of technology for non-philosophers. Dordrecht: Springer.

De Vries, M.J. (2012). Philosophy of technology. In Williams, P.J. (Ed.). *Technology Education for teachers*. Rotterdam: Sense.

De Vries, M.J. (2016). Teaching about technology: An introduction to the philosophy of technology for non-philosophers. Basel: Springer.

De Vries, M.J. & Tamir, A. (1997). Shaping concepts of technology: What concepts and how to shape them. *International Journal of Technology and Design Education*, 7(3): 3-10.

DiCicco-Bloom, B. & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education*, 40(4): 314-321.

Dixon, R.A. (2013). Trends and issues in Technology Education in the USA: Lessons for the Caribbean. *Caribbean Curriculum*, 21: 47-79.

Doll, W.E. 1993. A post-modern perspective on curriculum. New York: Teachers College Press.

Donald, D.; Lazarus, S. & Lolwana, P. (1997). Educational psychology in social context: Challenges of development, social issues & special need in southern Africa. Oxford: Cape Town.

Doyle, L. & Hill, R. (2008). Our children, our future- achieving improved primary and secondary education outcomes for indigenous students: An overview of investment opportunities and approaches. AMP Foundation. Available at: http://www.amp.au/ampfoundation . Accessed 1 May 2014.

Driver, R., Asoko, H., Leach, J., Mortimer, E. & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, 23 (7): 5-12.

Dyson, L.E. (2002). Designing for a culturally affirming indigenous computer literacy course. Paper presented at the ASCILITE Annual Conference of Australasian Society for Computers in Learning in Tertiary Education. Auckland, New Zealand.

Engdasaw, Z. (2013). Constructivists' didactics in teaching Technology Education in Ethiopian Technology University practices and challenges. *Mediterranean Journal of Social Sciences*, 4 (1): 391-400.

Ertmer, P.A. & Newby, T.T. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 26 (2): 43-71.

Esjeholm, B.T. (2015). Design knowledge interplayed with student creativity in D&T projects. *International Journal of Technology and Design Education*, 25: 227-243.

Fails, J.A., Guha, M.L. & Druin, A. (2012). Methods and techniques for involving children in the design of new technology for children. *Human Computer Interaction,* 6(2): 85-166.

Fleischmann, K. (2015). After the Big Bang: What is next in design education. *Special Issue: 10th Anniversary*, 8(3): 123-142.

Fossey, E., Harvey, C., McDermott, F. & Davidson, L. (2002). Understanding and evaluating qualitative research. *Australian and New Zealand Journal of Psychiatry*, 36(6): 717-732.

Fox, N. (2009). Using interviews in a research project. The NHIR RDS EM/YA. Available at: www.rds-eastmidlands.nihr.ac.uk. Accessed 28 April 2014.

Fraser, J.D.C. (2006). Mediation of learning. In Nieman, M.M. & Monyai, R.B. (Eds.). The educator as mediator of learning. Pretoria: Van Schaik Publishers.

Gall, J.P., Gall, M.D. & Borg, W.R. (2005). Applying educational research: A practical guide. Boston: Pearson

Galloway, C. (2010). Vygotsky's constructivism. In Orey, M. (Ed). In global text: Emerging perspectives on learning, teaching and technology. Zurich: Jacobs Foundation.

Gauteng Department of Education. (2010). Gauteng, Science & Technology Education improvement strategy 2009-2014. Johannesburg: Government Printers.

Gay, L.R. & Airasian, P. (2003). Educational research: competencies for analysis and applications. Upper Saddle River: Pearson.

Gay, R.L., Mills, G.E. & Airasian, P.W. (2011). Educational research: competencies for analysis and applications. Boston: Pearson.

Ghazali, I., Hanim, S., Rashid, S.H.A., Dawal, S.Z.M., Tontowi, A.E. & Aoyama, H. (2011). Sustainable manufacturing: A framework of cultural aspects for sustainable product design. Paper presented at the 4th International Product Design and Development. Yogyakarta, Indonesia.

Gibbs, L., Kealy, M., Willis, K., Green, J., Welch, N. & Daly, J. (2007). What have sampling and data collection got to do with good qualitative research? *Australian and New Zealand Journal of Public Health*, 31(6): 540-544.

Gibson, K. (2012). Student teachers of Technology and Design: Can short periods of STEM-related industrial placement change student perception of engineering and

technology? *Design and Technology: An International Journal*, 17(1): 18-29.

Given, L. M., Winkler, D. & Willson, B. (2014). Qualitative research practice: Implications for the design and implementation of a research impact assessment exercise in Australia. Sydney: Charles Sturt University.

Govender, I., Mabuza, L.H., Ogunbanjo, G.A. & Mash, B. (2014). African care research: Qualitative data analysis and writing results. *African Journal of Primary Health Care & Family Medicine*, 6(1): 1-5.

Gray,C. & Macblain, S. (2012). Learning theories childhood. London: Sage.

Green, B.A. (2010). Understand schema, understand difference. *Journal of Instructional Psychology*, 37 (2): 133-145.

Guba, E.G. & Lincoln, Y.S. (1982). Establishing dependability and confirmability in naturalistic inquiry through an Audit. Paper presented at the Annual Meeting of the American Educational Research Association. New York, USA.

Gumbo, M. T. (2001). Multicultural education and its politics. *South African Journal of Education, 21*(4), 233-246.

Gumbo, M.T. (2012). Claiming indigeneity through the school curriculum, with specific reference to Technology Education. *African Education Review*, 9(3): 434-451.

Gumbo, M.T. (2013). A Bumpy curriculum, curriculum change and its impacts on Technology Education in South Africa: Voices from academy. Paper presented at 75th International Technology and Engineering Educators Association Conference. Colombus, USA.

Gumbo, M.T. (2014). An action research pilot study on the integration of indigenous technology in Technology Education. *Mediterranean Journal of Social Sciences,* 5(10): 386-392.

Gumbo, M.T. & Williams, P.J. (2014). Discovering Grade 8 Technology teachers' pedagogical content knowledge in the Tshwane District of Gauteng Province *International Journal of Science*, 6(3): 479-484.

Gumbo, M.T. (2015a). Africa as a player in the puzzle game of development in science, technology and innovation: Issues of power, energy and human capital. Paper presented at ICSHER Conference. Awka, Nigeria.

Gumbo, M.T. (2015b). Indigenous technology in Technology Education curricula and teaching. In Williams, P.J., Jones, A. & Bunting, C. (Eds.). *Contemporary issues in Technology Education: The future of Technology Education*. Hamilton: Springer.

Gumbo, M.T. (2016a). Contesting technology education curriculum for the schooling of African learners in South Africa. In Msila, V. & Gumbo, M.T. (Eds.). *Africanising the curriculum: Indigenous perspectives and theories*. Stellenbosch: Sun Press.

Gumbo, M.T. (2016b). Pedagogical principles in Technology Education. In Emeagwali, G. & Shizha, E. (Eds). *African indigenous knowledge and the sciences*. Rotterdam: Sense.

Gumbo, M.T. (2018). Addressing the factors responsible for the misunderstanding of Technology Education with other subject fields. *Perspectives in Education,* 36(1): 128-144.

Haik, Y. & Shahin, T.M. (2011). Engineering design process. Stanford: CengageLearning.

Hamilton-Ekeke, J.T. & Dorgu, E.T. (2015). Curriculum and indigenous education for technological advancement. *British Journal of Education, 3*(11): 32-39.

Hancock, D.R. & Algozzine, B. (2011). Doing case study research: A practical guide for beginning researchers New York: Teachers College Press.

Hays, J. (2009). Learning indigenous systems. Cape Town: HSRC Press.

Helme, S. & Lamb, S. (2011). Closing the gap for indigenous students. Resource sheet no. 6. Canberra: Closing the Gap Clearinghouse.

Hergenhahn, B.R. & Olson, M.H. (2013). Introduction to theories of learning. Pearson Prentice-Hall. Upper Saddle River.

Hill, A.M. (1998). Problem solving in real-life contexts: An alternative for design in Technology Education. *International Journal of Technology and Design Education*, 8(3): 2003-220.

Hoadley, U. (2010). Tribes and territory: Contestation around curriculum in South Africa. In Pinar, W.F. (Ed.). *Curriculum studies in South Africa: Intellectual Histories & Present Circumstances*. Palgrave MacMillan. New York.

Holdt, J.M.D. & Richter, E.F.S. (2005). Spot on Technology Grade 7: Learners' book. Sandton: Heinemann.

Howard, T.C. (2003). Culturally relevant pedagogy: Ingredients for critical teacher reflection. *Theory into Practice*, 42(3): 195-202.

Hudson, C.C. & Whisler, V.R. (2010). Contextual teaching and learning for practitioners. *Systemics, Cybernetics and Informatics*, 6(4): 54-58.

Hussain, I. (2012). Use of constructivist approach in higher education: An instructor's observation. *Creative Education, 3*(2): 179-184.

ITEA. (2000). Standards for technological literacy: Content for the study Technology. International Technology Education. Availble at: www.iteaconnect.org. Accessed 22 March 2014.

Jelsma, J. & Clow, S. (2005). Ethical issues relating to qualitative research. *South African Journal of Physiotherapy,* 61(1): 3-6.

Johnson, R.B. & Christensen, L. (2008). Educational research: Quantitative, qualitative, and mixed approaches. Thousand Oaks: Sage.

Johnson, R.B. & Christensen, L. (2014). Educational research: Quantitative, qualitative and mixed approaches. Los Angeles: Sage.

Johnson, R.B. & Christensen, L. (2017). Educational research: Quantitative, qualitative and mixed approaches. Los Angeles: Sage.

Jonassen, D.H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm. *Educational Technology Research and Development*, 39(3): 5-14.

Jordan, A., Carlile, O. & Stack, A. (2008). Approaches to learning: A guide for teachers. McGraw Hill. Maidenhead.

Kagoda, A.M. (2009). Integrating appropriate indigenous knowledge in the Geography lessons in secondary schools of Uganda. *Current Research Journal of Social Sciences*, 1(3): 117-122.

Kaino, L.M. (2013). Traditional knowledge in curricula designs: Embracing indigenous Mathematics in classroom instruction. *Studies of Tribes and Tribals*, 11(1): 83-88.

Kajornboon, A.B. (2005). Using interviews as research instruments. *E-journal for Research Teachers*, 2(1): 1-9.

Kalpana, T. (2014). Constructivist perspective on teaching and learning: A conceptual framework. *International Research Journal of Social Sciences*, 3 (1): 27-29.

Karagiorgi, Y. & Symeou, L. (2005). Translating constructivism into instructional design: potential and limitations. *Educational Technology & Society,* 8(1): 17-27.

Kim, H. & Lee, W. (2014). Everyday design as a design resource. *International Journal of Design*, 8(1): 1-13.

Klapwijk, R.M. (2009). Training primary school teachers to nurture creativity in Design and Technology. Available at: www.sefi.be/wp-content/abstracts2009/Klapwijk.pdf. Accessed 25 August 2016.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *The American Journal of Occupational Therapy,* 45(3): 214-222.

Kussumua, I.T.J.T. (2007). A constructivist learning event using computers at the Instituto Superior de Ciências de Educação (ISCED) – Angola. Unpublished MEd thesis. Pretoria: University of Pretoria.

Lacey, A. & Luff, D. (2007). Qualitative research analysis: The NIHR for the East Midlands. Nottingham: Yorkshire & The Humber.

Laubscher, R. (2001). Technology Education materials and technological processing. Johannesburg: Rand Afrikaans University.

Leahy, K. & Phelan, P. (2014). A review of Technology Education in Ireland: A changing technological environment promoting design activity. *International Journal of Technology and Design Education*, 24: 375-389.

Lemus, J.D., Seraphin, K.D., Coopersmith, A. & Correa, K.V. (2014). Infusing traditional knowledge and ways of knowing into science communication courses at the University of Hawai'i. *Journal of Geoscience Education,* 62(1): 5-10.

Leonard, K., Noh, E. & Orey, M. (2010). Introduction to emerging perspective on learning, teaching and technology. In Orey, M. (Ed.). *In global text: Emerging perspectives on learning, teaching and technology*. Zurich: Jacobs Foundation.

Levin, I. & Kojukhov, A. (2008). Virtualisation and educational theory in post-industrial society. Paper presented at PATT-20 Conference. Tel Aviv, Israel.

Liengme, C.A. (1981). Plants used by the Tsonga people of Gazankulu. *Bothalia*, 13: 501-518.

Lodhi, S. & Mikulecky, P. (2010). Management of indigenous knowledge for developing countries. Paper presented at WSEAS International Conference on Communication and Management in Technological Innovation and Academic Globilisation. Wisconsin, USA.

Lundgren, A. (2006). The transfer of chemical knowledge: The case of chemical technology and its textbooks. *Science & Education*, 15: 761-778.

Machaisa, R. (2006). Culture, memory and trauma. Paper presented at the Third Annual National Oral History Conference. Richard's Bay, South Africa.

Maluleke, R. (2013). The role of technology teachers' knowledge in promoting Grade 7 leaners' higher order thinking skills at Johannesburg West District of Gauteng Province. Unpublished MEd dissertation. Pretoria: University of South Africa.

Mapara, J. (2009). Indigenous knowledge systems in Zimbabwe: Juxtaposing postcolonial theory. *The Journal of Pan African Studies*, 3(1): 139-155.

Mason, J. (2010). Qualitative researching. Los Angeles: Sage.

Mathers, N., Fox, N. & Hunn, A. (1998). Using interviews in a research project. Sheffield: Trent Focus Group.

Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *Africa Spectrum,* 5(2): 57-71.

Mawson, W.B. (2013). Emergent technological literacy: What do children to school? *International Journal of Technology and Design Education*, 23(2): 443-453.

Mays, T. (2014). Teaching, learning and curriculum resources. In du Preez, P. & Reddy, C. (Eds.). *Curriculum Studies: Visions and imagining*. Pearson: Cape Town.

McMillan, J.H. & Schumacher, S. (2010). Research in education: Evidence-based inquiry. Boston: Pearson.

McNair, V. & Clarke, R.B. (2007). Effective technology and design teaching: Getting it right in the classroom. *International Journal Technology Design Education*, 17: 271-290.

Meyiwa, T., Letsekha, T.& Wiebesiek, L. (2013). Masihambisane, lessons learnt using participatory indigenous knowledge research approaches in a school-based collaborative project of the Eastern Cape. *South African Journal of Education*, 33(4): 1-15.

Mirian III, J.B. (2012). Questioning Indian land workshop: A ceremony based approach to learning. Unpublished MA thesis. Bozeman: Montana State University.

Mkapa, B. (2004). Indigenous knowledge: A local pathway to global development.   Available at: http://worldbank.org/afr/ik. Assessed 29 October 2013.

Moalosi, R., Popovic, V. &Hickling-Hudson, A. (2007). Product analysis based on Botswana's postcolonial socio-cultural perspective. *International Journal of Design*, 1(2): 35-43.

Moalosi, R., Popovic, V. & Hickling-Hudson, A. (2010). Culture-oriented product design. *International Journal of Technology and Design Education*, 20: 175-190.

Moletsane, M.,Stofile, S. & Raymond, E. (2013). Cognitive and behavioural challenges. In Pienaar, C.F. & Raymond, E.B. (Eds.). *Making inclusive education work in classrooms*. Pearson: Cape Town.

Moriarty, J. (2011). Qualitative methods overview. London: School for Social Care Research.

Morrow, S.L. (2005). Quality and trustworthiness in qualitative research in counseling psychology. *Journal of Counseling Psychology*, 32(2): 250-260.

Morrow, W. (2002). Humanity in the contemporary world. In Asmal, K. & James, W. (Eds.). *Spirit of the Nation*. Cape Town: New Africa Education.

Mothwa, M.M. (2011). Teachers' experiences of incorporating indigenous knowledge inlife sciences classroom. Unpublished dissertation. Johannesburg: University of Johannesburg.

Mourtons, N.J. (2012). Defining teaching and assessing engineering design skills. Available at: www.engr.sjsu.edu/nikos. Assessed 15 March 2014.

Mukuka, G.S. (2010). Indigenous knowledge systems and intellectual property laws in South Africa. Unpublished Thesis. Johannesburg: University of the Witwatersrand.

Mwamwenda, T.S. (2004). Educational psychology: An African perspective. Heinemann: Sandton.

Naidoo, P.D. (2010). Teachers' interpretation and implementation of the policy on indigenous knowledge in the Science National Curriculum Statement. Unpublished DEd Thesis. Durban: University of KwaZulu-Natal.

Nam, C.S. & Smith-Jackson, T.L. (2007). Web-based learning environment: A theory- based design process for development and evaluation. *Journal of Information Technology Education,* 6: 23-43.

National Council for Curriculum and Assessment (NCCA). (2007). Learning certification design and communication graphics syllabus. For implementation in September 2007. Dublin: National Council for Curriculum and Assessment.

Ndlangamandla, M.M. (2014). The contribution of indigenous knowledge use on the livelihood of rural women in the lowveld region of Swaziland: A case study of handicrafts. Unpublished dissertation. Pretoria: University of South Africa.

Neuman, W.L. (2011). Social research methods: Qualitative and quantitative approaches. Boston: Pearson.

New Zealand Ministry of Education. (2007). The New Zealand Curriculum. Wellington: Learning Media Limited.

Nichola, D.B., Globerman, J., Antle, B. J., McNeill, T. & Lach, L.M. (2006). Processes of metastudy: A study of psychosocial adaptation to childhood chronic health conditions. *International Journal of Qualitative Methods*, 5(1): 55-66.

Nieman, M.M. & Pienaar, G.E. (2006). The role of the learning process, learning styles and learner difference in the mediation of learning. In Nieman, M.M. & Monyai, R.B. (Eds.). *The educator as mediator of learning*. Pretoria: Van Schaik.

Nixon, J., Martin, J., McKeown, P.& Ranson, S. (1996). Encouraging learning towards a theory of the learning school. Buckingham: Open University Press.

Norström, P. (2011). Technology education and non-scientific technological knowledge. Unpublished doctoral thesis. Stockholm: KTH Royal Institute of Technology.

Norström, P. (2014). Technological knowledge and Technology Education. Stockholm: KTH Royal Institute of Technology.

Ntuli, P.P. (1999). The missing link between culture and education: Are we still chasing gods that are not our own. In Makgoba, M.W. (Ed.). *African Renaissance*. Sandton: Mafube.

OECD. (2012). Equity and quality in education: supporting disadvantaged students in schools. Paris: OECD.

Orb, A., Eisenhauer, L. & Wynaden, D. (2000). Ethics in qualitative research. *Journal of Nursing Scholarship*, 33(1): 93-96.

Onrstein, C. & Hunkins, F.P. (2004). Curriculum foundations, principles and issues. Pearson: Boston.

Ornstein, A.C., Pajak, E.F. & Ornstein, S.B. (2011). Contemporary issues in curriculum. Pearson: Boston.

Owen-Jackson, G. & Steeg, T. (2007). The role of technical knowledge in Design and Technology. In Barlex, D. (Ed.). *Design and Technology for the next generation: A collection of provocative pieces*. Whitchirch: Cliffe.

Pawilen, G.T. (2013). Integrating indigenous knowledge in the elementary science curriculum. *Harris Education Journal*, 1(1): 21-31.

Pence, A. & Schafer, J. (2006). Indigenous knowledge and early childhood development in Africa: The Early Childhood Development Virtual University. *Journal for Education in International Development, 2*(3): 1-16.

Pete, S., Schneider, B.& O'Reilly, K. (2013). Decolonising our practice- Indigenizing our teaching. *First Nations Perspectives*, 5(1): 99-115.

Peter, U.T. (2015). The evolution of African indigenous science and Technology. Available at: www.iiste.org. Assessed 24 May 2016.

Philbert, N.M., John, M.K. & Cosmas, M. (2014). Assessing educators' views on the implementation of Technology Education in selected schools. *Mediterranean Journal of Social Sciences*, 5(16): 463-472.

Phiri, A.D. (2008). Exploring the integration of Indigenous science in the primary school science curriculum in Malawi. Unpublished Doctor of Philosophy dissertation. Blacksburg: Virginia Polytechnic Institute and State University.

Potgieter C. (2011). The design process. In Pudi, T.I. (Ed). *Understanding Technology Education from South African perspective*. Pretoria: Van Schaik.

Powell, K.C. & Kalina, C.J. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education*, 130(2): 241-250.

Pudi, T.I. (2007). Technology and Technology Education. In Pudi, T.I. Ed, *Understanding Technology Education from South African perspective*. Pretoria: Van Schaik.

Purao, S. & Wu, A. (2013:2). Towards values-inspired design: The case of citizen- centric services. Paper presented at 34th International Conference on Information Systems. Millan, Italy.

Puri, S.K. (2007). Integrating scientific with indigenous knowledge: Constructing knowledge alliances for land management in India. *MIS Quarterly*, 31(2): 355- 379.

Reitsma, L., Smith, A. & Van den Hoven, E. (2013). Story beads: Preserving indigenous knowledge through tangible interaction design." Paper presented at the International Conference on Culture and Computing. Kyoto, Japan.

Ritchie, J., Lewis, J., Nicholls, C.M. & Ormston, R. (2013). Qualitative research practice: A guide for social science students and researchers. Los Angeles: Sage.

Richter, B.W., Van der Walt, J.L. & Visser, A. (2004). Teacher education in, and for, new Africa. *Africa Education Review,* 1(1): 3-20.

Roberts, P., Priest, H. & Traynor, M. (2006). Reliability and validity in research. *Nursing Standard,* 20(44): 41-45.

Robinson, K., Minkin, L., Bolton, E., French, D., Fryer, L., Greenfield, S. & Green, L. (1999). All our futures: The Report of the National Advisory Committee on Creative and Education. London: DfEE & DCMS.

Ropohl, G. (1997). Knowledge types in technology. *International Journal of Technology and Design Education*, 7: 65-72.

Rutland, M. (2009). Art and Design and Design and Technology: Is there creativity in the designing? *Design and Technology Education: An International Journal*, 14(1): 56-67.

Saldana, J. & Omasta, M. (2018). Qualitative research: Analysing life. Sage: Los Angeles or London.

Salia-Bao, K. (1989). Curriculum development and African culture. Edward Arnold London: Hodder & Stoughton.

Sarlemijn, A. & De Vries, M.J. (2005). Design methodology in the context of the Eindhoven University of Technology: Technology and Society Program. Available at: www.designresearch.nl/PDF/DRN1995.pdf. Accessed 23 June 2017.

Savenye, W.C. & Robinson, R.S. (2004). Qualitative research issues and methods: An introduction for educational technologists. In Jonassen, D.H. & Harris, P. (Eds.). *Handbook of research for educational communications and technology*. Mahwah: Lawrence Erlbaum Associates.

Schiele, J.H. (1994). Africentricity: Implications for higher education. *Journal of Black Studies*, 25(2): 150-169.

Schirmer, B.R., Casbon, J. & Twiss, L.L. (1997). Diverse learners in the classroom: Teacher beliefs about learning: What happens when the child does not fit the schema? *The Reading Teacher*, 5(8): 690-692.

Sears, S. (2003). Introduction to contextual teaching and learning. Bloomington: Phi Delta Kappa Fastbacks.

Seel, N.M. (2001). Epistemology, situated cognition and mental models: Like a bridge over troubled water. *Intructional Science*, 29: 403-427.

Shan, Y.N. (2011). Contextualised teaching towards active learning. *Centre for Development of Teaching and Learning*, 14 (2): 1-3.

Shidza, E. (2014). Rethinking contemporary sub-Saharan African school knowledge: Restoring the indigenous African cultures. *International Journal for Cross Disciplinary Subjects in Education (IJCDSE),* 4(1): 1870-1878.

Singh, W. (2014). Gauging the impact of community university engagement initiative in India. New Delhi: Participatory Research in Asia (PRIA).

Singh, N. & Reyhner, J. (2013). Indigenous knowledge and pedagogy for indigenous children. In Reyhner, J. (Ed.). *Honoring our children: Culturally appropriate approaches for teaching indigenous students.* Flagstaff: Northern Arizona University.

Skamp, K. (2015). Teaching science constructively. In Skamp, K. & Preston, C. (Eds.). *Teaching science constructively.* CENGAGE: South Melbourne.

Slattery, P. (2006). Curriculum development in the postmodern era. New York: Routledge.

Smith, B. (2002). Atlas.ti for qualitative data analysis. *Perspectives in Education*, 20 (3): 65-76.

Snape, D. & Spencer, L. (2003). The foundations of qualitative research. In Ritchie, J. & Lewis, J. (Eds.). *Qualitative research practice: A guide for social science researchers and students.* London: Sage.

Solomonidou, C. & Tassios, A. (2007). A phenomenographic study of Greek primary school students' representations concerning technology in daily life. *International Journal of Technology and Design Education*, 17: 113-133.

Stevens, L.R. (2012). Culturally responsive formative assessment. Unpublished MSc dissertation. Bozeman: Montana State University.

Sun, H. (2013). Critical design sensibility in postcolonial conditions. Tacoma: University of Washington Tacoma.

Svinicki, M. (1993). What they don't know can hurt them: The role of prior knowledge in learning. Austin: The University of Texas.

Swan, K. (2005). A constructivist model for thinking about learning online. In Bourne, J. & Moore, J.C. (Eds.). *Elements of quality online education: Emerging communities.* Needham: Sloan-C.

Taylor-Powell, E. & Renner, M. (2003). Analyzing qualitative data. Madison: University of Wisconsin-Extension.

Ter-Morshuizen, K.J., Thatcher,C. & Thomson, R. (1997). Primary technology: Teacher's resource book for Grades 1 to 7. Pietermaritzburg: Shuter & Shooter.

Thomas, P. Y. (2010). Towards developing a web-based blended learning environment at the University of Botswana. Unpublished Doctoral dissertation. Gaborone: University of Botswana.

Thomas, R. (1992). Cognitive theory-based teaching and learning in vocational education. Columbus: Ohio State University.

Travelyan, J.P. (2009). Engineering education requires a better model of engineering Paper presented at the Research in Engineering Education practice. Symposium. Carns, Australia.

Turuk, M.C. (2008). The relevance and implications of Vygotsky's social theory in second language classroom. *ARECLS*, 5: 244-262.

United Nations. (2005). Permanent forum on indigenous people: Report on thefourth session. New York: Economic and Social Council Report.

Valenzuela, D. & Shrivastava, P. (2002). Interview as a method for qualitative research. Available at: www.public.asu.edu/~kroel/www500/interview%20Fri.pdf. Accessed 14 November 2017.

Vandeleur, S. (2010). Indigenous technology and culture in the technology curriculum: Starting the conversation. A case study. Unpublished PhD Thesis. Grahamstown: Rhodes University.

Van Doorn, F. & Klapwijk, R. (2013). Human-centred design in primary schools: Paper presented at 2nd International Conference for Design Education Researchers. Oslo, Norway.

Van Putten, S., Botha, J., Mofolo-Mbokane, B., Mwambakana, J. & Stols, G. (2014). The culture-rich mathematics class: Maximising learning opportunities. In Vandeyar, S. (Ed.). Good practice in culture-rich classrooms: Research-informed perspectives. Cape Town: Oxford University Press.

Van Tassel-Baska, J., Bracken, B. & Drummond, D. (2003). The William and Mary Classroom Observation Scales-Revised (Part 3) Student Observation. Williamsburg: Center for Gifted Education.

Van Teijlingen, E. (2014). Semi-structured interviews. Poole: Bournemouth University.

Van Wyk, B. (2012). Research design and methods Part I. Cape Town: University of Western Cape.

Van Wyk, J.A. (2002). Indigenous knowledge systems: Implications for Natural Science

and Technology teaching and learning. *South African Journal of Education*, 22 (4): 305-312.

Veak, T. (2000). Whose technology? Whose modernity? Questioning Feenberg's questioning technology. *Science, Technology & Human Values*, 25(2): 226-237.

Venter, E. (2004). The nation of ubuntu and communalism in African educational discourse. *Studies in Philosophy and Education,* 23: 149-160.

Von Glasersfeld, E. (1995). A constructivist approach to teaching. In Steffe, L.P. & Gale, J. (Eds.). *Constructivism in education.* Hillsdale: Erlbaum Associates.

Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications,* 6(4): 1-17.

Weegar, M.A. & Pacis, D. (2012). A comparison of two theories of learning: Behaviorism and construction of applied to face-to-face and online learning. Paper presented at the E-leader. Manila, Philippines.

Welman, C., Kruger, F. & Mitchell, B. (2010). Research methodology. Cape Town: Oxford University Press.

Wertch, J.V., Rio, P.D. & Alvarez, A. (1995). Sociocultural studies of mind. Oakleigh: Cambridge University Press.

Wiersma, W. & Jurs, S.G. (2009). Research methods in education: An introduction. Boston: Pearson.

Williams, H. & McOwan, P. W. (2016). Manufacturing magic and computational creativity. *Frontiers in Psychology*, 7(855): 1-10.

Wilson, B.G. (2010). Constructivism in practical and historical context. In Reiser, B. & Dempsey, J. (Eds.). *Current trends in instructional design and technology*. Upper Saddle River: Pearson Prentice Hall.

Wong, Y.L. & Siu, K.W.M. (2012). Is there creativity in design? From a perspective of school Design and Technology in Hong Kong. *Asia Pacific Education Review*, 13: 464-474.

Yager, R.E. (1996). A current research paradigm provides the basis for a new approach to curriculum, instruction and teacher education in science. In Gupta, V.K. (Ed.). *Science and Technology Education*. Arun: Chandigarh.

Yishak, D.M. & Gumbo, M.T. (2014). Indigenising the curricula in Ethiopia from Gamo ethnic group perspective: The case of constitutional, policy and strategy provisions. *Mediterranean Journal of Social Sciences*, 5(10): 185-197.

Yu, K.C., Lin, K.Y. & Hung, K.F. (2010). Teaching science through technology: A confluence of knowledge, design and construction. *World Transactions on Engineering and Technology Education*, 8(4): 436-441.

Zhang, Y. & Wildemuth, B. M. (2009). Qualitative analysis of content. *Applications of Social Research Methods to Questions in Information and Library Science,* 318: 1-12.

APPENDICES

APPENDIX 1: INTERVIEW GUIDE FOR TEACHERS AND HEADS OF DEPARTMENTS (HoDs)

THEMES AND QUESTIONS

The value of indigenous knowledge (IK)

1. What is your understanding of indigenous knowledge?

2. What indigenous knowledge is evident in your locality?

3. What technological indigenous designs are you aware of in your locality?

4. What skills can you identify by inspecting such designs?

5. Do you think that the integration of these skills in the teaching of Technology can help make the learning of design skills more meaningful to the learners? Give reasons for your answer.

Indigenous knowledge as content

1. Explain the CAPS design skills content that is being taught to learners.

2. In your opinion, does this content include the aspects of indigenous design skills that you have mentioned? Why do you think it does?

3. Please explain how this content (of design skills) can be made relevant to the learners' cultural world.

4. Have you made any attempts to integrate indigenous knowledge in the design skills content that you plan to teach your learners and if so, how did you do it?

5. How did your learners react to such integration?

Teaching strategies

1. Please tell me about the methods you apply in teaching design skills.

2. Considering your learners' socio-cultural environment, how do you make these methods culturally relevant so that they can promote meaningful learning?

3. How do your teaching methods help to transform the dominant design-make-evaluate method?

4. How do you teach in a way that allows learners to use their own knowledge in completing the design projects that you plan for them?

5. From an indigenous knowledge point of view, how does your teaching provide opportunities for your learners to co-construct during the process of designing a solution to an existing problem?

6. Have you used any indigenous artifacts to teach design skills and if so, what artifacts did you use and how did you use them?

7. How could you use the inquiry teaching approach to promote the use of indigenous knowledge acquired from indigenous communities?

8. How could you use the discovery teaching approach to promote the use of indigenous knowledge acquired from indigenous communities?

Learning strategies

1. Which learning methods do you use in your design process lessons to relate learning to the learners' contexts?

2. How can those learning methods be used to accommodate indigenous design skills?

3. Which specific learning method do you use to ensure that learners engage in the co-construction of knowledge in their design tasks?

Assessment strategies

1. Which assessment methods do you use to promote the development of design skills from indigenous perspectives?

2. How do you use them?

3. How and why do your learners respond to assessment tasks that integrate indigenous knowledge?

The role of MKOs

1. Have you ever invited indigenous community members, especially elders, who are experts in some aspects of technology, to demonstrate their technological knowledge to the learners?

2. If so, for which lesson(s) did you invite them?

3. What exactly did they do?

4. How could you use their skills in the teaching of design skills?

APPENDIX 2: INTERVIEW GUIDE FOR TECHNOLOGY EDUCATION SPECIALISTS

The role of integrating indigenous knowledge (IK)

1. What is your understanding of indigenous knowledge?

2. Please explain the design skills content in the CAPS.

3. Do you think that the CAPS caters for the integration of indigenous knowledge? If yes, how is this done?

4. How do you help your teachers to integrate indigenous knowledge in their teaching?

5. Do you think that the integration of indigenous knowledge is important in the teaching of design skills? Why?

6. What advice would you give Technology teachers about making the content of design skills relevant to the learners' cultural world?

7. Which methods can you suggest for making content relevant, and why do you think that those methods are appropriate?

8. In your view, how can Technology teachers involve their learners during the teaching of the design process and encourage them to use their indigenous knowledge?

9. Which assessment methods would you advise Technology teachers to use to promote the development of design skills from the indigenous knowledge point of view?

10. Can Technology teachers involve indigenous community members, especially the elders, who are experts in design skills? For what reason would they invite them?

11. With which lesson(s) do you think expert elders can be asked to assist? How will they assist the teacher?

12. Which indigenous technological artifacts can Technology teachers use in the teaching of design skills?

APPENDIX 3: INTERVIEW GUIDE FOR PARENTS

THEMES AND QUESTIONS

The value of integrating indigenous knowledge (IK)

1. What is your understanding of local knowledge?

2. How do you teach local knowledge to your children?

3. Do you think that the integration of local knowledge in Technology is important in teaching design skills? Why?

IK as content

1. Please explain what local knowledge you think can be taught to your children to inculcate design skills?

2. How is the design skills content taught in schools related to the learners' cultural world?

Teaching strategies

1. Please tell me what you know about indigenous teaching strategies.

2. How can teachers make the content meaningful to your children, considering their sociocultural environment?

3. How do you use indigenous methods to promote the acquisition of design skills at home?

Learning strategies

1. Please explain the indigenous learning strategies that you use in order to help your children develop design skills.

2. How can those learning strategies be used to integrate indigenous knowledge to cultivate design skills?

Assessment strategies

1. Which assessment strategies that represent an indigenous perspective can be used by teachers to promote the development of design skills?

2. How can teachers use culturally responsive feedback to promote the use of indigenous knowledge in assessing design skills?

The role of MKOs

1. Has a Technology teacher ever invited you to your child's school to share your knowledge with the learners?

2.   If so, for which lesson(s) you were invited?

3.   What exactly did you do?

4.   How could you assist the teacher in the teaching of design skills?

APPENDIX 4: INTERVIEW GUIDE FOR TECHNOLOGY LEARNERS

QUESTIONS

1. What African knowledge are you taught at home?

2. How much of that knowledge is technological?

3. Do you think such knowledge should be taught in schools? Explain why you think so.

4. Do your Technology lessons that teach the design process include technologies related to your culture? What are they?

5. How do you apply the process steps design, make, evaluate and communicate in your cultural context?

6. Are any of them included in the learning of the design process? How?

7. Does learning those steps in any way integrate the design, make, evaluate and communicate skills from your culture?

8. How well do you understand lessons that integrate indigenous knowledge?

9. Which methods do you think your teacher should use in order to integrate indigenous knowledge?

10. How can such methods help you to understand Technology better?

11. Can you think of any assessment strategies that your teachers used in the past that helped to promote the integration of indigenous knowledge?

12. Can you identify anyone from your community who is an expert in some form of technological design?

13. If you can, what form of design is it?

14. How can the designs you mentioned help you to understand and apply the design process?

APPENDIX 5: CLASSROOM OBSERVATION CHECKLIST

Observer: …………………………......................

Teacher: ....

School: ....

Number of learners: ....

Date of observation: ....

Time of observation: ....

Specific lesson aim: …………………………….

Topics: …………………….………………………

PART 1: OBSERVATION OF TEACHER'S ROLE

Accommodation of IK in the teaching of design skills			
Item observed	Yes	No	Evidence/Comment
1. The content taught is derived from indigenous contexts.			
2. The scenarios given by the teacher integrate indigenous knowledge.			
3. Learners are organised for collaborative learning, which is consistent with organisational behaviour in indigenous communities.			
4. Design tasks give learners opportunities to design artifacts from their cultural perspective.			
5. Evidence of the use of indigenous technologies is present.			
Differentiated teaching methods			

	Yes	No	Evidence/Comment
1. The teacher accommodates learners' indigenous knowledge.			
2. The teaching methods used promote the integration of indigenous knowledge in the process of designing, making, evaluating and communicating skills.			
Differentiated assessment methods			
1. Different assessment methods are used to allow the integration of indigenous knowledge.			
2. Culturally responsive feedback is used in the assessment of learners.			
3. The assessment of the learners' capability tasks has relevance to their indigenous contexts.			

PART 2: OBSERVATION OF LEARNERS' ROLES

Learners' development of design skills			
Item observed	Yes	No	Evidence/Comment
Ability to identify problems from indigenous scenarios			
Ability to generate different ideas, including those that speak to indigenous knowledge			
Ability to make products that are suitable for indigenous contexts			
Ability to evaluate new products by considering their relevance to their (learners') own indigenous contexts			
Motivated to learn when indigenous technology is used			

Ability to grasp design skills when indigenous knowledge is integrated			
Ability to generate innovative ideas when indigenous knowledge is integrated			

APPENDIX 6: DOCUMENT ANALYSIS GUIDE

Aspect	Information
1. Type of document (Textbook, CAPS documents, ATP, Lesson plans, assessment plans or question papers)	
2. Date of document analysis	
3. Author of document	
What are the main topics in the document?	
Is there any evidence of indigenous knowledge in the document?	
Level of indigenous knowledge content (progression of indigenous knowledge concepts)	
Do the suggested approaches promote a culturally relevant pedagogy?	
Is there evidence of the use of indigenous knowledge in different assessment activities?	

APPENDIX 7: ARTIFACT ANALYSIS GUIDE

Artifact analysed: ……………………………………………………

Items	Yes/No	Explanation of observed phenomenon
The artifact is meant to solve a local problem.		
The artifact seems to be sourced from indigenous context.		
The artifact was influenced by indigenous values and attitudes.		
The material shows indigenous cultural features.		
The materials used are widely accessible in the local environment.		
Indigenous skills were used to process the raw materials.		
The finishing of the design shows the use of indigenous skills.		

APPENDIX 8: REQUEST TO CONDUCT RESEARCH IN THE VHEMBE DISTRICT

19413 Phakama Crescent

Ext 9

Kagiso

1754

10 October 2018

The District Director

Limpopo Department of Education

Vhembe District

Private Bag X 2250

Sibasa

0970

Tel: 015 962 5715

Dear Dr Rambiyana

Re: Request to conduct research at the Vhembe District Office and Malamulele East and North East Circuit schools.

I, Richard Maluleke, am currently studying towards a doctoral degree under the supervision of Professor Mishack Gumbo, a professor in the Department of Science and Technology Education at the University of South Africa (UNISA). I hereby request permission to conduct a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective' at the above-mentioned schools. The aim of this study is to examine the role of indigenous knowledge in developing Senior Phase learners' design skills in Technology Education. Your department has been selected because I am doing education-related research that will benefit the learners and other stakeholders in education, such as teachers, in contexts where the findings of the study may be relevant.

I intend to involve three schools in the Malamulele East and North East Circuits in this research. Eighteen learners will be involved in focus group interviews, three HoDs and nine teachers will be involved in individual interviews, and lessons will be observed. I also intend

to conduct individual interviews with three Technology Education specialists from the Vhembe District Office. This study may benefit you and other Technology Education specialists as I hope to show how the teaching of design skills may be improved to the advantage of learners. I would like to inform you that the participants in this study will not be exposed to any risk. No compensation or incentives will be offered for participation in the research, which will be conducted during the first term of the 2019 academic year. The findings of the research will be used solely for the purpose of this study, and the participation of learners, teachers, HoDs and Technology Education specialists will be voluntary. The names of the schools and the participants in this study will be kept confidential. This study will play a crucial role in teaching and learning as it will help Technology teachers to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology.

Should you have any queries, please do not hesitate to contact me at the number provided below.

Thanking you in anticipation for your cooperation in this regard.
Yours faithfully
Mr Maluleke Richard (DEd student)
University of South Africa
Cell no. 0722915582
Email: richardmaluleke@gmail.com
Researcher's signature: _____   Date: _____

APPENDIX 9: REQUEST TO CONDUCT RESEARCH IN THE MALAMULELELE EAST AND NORTH EAST CIRCUITS

<div align="right">

19413 Phakama Crescent

Ext 9

Kagiso

1754

10 October 2018

</div>

The Circuit Manager

Dear Sir/Madam

Re: Request to conduct research in your circuit schools

I, Richard Maluleke, am currently studying towards a doctoral degree under the supervision of Professor Mishack Gumbo, a professor in the Department of Science and Technology Education at the University of South Africa (UNISA). I hereby request permission to conduct a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective'. The aim of this study is to examine the role of indigenous knowledge in developing Senior Phase learners' design skills in Technology Education. Your department has been selected because I am doing education-related research that will benefit the learners and other stakeholders in education, such as teachers, in contexts where the findings might have relevance.

I intend to involve three schools in the Malamulele East and North East Circuits in this research. Eighteen learners will be involved in focus group interviews, three HoDs and nine teachers will be involved in individual interviews, and their lessons will be observed. I also intend to conduct individual interviews with three Technology Education specialists from the Vhembe District Office. This study may benefit you and other Technology Education specialists as I hope to show how the teaching of design skills may be improved for the benefit of learners. I would like to inform you that the participants in this study will not be exposed to any risk. No compensation or any incentives will be offered for participation in the research. The research will be conducted during the first term of the 2019 academic year and the findings will be used solely for the purpose of this study. The participation of learners, teachers, HoDs

and Education specialists will be voluntary and the names of the schools and all the participants in this study will be kept confidential. This study will play a crucial role in teaching and learning as it will help Technology teachers to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology.

Should you have any queries, please do not hesitate to contact me at the number provided below.

Thanking you in anticipation for your cooperation in this regard.

Yours faithfully

Mr Maluleke Richard (DEd student)

University of South Africa

Cell no. 0722915582

Email: richardmaluleke@gmail.com

Researcher's signature: _____ Date: _____

APPENDIX 10: REQUEST TO CONDUCT RESEARCH AT THREE PRIMARY SCHOOLS

19413 Phakama Crescent

Ext 9

Kagiso

1754

10 October 2018

The Principal

Dear Sir/Madam

Re: Request to conduct research at your school.

I, Richard Maluleke am currently working towards a doctoral degree under the supervision of Professor Mishack Gumbo, a professor in the Department of Science and Technology Education at the University of South Africa (UNISA).

I hereby request permission to conduct a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective.' The aim of this study is to examine the role of indigenous knowledge in developing Senior Phase learners' design skills in Technology Education. Your school has been selected because I am doing education-related research that will benefit the learners and teachers at your school and other schools where the findings of the study may be relevant. This study will play a crucial role in teaching and learning as it will help Technology teachers to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology.

Six learners will be involved in focus group interviews and individual interviews will be conducted with one HoD and three teachers. I will also observe lessons. I would like to inform you that the participants in this study will not be exposed to any risk. No compensation or incentives will be offered for participation in the research, which will be conducted during the first term of the 2019 academic year.

The findings of the research will be used solely for the purpose of this study, and the participation of learners, teachers and HODs will be voluntary. The names of the schools and all the participants in this study will be kept confidential.

Should you have any queries, please do not hesitate to contact me at the number provided below.

Thanking you in anticipation for your cooperation in this regard.

Yours faithfully

Mr Richard Maluleke (DEd student)

University of South Africa

Cell no. 0722915582

Email: richardmaluleke@gmail.com

Researcher's signature: _____   Date: _____

APPENDIX 11: PARTICIPANT INFORMATION SHEET AND CONSENT FORM FOR TECHNOLOGY EDUCATION SPECIALISTS

Date: 10 October 2018

Title: An alternative design-based pedagogy for Technology Education: An indigenous perspective

Dear Technology Education Specialist

My name is Richard Maluleke and I am currently studying towards a doctoral degree at the University of South Africa (UNISA) under the supervision of Prof. Mishack Gumbo, a professor in the Department of Science and Technology. I am inviting you to participate in a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective'. This study is expected to collect important information that could play a crucial role in teaching and learning as it will help Technology teachers to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology.

I obtained your contact details from the District Director of Vhembe and would like to invite you to participate in the study as you are a Senior Phase Technology Education specialist. I would like to interview you to obtain your views on the nature of the influence that indigenous knowledge has on the development of learners' design skills in the subject Technology.

You will be involved in only one individual interview of approximately forty-five minutes. A semi-structured interview and probing questions will be used, and with your permission I would like to make an audio recording of the interview. The collected information will be used solely for the purposes of this study.

Your participation will be voluntary and you will be free to withdraw at any time without any negative consequences. This study will play a crucial role in teaching and learning as it will lead to new insight into the value of the integration of indigenous knowledge in the teaching of design skills and will help Technology teachers and learners to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology. This study may also benefit you and other Technology Education specialists as it is envisaged that the findings will indicate how the teaching of design skills can be improved for the benefit of learners. Your

anonymity and confidentiality will be ensured by using codes for your name in the report on this study.

I will store hard copies of your answers in a locked filing cabinet for a period of five years, after which they will be destroyed by shredding. You will not receive any payment for your participation in this study, which will be conducted once I have received a written letter of approval from the Research Ethics Review Committee at UNISA. A copy of the letter of approval can be obtained from me on request.

If you would like to be informed of the final research findings, please contact Richard Maluleke on 0722915582, or email richardmaluleke@gmail.com. The findings will be accessible for a period of five years.

Should you have any queries, please do not hesitate to contact me.

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

If you are willing to participate in this study, you are kindly requested to complete the attached consent form.

Yours faithfully

Mr Richard Maluleke (DEd student)

Researcher's signature: _____ Date: _____

APPENDIX 12: CONSENT TO PARTICIPATE IN STUDY (Return slip)

I, _____ (participant's name), confirm that the person asking my consent to take part in this research has informed me about the nature, procedure, potential benefits and anticipated inconvenience of participation. I have read and understand the details of 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 negative consequences.

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 agreed to.

I agree to the recording of the interview by means of _____ (insert specific data collection method).

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

Participant's name and surname (Please print):

_____

Participant's signature: _____

Researcher's name and surname (Please print):

_____

Researcher's signature_____

Date: 10 October 2018

Title: An alternative design-based pedagogy for Technology Education: An indigenous perspective

Dear Sir/Madam

My name is Richard Maluleke and I am currently studying towards a doctoral degree at the University of South Africa (UNISA) under the supervision of Prof Mishack Gumbo, a professor in the Department of Science and Technology. I would like to invite you to participate in a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective'. The findings of this study are expected to provide important information that could play a crucial role in teaching and learning as it will help Technology teachers and Heads of Departments to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology. You are invited because you are a Senior Phase Technology Head of Department and I would like to find out how you view the role of indigenous knowledge in the development of learners' design skills in the subject Technology. I obtained your contact details from your school principal.

Should you agree to participate, I will conduct an individual interview of at least forty-five minutes with you and will also observe one of your lessons for a whole period. With your permission I would like to make an audio recording of the interview. The collected information will be used solely for the purpose of the study. Semi-structured interviews will be used, which will include a series of open-ended and probing questions. You are kindly requested to provide me with the following documents: the CAPS Technology document, Technology textbooks, an annual teaching plan (ATP) and question papers.

Your participation in this study is voluntary and you will be free to withdraw at any time without any negative consequences.

This study will play a crucial role in teaching and learning as it will help Technology teachers to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology. This study may benefit you and other HoDs as I hope to show how the teaching of design skills may be improved to the advantage of learners. Your anonymity and confidentiality will be ensured by using codes instead of your name and your school name in my report on the findings of this study. The hard copies of your answers will be stored in a locked filing cabinet for a period of five years, after which they will be destroyed by shredding. You will not receive any compensation for your participation in this study. This study will only be conducted once I have received a written letter of approval from the Research Ethics Review Committee. A copy of approval letter can be obtained from me on request.

If you would like to be informed of the final research findings, please contact Richard Maluleke on 0722915582 or email richardmaluleke@gmail.com. The findings will be accessible for a period of five years.

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

If you are willing to participate in this study, you are kindly requested to complete the attached consent form.

Yours faithfully

Mr Richard Maluleke (DEd student)

Researcher's signature: _____ Date: _____

APPENDIX 14: CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

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

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 agreed to.

I agree to the recording of the interview by means of _____ (insert specific data collection method).

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

Participant's name and surname (Please print)

_____

Participant' signature

_____

Researcher's name and surname (Please print)

_____

Researcher's signature

_____

APPENDIX 15: PARTICIPANT INFORMATION SHEET AND CONSENT FORM FOR PARENTS

Date: 10 October 2018

Title: An alternative design-based pedagogy for Technology Education: An indigenous perspective

Dear Parent

My name is Richard Maluleke and I am currently studying towards a doctoral degree under the supervision of Prof Mishack Gumbo, a professor in the Department of Science and Technology at the University of South Africa (UNISA). I would like to invite you to participate in a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective', which is intended to collect important information that could play a crucial role in teaching and learning as it will help Technology teachers and learners to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology. You are invited to participate because you are a parent who possesses local knowledge and I would like find out how you view the role of indigenous knowledge in the development of learners' design skills in the subject Technology. I obtained your contact details from community members who regard you as knowledgeable.

I will conduct a focus group interview of at least fifty minutes with a group of participating parents. I will use semi-structured interviews, which will involve a series of open-ended and probing questions. With your permission I would like to make an audio recording of the interview. The information that I collect will be used solely for the purpose of this study.

Your participation in this study will be voluntary and you will be free to withdraw your participation at any time without any negative consequences. The findings of this study will play a crucial role in teaching and learning as it will help Technology teachers and learners to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in the subject Technology. This study may benefit you and other parents by providing information on how the teaching of design skills may be improved for the benefit of learners. Your anonymity and confidentiality will be ensured as in my report on the findings of this study I will use codes instead of your name.

I will store the hard copies of your answers in a locked filing cabinet for a period of five years, after which they will be destroyed by shredding. You will not receive any compensation for your participation in this study. I will only conduct this study once I have receiving a written letter of approval from the Research Ethics Review Committee. A copy of the letter of approval can be obtained from me on request.

If you would like to be informed of the final research findings, please contact Richard Maluleke on 0722915582, or email richardmaluleke@gmail.com. The findings will be accessible for a period of five years.

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

If you are willing to participate in this study, you are kindly requested to complete the attached consent form.

Yours faithfully

Mr Richard Maluleke (DEd student)

Researcher's   name: ———————— Signature: _____

Date: _____

APPENDIX 16: CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____(participant's name), confirm that the person asking my consent to take part in this research has informed me about the nature, procedure, potential benefits and anticipated inconvenience of participation. I have read and understand the details of 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 negative consequences.

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 agreed to.

I agree to the recording of the interview by means of (insert specific data collection method).

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

Participant's name and surname (Please print)

_____

Participant's signature

_____

Researchers' name and surname (Please print)

_____

Researcher's signature

_____

APPENDIX 17: PARENTAL CONSENT FOR PARTICIPATION OF MINORS IN A RESEARCH PROJECT

Date: 10 October 2018

Title: An alternative design-based pedagogy for Technology Education: An indigenous perspective

Dear Parent

I would like to invite your child to participate in a study entitled 'An alternative design-based pedagogy for Technology Education: An indigenous perspective'. I am undertaking this study as part of my doctoral research at the University of South Africa with the purpose of determining how indigenous knowledge influences the development of learners' design skills in the subject Technology. This study will play a crucial role in teaching and learning as it will help Technology teachers and learners to reflect on the role of indigenous knowledge (IK) in the acquisition of design skills in Technology.

Permission for your child's participation in this study is herewith requested as I would like to find out how learners view the role of IK in the acquisition of design skills. I expect to have eighteen children participating in the study. If you allow your child to participate, I shall request him/her to take part in a group interview of at least fifty minutes, which will be conducted at your child's school in the first term of the 2019 academic year. Any information that is obtained in connection with this study will remain confidential and will only be disclosed with your permission. Your child's responses will not be linked to his/her name in any written or verbal report relating to this study. Such a report will be used for this research study only.

Participation in this study does not hold any foreseeable risk for your child. There will be no compensation for, or direct benefits from participating in the study. However, it is hoped that the findings of the study will benefit education by helping Technology teachers and learners to see how the teaching of design skills can be improved for the benefit of your child.

Your child's participation in this study is voluntary and he/she may decline to participate, or may withdraw from participation at any time without any negative consequences. Similarly, if

you agree to allow your child to participate in the study, you too are free to change your mind later. The interview will be conducted at your child's school with the prior approval of the school and your child's teacher. However, if you do not want your child to participate, he/she will be temporarily accommodated in another Grade 7 class to continue with his/her school work as usual without any interruption while the study is being conducted. In addition to your permission, we also require your child to agree to participate in the study, and you will be asked to sign the accompanying consent form and your child will asked to sign assent form. If your child does not wish to participate in the study, there will be no negative consequences. The information gathered during the interview with your child will be stored securely on a password-protected computer in my locked office for five years, after which all records will be deleted.

My contact number is 0722915582 and my email address is richardmaluleke@gmail.com. Your signature below indicates that you have read the information provided above and have decided to allow your child to participate in the study. You may keep the copy of this letter.

Name of child:⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

Sincerely

Parent/guardian's name (Please print) and signature:_____

Date:_____

Researcher's name: _____

Researcher's signature: _____

Date: _____

APPENDIX 18: REQUEST FOR PRIMARY SCHOOL LEARNERS TO PARTICIPATE IN RESEARCH PROJECT

Dear Technology learner

My name is teacher <u>Richard Maluleke</u> and would like to ask you some questions in order to find out what you think about the role of African Indigenous Knowledge in the development of design skills. I would like know whether the indigenous knowledge that you have acquired in your community has helped you to understand what you learn about design skills in your Technology class at school. I will not ask you to do anything that may be harmful to or that you do not want to do. I will also ask your parents' permission for your participation in this study. If you do not want to take part, it will be fine with me. Remember, you can say yes or no and no one will be upset if you do not want to take part, or even if you agree to take part but later change your mind and decide to stop. You are welcome to ask me any questions that you may have about my study.

Please speak to your mom or dad about taking part before you sign this letter. Signing your name at the bottom means that you agree to take part in this study. A copy of this letter will be given to your parents.

Regards

Teacher: RICHARD MALULEKE

Signature: _____ Date_____

Your name	Yes, I will take part	No, I do not want to take part
Name of the researcher: Richard Maluleke		
Date:		

Witness:		

APPENDIX 19: FOCUS GROUP CONSENT AND CONFIDENTIALITY AGREEMENT FOR PARENTS

I, _____, hereby grant Mr Richard Maluleke permission to use the information I share during the focus group session for research purposes. I am aware that the group discussions will be digitally recorded and consent to these recordings, provided that my privacy will be protected. I undertake not to divulge any information that is shared in the group discussions to any person outside the group in order to maintain confidentiality.

Participant's name (Please print):

_____

Participant's signature:

_____

Researcher's name: <u>RICHARD MALULEKE</u>   Researcher's signature: _____
_____

Date:_____

APPENDIX 20: FOCUS GROUP ASSENT AND CONFIDENTIALITY AGREEMENT FOR LEARNERS

I_____ grant Mr Richard Maluleke permission to use the information I share during the focus group for research purpose. I am aware that the group discussions will be digitally recorded and assent to these recordings, provided that my privacy will be protected. I undertake not to divulge any information that is shared in the group discussions to any person outside the group in order to maintain confidentiality.

Participant's name (Please print):

Participant's signature: _____

Researcher's name: <u>RICHARD MALULEKE</u>   Researcher's signature: _____

 Date: _____

APPENDIX 21: RESEARCH ETHICS CLEARANCE CERTIFICATE

UNISA | university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2018/11/14

Ref: **2018/11/14/47288906/41/MC**

Name: Mr R Maluleke

Student: 47288906

Dear Mr Maluleke

Decision: Ethics Approval from
2018/11/14 to 2023/11/14

Researcher(s): Name: Mr R Maluleke
E-mail address: richardmaluleke@gmail.com
Telephone: +27 72 291 5582

Supervisor(s): Name: Prof MT Gumbo
E-mail address: gumbomt@unisa.ac.za
Telephone: +27 12 429 3339

Title of research:

An alternative design based pedagogy for Technology Education: An indigenous perspective

Qualification: D. Ed in Science and 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 2018/11/14 to 2023/11/14.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2018/11/14 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(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

2. 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.

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.

4. 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.

5. 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.

6. 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.

7. No field work activities may continue after the expiry date **2023/11/14**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2018/11/14/47288906/41/MC** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,

Prof VG Gasa
CHAIRPERSON: CEDU RERC
Gumbomt@unisa.ac.za

Prof V McKay
EXECUTIVE DEAN
Mckayvi@unisa.ac.za

Approved - decision template – updated 16 Feb 2017

LIMPOPO
PROVINCIAL GOVERNMENT

DEPARTMENT OF
EDUCATION

REF: 12/1/10/8   ENQ: MATIBE M.S CONTACT NO: 082 300 4774

Mr MALULEKE RICHARD
19413 PHAKAMA CRESCENT
EXT 9
KAGISO
1754

REQUEST TO CONDUCT RESEARCH AT VHEMBE DISTRICT OFFICE AND MALAMULELE EAST AND NORTH EAST CIRCUIT SCHOOLS.

1. This serves to inform you that your request to conduct research at the above-mentioned institutions has been approved.

2. You are expected to ensure that your interaction with learners and educators will not disrupt teaching and learning activities.

3. We appreciate your commitment to adhere to ethical considerations and hope that your study will contribute immensely in the field of Technology Education.

4. Kindly inform the Circuit Managers, Principals of selected schools and the District co-ordinator of Technology prior to commencing your collection of data.

5. Wishing you the best in your intellectual endeavours.

DISTRICT DIRECTOR

14 01 2019
DATE

REQUEST TO CONDUCT RESEARCH AT VHEMBE DISTRICT OFFICE AND MALAMULELE EAST AND NORTH EAST CIRCUIT SCHOOLS. Mr MALULEKE RICHARD

APPENDIX 23: PERMISSION LETTER APPROVAL FROM MALAMULELE CIRCUIT

LIMPOPO
PROVINCIAL GOVERNMENT

DEPARTMENT OF EDUCATION
VHEMBE EAST DISTRICT
MALAMULELE EAST CIRCUIT

Private Bag X9259
SASELAMANI
0928
Tel.: (015) 853 1089
11 December 2018

Enq: NDOUVHADA M.M
Cell: 079 272 5166
Email: ndouvhadamm@gmail.com

TO: MR MALULEKE RICHARD
DEd STUDENT UNISA

Sir

RE: **PERMISSION GRANTED FOR YOUR DOCTORAL RESEARCH STUDY.**

1. The above letter refers.

2. This note serves to permit you for your Doctoral Research Study as submitted to Malamulele East Circuit in Vhembe East District.

3. Hope you will comply with the research ethical considerations as directed to all researchers.

4. Wish you all the best in your studies.

Yours truly

NDOUVHADA M.M
CIRCUIT MANAGER
MALAMULELE EAST CIRCUIT

EDITOR'S STATEMENT

FJ Opper – Translator and Language Editor
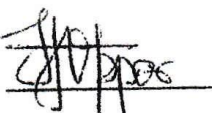
6 Birkenhead Avenue
CAPE ST FRANCIS
6312   Tel 042 298 0330 / 082 5326 015

TO WHOM IT MAY CONCERN

Herewith I, FJ OPPER, confirm that I undertook the language editing of
Mr Richard Maluleke's doctoral thesis titled:

**AN ALTERNATIVE DESIGN-BASED PEDAGOGY FOR
TECHNOLOGY EDUCATION: AN INDIGENOUS PERSPECTIVE**

8 June 2019