Boys' and girls' perspectives on learning technology education concepts: a case study of primary schools

by

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I declare that the work I am submitting for assessment/review contains no section copied in whole or in part from other sources unless explicitly identified by quotation marks and with detailed, complete and accurate referencing.

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ABSTRACT

Ukusebenza kwentando yeningi eNingizimu Afrika (SA) kwaletha izinguquko eziningi endleleni abantu baseNingizimu Afrika ababephila ngayo. Umkhakha wezemfundo nawo wathinteka ngenxa yalezo zinguquko. Izifundo ezazifundwa ngaphambili zahlelwa kabusha zaba yizifundo ezintsha ezihloselwe ngokuyinhloko ukugxilisa ifilosofi ye-Outcomes Based Education (OBE) exhumaniswa neSitatimende Sikazwelonke Sohlelo Lwezifundo (i-NCS). Kwabonakala ukuthi imfundo yangesikhathi sombuso wobandlululo yayithuthukisa ukufunda okungahileli ukucabanga nokuqonda, nokungayamukeli imibono ehlukile, okuyimfundo eyakhiqiza abafundi abangakwazi ukucubungula izinto, ukusungula izinto, ukuza nemibono nemicabango emisha, ababengakwazi ukusebenzisa lokho abakufunde ekilasini ezimweni ezihlukahlukene nezishintshashintshayo. Lokhu kwadala izinselele ezinkulu ezweni. Abafundi abaningi abakhiqizwa yimfundo yangesikhathi esidlule babengakwazi ukubhekana nezidingo zomphakathi ezishintsha njalo. Lokho kwenza izifundo eziningi zaba yinhlekisa ngoba ezikuqukethe kwakungaqondakali.

Izifundo ezinjengeSayensi, Izibalo Nezobuchepheshe zidinga, phakathi kokunye, ukuba abafundi bafunde futhi basebenzise leyo mfundo ezimweni abangazijwayele ngenxa yezinjongo ezihlukahlukene. Ukusetshenziswa kokuqukethwe kudinga, phakathi kwezinye izinto, ukuthi abafundi bakha okushiwo kokuqukethwe okufundwayo, benze ukuzihlanganisa phakathi kwezingcezu zokuqukethwe, bahlanganyele ekufundweni okususelwa kuProjekthi ngokusetshenziselwa, kokudala nokuhlolisisayo kokuqukethwe futhi bakwazi ukwakha ubudlelwano phakathi okusha nokuqukethwe okukhona esikhundleni sokulawula kabusha lokho okwethulwa ukubhekana nezinselelo umhlaba obhekene nazo njengamanje

Izitatimende Zenqubomgomo Yezikhombo Zokuhlola Nokuhlola (i-CAPS) ye-NCS, zafuna ukuguqula lelo hlobo lesimo semfundo ngokuqhakambisa ukuthuthukiswa kwamakhono ekhulu lama-21 afaka amakhono acacisayo, okudala, okuxazulula izinkinga. Kwakungenakwenzeka ukufeza izinhloso zekhulu lama-21 ngokusebenzisa ikharikhulamu yokufunda eyedlule nenethiwekhi yesikhathi esedlule. Ngokwengeziwe Ukwenza lokho kudinga, phakathi kokunye, ukuba baqonde okushiwo yisifundo kunokuba bamane nje babambe ngekhanda lokho abakufundiswayo kodwa bengakuqondi. Lokhu kwakunzima kakhulu ukukwenza ngesikhathi kusasetshenziswa ikharikhulami yemfundo endala eyayingakukhuthazi ukucabanga. Ngaphezu kwalokho, esikhathini esidlule imfundo yayigxile kubantu besilisa njengoba kwakulindeleke ukuba benze imisebenzi enzima emphakathini futhi lokho kwakuthinta nezinqumo abafundi ababezenza ngokuphathelene nezifundo zasesikoleni. Ngenxa yalokho, abesilisa kwakulindeleke ukuba bakhethe futhi benze kahle ezifundweni ezinjengeSayensi, Izibalo kanye Nezobuchwepheshe. Uma kwenzeka owesifazane enze kahle ezifundweni zakhe, lokho kwakubhekwa njengento eyivela kancane.

Nokho, sekudlule iminyaka engu-23 kwaqala ukusebenza intando yeningi, kodwa imiphumela yalokho okwakwenzeka esikhathini esidlule isabonakala futhi ithinta zonke izingxenye zokuphila kwethu. Imiphumela yezifundo zeSayensi Nezobuchwepheshe kubesilisa nabesifazane ibonisa ukuthi okwakwenzeka esikhathini esidlule akukashintshi. Uhlelo olusha lwemfundo luhlose ukushintsha imiphumela eyayibangelwa umbuso wobandlululo, futhi kumelwe ukuba manje lolo shintsho siyalubona eNingizimu Africa nezemfundo kumelwe ngabe sezithuthukile. Kodwa abafundi abaningi basadonsa kanzima futhi kubi kakhulu lapho kuziwa emiphumeleni yeSayensi Nezobuchwepheshe. Ngakho, ukufundwa kwalezi zifundo kudala izinselele ezinkulu futhi ukuphumelela kwanoma yiluphi uhlelo lwemfundo kunqunywa, phakathi kokunye, imiphumela etholakala ngokusetshenziswa kweSayensi Nezobuchwepheshe, ikakhulukazi kule nkathi ye-4th Industrial Revolution (4IR). Iqiniso liwukuthi, abafundi abanawo umbono omuhle ngokufunda iSayensi Nezobuchwepheshe. Amantombazane ayizisulu eziyinhloko futhi okulindelwe umphakathi kuyimbangela eyinhloko yemibono enjalo, kuthinta isilinganiso sokuphumelela kwamantombazane ezifundweni zeSayensi Nezobuchwepheshe.

Kulolu cwaningo, umcwaningi ubehlose ukuqonda imibono amantombazane nabafana abanayo mayelana nokufunda izinto zobuchwepheshe kwezinye izikole zamabanga aphansi eGert Sibande Education District eSifundazweni saseMpumalanga. Ukuze enze lokho, umcwaningi usebenzise indlela yokucwaninga emsiza aqonde ehilela ukuxoxa nabantu nokuzinika isikhathi sokubabuka ukuze aqongelele imininingwane. Ngamabomu kwakhethwa abafundi abayishumi ezikoleni ezinhlanu zamabanga aphansi. Izingxoxo nabo zaqoshwa kusetshenziswa umshini wokuqopha izwi, kwabhalwa namaphuzu ahambisana nalezo zingxoxo. Ngaphezu kwalokho, kwaba nesikhathi sokubuka laba bafundi abakhethiwe ukuthi baziphatha kanjani ekuphileni okuvamile.

Kulolu cwaningo, umcwaningi wafuna ukuvula imibono yabafana namantombazane ngokufunda imiqondo yezobuchwepheshe ezikoleni zamabanga aphansi esifundeni saseGert Sibande esifundazweni saseMpumalanga. Ukufunda ukubuka, ukubuka, imizwa kanye nesimo sengqondo sabafundi (abafana namantombazane) maqondana nokufunda imiqondo yeTekhnoloji kwakudinga ukuba bahumushe imizwa yabo, ukubuka kwabo, imibono kanye nemizwa yabo maqondana nemicabango enjalo.Ukuze enze lokho, umcwaningi wasebenzisa ifilosofi yama-intepretivists njengoba anikeza umcwaningi ithuba lokuthola izampula zabafundi ukwenza ingxenye yesampula ukuthola ukuthi bazizwa kanjani, babuke futhi babone ukufundwa kwemiqondo.

Ukuhlolwa kwezincwadi kwembula, phakathi kokunye, ukuthi ekufundeni iSayensi Nezobuchwepheshe abafundi abangamantombazane eNingizimu Afrika basathonywa umbono womphakathi othi amadoda yiwo abalulekile. Kuyiqiniso ukuthi abesilisa nabesifazane abakhekanga ngendlela efanayo ngokomzimba, kodwa umehluko kwezemfundo uxhomeke endleleni umphakathi ofuna abantu bobulili obuthile baziphathe ngayo. INingizimu Afrika akulona lodwa izwe elinalezi zinkinga. Amazwe anjenge-Ghana ne-Ireland nawo ayathinteka. Kungase kungafani ncamashi, kodwa umbono womphakathi wendlela okumelwe kuphilwe ngayo uye wabonakala unomthelela omkhulu ekufundweni kweSayensi Nezobuchwepheshe. Inani elincane lonjiniyela besifazane eNingizimu Afrika nakwamanye amazwe libangelwa yindlela imiphakathi eyakheke ngayo.

Okutholakale ngesikhathi kuhlolwa izincwadi kuye kwafakazelwa okutholakale ocwaningweni. Idatha eye yacubungulwa iye yafakazela ukuthi ngempela amantombazane nabafana bathonywa okulindelwe umphakathi kubo lapho bekhetha, befunda nalapho bephumelela ezifundweni zeSayensi, Ezobuchwepheshe Nezibalo. Kuye kwembulwa nokuthi imisebenzi kwezeSayensi, Izibalo Nezobuchwepheshe ibonakala iheha abafana kakhulu kunamantombazane. Ngokuvamile, amantombazane akhetha lezi zifundo ngoba zingekho ezinye angazikhetha nangenxa yokuthi ngeke aphumelele ekuphileni ngaphandle kwezobuchwepheshe. Abafana babonisa uthando nokuzimisela okukhulu kunamantombazane lapho befunda lezi zifundo. Okokugcina, abafana babonise ukukwazi ukuzenzela izinqumo lapho benza lezi zifundo kunamantombazane. Amantombazane ngokuvamile ancika kothisha nakubazali babo.

ABSTRACT

The coming into being of the new democratic dispensation in South Africa (SA) brought many changes in the way South Africans lived their lives. The education sector was not spared from this transformation. The existing school subjects offered were reconfigured into new disciplines whose main intention was to inculcate the philosophy of outcomes based education (OBE), which is mediated through the National Curriculum Statement (NCS).

Moreover, it was realised that the apartheid education system promoted rote and dogmatic learning, which produced learners who were unable to be critical, creative, innovative and original in transferring classroom-learnt content, skills and values to different and dynamic contexts. This presented many challenges to the country. Most learners produced by the education system prior to the new political dispensation could not respond to the ever-changing needs of society. That made a mockery of many subjects because the content could not be understood, and learners could not relate to them.

Subjects, such as science, mathematics and technology (SMT), require that learners engage and apply content in unfamiliar environments for different purposes. The application of content requires that learners construct meaning out of subject content; make associations between the content's components; and engage in project-based learning for practical, creative and critical application of the content. Instead of regurgitating what is presented in their lessons, learners need to form associations between new and existing content in order to deal with the challenges that the world is currently facing.

The Curriculum and Assessment Policy Statements (CAPS) of the NCS sought to change a stagnant form of education by promoting the development of skills appropriate to the 21st century, which include critical, creative and problem-solving skills/attitudes that the outmoded and rote-learning curriculum of the past did not foster. Additionally, the apartheid era education system favoured males who were expected to perform particular social roles, which influenced learners' choice of school subjects. Thus, males were expected to take, and excel in, subjects such as SMT. In fact, if a female were to choose these fields, it was perceived as a unique occurrence or once-off episode.

Although, it has been 23 years since the dawn of the new democratic dispensation, the outmoded paradigms of the past are still prevalent, affecting every aspect of life. The performance of males and females in science and technology (S&T) still harbours those past patterns, although the new education system sought to change the apartheid patterns. By now, a new order should be established in SA, and education ought to have improved. However, most learners are still battling, especially with their performance in S&T, which has worsened. This poses serious challenges to the education system the success of which is determined, inter alia, by

its S&T outputs, especially in the era of the Fourth Industrial Revolution (4IR). Learners often have negative perceptions of these subjects, especially girls, who are not expected by society to succeed in them. These perceptions, which are based on societal expectations, affect the success of girls in S&T-related subjects.

In the study described in this research report, the researcher sought to unravel boys' and girls' perspectives on learning technological concepts in selected primary schools of the Gert Sibande Education District in the province of Mpumalanga. This required the researcher to interpret their views, feelings and attitudes concerning learning such concepts. Thus, the researcher followed the interpretivist paradigm that seeks to know about and understand research participants' experience and views of the situation being studied. Purposive sampling based on the researcher's knowledge and judgment of the population being studied was used in the study that comprised five females and five males who were purposively sampled.

The study followed a qualitative case study research design that involved the use of interview and observation techniques to collect data from ten learners who were purposively selected from five primary schools in different quintiles. The researcher used the promotional schedule of the previous years to select these learners for both interview and observation purposes. These ten learners (five boys and five girls) were chosen based on their percentage achievement (from high to low) as reflected by their schools' promotional schedules. The interview proceedings were recorded with the aid of an audio recorder, and notes were compiled to complement the interviews. Moreover, observation cues were used to observe the behaviour of the sampled learners in real-life situations.

The literature review revealed, inter alia, that female learners in South Africa are still affected by patriarchy in learning S&T. Although, biological differences exist between males and females, it has been proved that learning is mostly dependent on socialisation. SA is not the only country affected by these trends, as Ghana and Ireland, for example, are also affected. The picture may not be the same in all societies, but it has been proved that socialisation is a driving force in learning S&T, in particular. Thus, the small number of female engineers in SA and other countries is attributable to social factors.

The findings of the literature review were extensively corroborated by the findings of the case study. The analysed data proved that boys and girls are indeed affected by societal expectations in choosing and succeeding in MST. However, boys show more passion and dedication in pursuing these subjects than girls. In addition, the study revealed that boys demonstrate a greater degree of autonomy in learning, compared to girls who are often reliant on their teacher and parents.

DEDICATION

This study is dedicated to God the Almighty for giving me strength, wisdom and courage.

This study is also dedicated to my family: my wife, my parents and my children.

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KEY CONCEPTS

- Technology
- Perspectives
- Attitudes
- Perception

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LIST OF ABBREVIATIONS AND ACRONYMS

ATP	Attitudinal Technology Profile
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
EWN	Eyewitness News
GET	General Education and Training
FET	Further Education and Training
GSED	Gert Sibande Education District
HET	Higher Education and Training
HSRC	Human Science Research Council
ICT	information and communication technology
MDoE	Mpumalanga Department of Education
MMR	mixed methods research
MST	mathematics, science and technology
NCS	National Curriculum Statement
NDP	National Development Plan
NPC	National Planning Commission
NPPPR	National Policy Pertaining to the Programme and Promotion Requirements
NSC	National Senior Certificate
NST	Natural Sciences and Technology
OBE	outcomes-based education
OECD	Organisation for Economic Development
PCK	pedagogical content knowledge
PEDs	Provincial Education Departments
S&T	science and technology

SA	South Africa
SAAEA	Southern Africa Association for Educational Assessment
SKVs	skills, knowledge and values
STEM	science, technology, engineering and mathematics
STM	science, technology and mathematics
STME	science, technology and mathematics education
TAM	technology acceptance model
TIMSS	Trends in International Mathematics and Science Study
UK	United Kingdom
UNESCO	United Nations Educational Scientific and Cultural Organisation
USA	United States of America

CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Subjects like science, technology and mathematics (STM) are often viewed by learners and students as challenging subjects that require certain skills, knowledge, values (SKVs) and attitudes. Moreover, not everyone can attempt and succeed in them (Mubeen, Saeed & Arif, 2013). Even learners and students who have never attempted STM are inclined to view them as problematic and only meant for certain types of people (Van Rensburg, Ankiewicz & Myburgh, 1999). This negative perspective invariably affects their enthusiasm when considering any career that requires knowledge and skills in the technological field. In addition, it determines the extent to which they persist when faced with the challenging aspects of STM (Sláděk, Milěr & Benárová, 2011). In fact, learners who attempt STM, often fail, which negatively affects their perceptions and leads to a reluctance to exert further effort in these subjects (Cai, Fan & Du, 2016). On the one hand, there may be learners who defy the popular negative belief and succeed in such subjects. On the other hand, others may shy away from STM already at primary school level because of the perceived challenges (Mubeen, et al., 2013) leading to later poor performance that has dire consequences in the learners' academic lives. A vicious cycle then develops making it complicated to decipher the exact reason for the negative perspectives on learning these subjects.

However, at secondary and university levels, many learners attempt, and succeed in, STM (Cai et al., 2016). This may be due to eagerness, courage, persistence and 'willingness to pass their exit grades, which is the National Senior Certificate (NSC) in the South African context (Sanders, 2005). Others excel because higher education modules may require science and technology, engineering and mathematics (STEM) for the careers they would love to pursue (Sanders, 2005). In many countries, males are encouraged to do STEM as opposed to females who are perceived as being unsuitable for these fields because of their biological attributes and socio-culturally designed roles and responsibilities (Kimani & Mwikamba, 2010).

Negative beliefs, perspectives and expectations regarding STM may greatly affect the performance of both males and females, although success may not entirely depend on gender attributes (Cai et al., 2016). Other factors may be also involved, and their combined impact may determine the extent to which boys and girls succeed in STM/STEM. Nevertheless, perceptions, in particular, may play a meaningful role in the manner in which they are learnt and the degree of effort/persistency/time expended in studying them (Mubeen et al., 2013). Moreover, attitudes, either positive or negative, seem to play a particular role in the choices that learners make regarding STM/STEM subjects (Ardies, De Maeyer & Gijibels, 2013). However, little information is available on the role played by teacher and student variables in the development of learners' attitudes (Ardies et al., 2013).

In other words, there is no conclusive evidence indicating a direct correlation between teacher/learners' attitudes and the choice that learners make with regard to STM/STEM. Although, attitudes play a particular role in learners' perspectives on these subjects, which influence their choice of and the extent to which they persist and succeed in those subjects (Albarracín, Sunderrajan, Lohmann, Chan & Jiang, 2018), how they influence male and female grade 7 learners' learning of technological concepts, for example, is not clear. They may have certain attitudes or perspectives towards STEM, but this may not indicate how they generally learn the concepts or how the different genders learn these them.

Much has been written about the attitudes of boys and girls towards STEM subjects. Attempts to unravel the precise factors involved in the development of certain attitudes have been made from different viewpoints (Ardies et al., 2013). However, the study described in this research report did not delve into variables at play in the attitudes that learners may develop towards technology. Moreover, it did not seek to deal with all the STM subjects; it concentrated on the learning of technological concepts. Whereas scholars have mostly concentrated on the views of boys and girls influencing their choice of STM (Mubeen et al., 2013; Van Rensburg et al., 1999), as opposed to dealing extensively with the way they learn STM concepts, the current study dealt with the perspectives of boys and girls on learning technological concepts.

Nevertheless, the existing literature has explained the influence of boys'/girls' perspectives on STM learning. This has led to an understanding of the inherent factors that may answer the following question: "Why do girls and boys have different perspectives on learning technology in South African schools, in general, and particularly in selected primary schools of the Gert Sibande Education District.

1.2 BACKGROUND TO THE STUDY

The inequalities that are observed in the number of boys and girls who pursue technology-related careers in South Africa (SA) are, largely the result of how South Africans raise and groom their children (Makgeru, 2016: 97). A society's particular grooming and child-rearing practices play a role in developing the mental frameworks that shape and govern the manner in which the world is viewed by its members (Ardies et al., 2013). Therefore, a female child who grows up in a society that believes that females are not supposed to study any of the STEM subjects, is likely not to consider it, and even if she were to attempt them, may not succeed because society does not expect her to do so. Thus, she would not effectively learn the concepts embedded in the content (Chan & Cheung, 2018).

Societal contexts, political systems, philosophical dispositions, beliefs, knowledge systems and so on, have an influence on the development of societal frames of reference and they shape what is done and accepted by society (Chisholm, 2012). By that same token, SA is not exempt from the influences of socio-historical events that continue to influence the way that South Africans approach many phenomena, including the form, texture, purpose and aims of the curriculum as configured today. Attempts are being made to transform the lives of South Africans in many important areas, but the history of the apartheid past still haunts SA. It influences the manner society lives and conducts its business, as change/transformation is based on past trajectories (Chisholm, 2012).

During the apartheid era, South African society was largely male-dominated, the social system was engineered to favour males because they were believed to be the defenders of their country, and everything that involved physical and advanced mental activity was a preserve for males (Msila, 2007), leading to minimal opportunities being accorded to females. This may currently influence the motivation and persistence that boys tend to show in learning STEM concepts. In other words, boys are historically perceived to be more inherently skilled in tackling these subjects than girls (Msila, 2007).

If the social environment has gender-related expectations, then those who are raised in that context will, most likely, do as it dictates, which brings benefits to those whom it favours (Van der Vleuten, Jaspers, Maas & Van der Lippe, 2016). Therefore, SA continues to experience gross shortages of males and females who succeed in science and technology (S&T)-related studies/careers (Makgeru, 2016) and has to import technicians and engineers. The question that could then be raised is whether boys and girls differ in the way that they learn these concepts. They may differ in their perspectives and attitudes towards these subjects, but are they different in the way that they perceive the actual learning of the concepts? The study sought to answer that question and others, in line with the main question and sub-questions highlighted below.

Even though the curriculum has been changed and the Constitution makes provision for equal opportunities for all SA learners (Ramaligela, 2010), the challenges bequeathed from the past continue to plague and affect the current education system. These include inequality amongst learners of STEM, which society perceives as the most important subjects that can only be studied by a few capable individuals, especially males (Chan & Cheung, 2018). This perspective emanating from society becomes entrenched in schools. Thus, learners who grow up in environments where they are not expected to perform in STEM, tend to be docile and unwilling to exert effort in these subjects (Sanders, 2005).

In fact, females who are raised in environments where STEM are considered exclusive preserves for males, perpetuate and suffer the brunt of such thinking, which does not assist SA in overcoming the barriers of the past (Msila, 2007). Yet, according to Chisholm, (2012), modelling is critical to leaners' subject choice, and thus learners who are exposed to environments where the study of STEM is prioritised, regardless of their gender, tend to study them with enthusiasm. Therefore, the social milieu plays a pivotal role in shaping and creating the basic social frame of reference through which learners will later perceive the world (Van der Vleuten, et al., 2016). Mapotse (2015: 220) agrees that the environment indeed plays a role in shaping the mental fibre of those who find themselves in a given educational situation. Furthermore, it determines the knowledge levels of those who teach STEM, which is a critical factor in learners' choice and success in the subjects. Learners tend to identify themselves with people who embody values that they view to be important in their lives. Those who successfully teach these subjects may generate trust and positive feelings in learners, enabling them to better understand the content. According to Maposte (2015: 219), it is not only the socialisation of learners by society and teachers, but also the extent of the SKVs displayed by teachers while teaching STEM that generate eagerness and enthusiasm to do and succeed in them.

The above observation is not an exclusive SA experience because many countries experience similar challenges, which accounts for the skewed distribution of girls and boys in S&T-related careers (Sanders, 2005). There are many reasons that are attributable to this phenomenon, including child-rearing practices and different societal expectations of males and females on the part of family, friends, colleagues, teachers and education authorities, for example (Gasant, 2011). According to Gasant (2011: 2), many countries are patriarchal, which translates to the type of society produced. For instance, in countries where the girl child is not expected to engage in activities that are viewed as exclusively the domain of boys, both genders grow up in a framework that grooms their perceptions and attitudes towards one another (Mubeen et al., 2013). This may affect their attitudes and abilities to learn and understand the content in such subjects successfully.

Therefore, societal expectations have a direct bearing on how learners learn certain subjects, at the expense of others. Moreover, the skewed distribution of males and females in many sectors of society is largely related to this phenomenon (Van der Vleuten, et al., 2016). The South African National Planning Commission (NPC) acknowledges, and seeks to eradicate, these skewed patterns in the distribution of males and females who follow STEM-related careers for the growth and development of the country (South Africa, NPC, 2011). Additionally, the NPC affirms that SA has a serious shortage of STEM students, and that the school curriculum should promote and prioritise these subjects in order to avoid the importation of individuals skilled in these fields from other countries (NPC, 2011).

Therefore, the NPC (2011: 9) encourages South Africans and the Department of Basic Education (DBE) to create a supportive and conducive environment for both boys and girls to learn STEM subjects for the growth and development of the country and its people. In addition, Mapotse (2015: 223) suggests effective and responsive training mechanisms for teachers who teach these subjects in South African schools to give them the necessary attention, as there is observably a great need for the SKVs related to them. Therefore, the study described in this research report sought to understand the perspective of boys and girls on learning technological concepts in the Gert Sibande Education District, as the literature may not necessarily provide valuable information about the nature of the perspectives of boys and girls on studying technological concepts. If the perspectives of boys and girls at primary school level could be known, it may be possible to introduce suitable teaching approaches and methods to facilitate effective learning of the concepts. The disparities between boys and girls in learning STEM might be associated with the differentiated ways that different genders learn the concepts based on socialisation and other influences.

It is almost twenty-four years since SA attained its democracy and seven years since the promulgation of the National Development Plan (NDP). However, the skewed distribution of girls and boys who learn STEM subjects continues to affect careers and the country in general (Hsieh, Chen, & Lin, 2017). Therefore, the measures that SA has put in place have not succeeded in helping the country to produce the requisite number of graduates aiming to follow STEM-related careers, especially girls (Kimani & Mwikamba, 2010). For example, in 2017, out of 179 561 learners who wrote the subject "Physical Science" in grade 12, only 48 260 passed at 50% and above. In other words, a mere 26, 9% actually passed the subject, which is concerning (South Africa, DBE, 2018). In the same vein, the overall performance of learners in SA schools in mathematics, science and technology (MST) at the General Education and Training (GET) level has not come closer to reaching the goals of the NDP of 90% performance achievement in MST at the exit points of the GET phase, i.e. grades 3, 6 and 9 (DBE, 2018). The performance of learners in the range of 50% and above in grade 3 is 64, 5%, grade 6 is at 35.4% and grade 9 is at 2, 9%, which is far from reaching the expected performance levels in terms of the targets at the GET level (DBE, 2018).

The above clearly shows that the attempts that have been put in place are not yielding the desired results of improved performance in STEM, especially at the exit points of the SA education system. This state of affairs frustrates and disempowers learners who wish to pursue MST-related careers at tertiary institutions, and it has been going on for some time with little improvement (DBE, 2018). That is why few learners pursue MST-related careers at tertiary level, which confirms the observation of the NDP that SA imports technical skills from abroad (NPC, 2011). However, SA is determined to resolve these challenges, and this is seen, for example, in the MST strategy that the department is implementing (DBE, 2018).

The Department of Basic Education (DBE) (DBE, 2011a: 8) has realised the pitfalls, and it is against this background that it compels learners in the Senior Phase of the education system to do Natural Sciences and Technology (NST). The aim of this policy is, among others, to lay the needed foundation for pursuance of careers in S&T in line with the requirements of the National Curriculum Statement (NCS). The DBE also promotes the learning of science subjects in the field of STEM, including Physical Science, Life Science and Agricultural Science, so that the grave shortage of artisans and technicians can be resolved. In essence, this is an attempt to lay emphasis on the significance, importance and the need for more students to pursue S&T-related careers in the Higher Education and Training (HET) band for the growth and development of the economy of the country.

However, Makgeru (2016: 1) argues that SA has not yet made the desired impact on the learning of S&T, despite all the attempts that have been put in place to increase the number of students qualified for employment as artisans, architects, engineers, miners, electricians and geologists, for example. Moreover, there is still the problem of the gender imbalance of employees in these fields, of which less than 30% are females (Makgeru, 2016). Although this finding provides information about perspectives on STEM, it does not touch on the actual learning of the subject-related concepts. This was the aim of the study described in this research report, which focused on understanding the perspectives of boys and girls with regard to learning technological concepts.

Technology as a specific primary school subject faces many challenges some of which stem from the fact that many teachers who teach it lack pedagogical content knowledge (PCK) and attend workshops run by insufficiently trained facilitators, which has a direct negative effect on learners (Mapotse, 2015). If Technology teachers receive inadequate PCK training, there is a substantial possibility that learners will not acquire the necessary SKVs embedded in the subject because insufficiently trained teachers are prone to use irrelevant and unhelpful methods to teach technology-related concepts (Mapotse, 2015). Therefore, there seems to be a correlation between sufficiently trained and knowledgeable teachers and the ability to instil the required knowledge and skills in learners.

In support of this view, the Trends in International Mathematics and Science Study of 2015 (TIMSS-2015) found that South African grade 9 learners perform poorly in S&T test items. According to the TIMSS, this is largely attributed to the poor teaching of STM, as most teachers do not prepare and they assume that they know the subjects (Reddy, Visser, Winnaar, Arends, Juan, Prinsloo & Isdale, 2016). However, this finding refers to challenges that face teachers when they teach the subjects. It does not necessarily explain how learners themselves, for example, boys and girls in grade 7, perceive their learning of technology concepts. Moreover, negative perceptions of STEM cannot easily be extended to imply differences in the perspectives of these learners on learning technological concepts. In other words, it does not necessarily mean that learners having negative perceptions of STEM, which depend on their gender, reveals the different approaches they use in learning the concepts. Society may encourage them differently, but the actual learning process may depend on other factors that the study described in this research report sought to understand.

Despite the problems discussed above, trends in South African schools are slowly changing, which is mostly due to acculturation, urbanisation and the general demands of the 21st century, among other phenomena (Reddy, Zuze, Winnaar, Juan, Prinsloo, Arends & Rogers, 2015). According to Reddy et al. (2015: 24), a new trend is emerging whereby girls begin to outperform boys in STEM subjects in grade 9 of the South African schooling system. For instance, the 2017 TIMSS discovered that girls achieve slightly higher, compared to boys in both mathematics and science.

They achieved 21%, whereas boys achieved 10% (Reddy et al., 2015). In addition, Mullis, Martin, Goh & Cotter (2016: 39) found that in the 2011 TIMSS, girls outperformed boys in science and mathematics, although the difference was not statistically significant. The girls' average mark was 335, whilst that of the boys was 328 (Mullis et al., 2016). Reddy et al. (2015: 37) acknowledge that girls' confidence in learning science and mathematics is growing and attribute the shift to changed nurturing practices, exposure to the world of work and policies that encourage the equal participation of males and females in STEM.

Even though, there have been changes to the number and performance levels of boys and girls in STEM, much still needs to be done because negative perceptions are engraved in the social fibre of society (Reddy et al., 2015). Many attempts have been made, thus far, to deal with this challenge, but it recurs, which not only affects learners but also educators. For instance, Mapotse (2015: 221) finds that the conceptual understanding of technological concepts poses serious challenges to educators, which is manifested in South African STM learners. Clearly, if most S&T educators do not have the requisite PCK, their teaching will not help learners to develop the necessary SKVs inherent in these subjects (Mapotse, 2015).

As a result, most learners in South African schools, especially those in the Intermediate and Senior Phases, are still battling with the basic and fundamental concepts of S&T (Mji & Makgato, 2006). Thus, poor performance in subjects such as Physical, Life Science and Agricultural Science is attributed, among other factors, to a lack of the requisite foundational and fundamental SKVs in learners and educators at both the Intermediate and Senior Phases of the South African education system (Mji & Makgato, 2006). Judging by the skewness of the system, the girl child suffers the most. Even though, support could be given, the mere fact that the effects of the past apartheid system, which undermined the girl child are still prevalent in societal frames of reference, the girl child is not favoured compare to boys (Van der Vleuten et al., 2016).

The study dealt with the perspectives of boys and girls in learning technological concepts. This angle was assumed because most academics have concentrated, inter alia, on the topic of learners' choice regarding STEM, the amount of effort exerted in studying these subjects and the role of attitude in choosing and doing the subject. Moreover, they focussed on learners' persistence in the face of difficulty and the dropout rates in these subjects experienced by the system (Mubeen, Saeed & Arif, 2013; Van Rensburg et al., 1999; DBE, 2018; Albarracin & Lohman, 2018).

As stated above, South Africa has made many attempts to change the situation. However, it is important to interrogate the inequalities of learners following technological streams in SA so that the impact of choices made at both the GET and FET level of the schooling system can be understood in the context of various factors, including the perspectives of boys and girls on these subjects.

1.3 INEQUALITIES OF LEARNERS FOLLOWING TECHNOLOGICAL STREAMS

The new democratic dispensation in SA, heralded by the 1994 elections, ushered in reforms to the way South Africans needed to live their lives. Moreover, all aspects of life in SA had to be coordinated with that development to eradicate apartheid inequalities. As a result, these reforms affected all sectors of life in SA, including the education sector, which was transformed in line with the spirit and fibre of Act 108 of 1996 (the South African Constitution) to effect a contemporary and progressive subject offering in line with the global demands of the ever-changing technological world (Heymans, 2007). Thus, the advent of the new education system with its new and relevant 21st century subjects was the product of the reforms in an attempt to make education relevant, contemporary and futuristic (Stevens, 2006).

Technology as a school subject was then introduced with the intention of developing technological SKVs/attitudes and of instilling the creative use and mastery of products, processes and approaches to meet the growing demands of advanced and cost effective ways of living (Stevens, 2006). Technology comprises, inter alia, the utilisation of artefacts and processes by means of which labour productivity is increased by developing skills to address the myriad of technological challenges that SA currently faces in the context of global development (Heymans, 2007). In agreement with this view, the DBE (2011a:8), views technology as a subject that seeks to inculcate the understanding of technological concepts for the development of a technologically literate society whose people can effectively participate and compete in global technological advancement for continued existence in the ever-changing world.

In terms of the National Policy Pertaining to the Programme and Promotion Requirements (NPPPR) of the NCS, Technology is one of nine subjects at the Senior Phase of the South African schooling system that South African learners should do to meet the requirements of a subject combination for the production of balanced and well-adapted learners. This requirement is aimed at fulfilling the promotion and progression requirements of the NCS at the Senior Phase (grades 7-9) and across the South African education system (DBE, 2011b). In its Curriculum and Assessment Policy Statement (CAPS), the DBE views Technology as a subject that could assist SA in producing engineers, technicians, geologists and artisans, of which the country is in dire need, and in realising its growth and developmental agenda (DBE, 2011a). To that end, Technology seeks to cultivate the SKVs that could enable South African citizens to develop and apply innovative, creative and critical thinking in dealing with the ever-growing technological challenges that face SA (Heymans, 2007).

Although, it is over two decades since the first educational reforms in SA, educational challenges continue to beset the ideal that the NCS envisages. Certain strides have been reached so far, but the education system continues to have challenges, especially in the areas of technology education and economic development (Kimani & Mwikamba, 2010). Thus, the NPC acknowledges that SA is beset with gross shortages of artisans, technicians and engineers because of the slow pace of transformation in the education sector, despite huge resources being continually allocated to it (NPC, 2011).

To correct this situation, the NPC proposes the institutionalisation of technological education across all sectors of SA so that the country will not fall victim to the digital divide and procure technological expertise from other countries (NPC, 2011). Alongside this challenge, SA witnesses both inequalities and a slow pace of technological development, which affects its competitiveness on the global economic front. Makgeru (2016), in agreement with the NPC (2011), acknowledges that educational transformation in SA has been slow, which contributes to the gross lack of technologically trained artisans, technicians and engineers, leading to the importation of skills that the country could generate on its own.

In addition, Makgeru (2016:97) observes disparities and inequalities in the gender of learners who take technology-related subjects at South African high schools and universities. In fact, more males than females are enrolled to study in faculties of engineering, technology, information and communication technology (ICT), mining and other related subjects, which represents the thinking fibre of SA as a country (Makgeru, 2016). Only 6.1% of females, compared to 19. 1% of males had enrolled in the faculties of STEM in South African universities as at year 2000, and the trend was projected to increase, judged by the outputs in these fields from the Basic Education Sector (Statistics South Africa [STATS SA], 2017).

However, in countries like Spain, a different picture is seen. For example, Ibáñez, Fàbregues, et al. (2018: 43) contend that in the academic year 2015–2016, females, compared to males, represented a significant percentage of enrolments in many scientific disciplines, such as mathematics, chemistry and biology (Ibáñez et al., 2018). Above all, women outnumbered men in disciplines related to the provision of health care, such as medicine or pharmacy (Ibáñez et al., 2018). Probably, the attitudes and perceptions of the Spanish differ from those in SA. Judging by the findings of the literature review in Chapter 2 of this research report, it could be said that the Spanish may have a different worldview, ideology and philosophy as well as dissimilar values regarding the role of women in education. It will be proven in Chapter 2 that societal perceptions, expectations and perspectives concerning learning certain subjects have a tendency to influence learners' self-efficacy, determination and self-regulation in pursuing certain subjects over others.

In South Africa, this way of thinking predominantly demonstrates the perceptual framework of most South Africans regarding STEM subjects. This challenge is precisely attributed to the socialisation of SA society, which is transferred to all sectors of life. In other words, SA is still struggling with patriarchy, which leads to few girls opting for technologically inclined careers at South African universities. An average of 30% of girls who do STEM subjects do not pass them at the required levels, and most drop them because of their perceived difficulty, which prolongs the period they take in completing their junior degrees (Kimani & Mwikamba, 2010). It is also interesting to note that in the field of engineering and engineering technology, 84,9% of males and 15,1% of females were enrolled. Moreover, in the field of physical sciences, only 3,7% males and 2,7% of females were enrolled (STATS SA, 2017). This shows the continued disparities plaguing both higher and basic education in SA. Consequently, if a female student excels in S&T, it is regarded as an exception to the norm (Hsieh et al., 2017).

Heymans (2007:14) found that the number of girls who choose and succeed in technology-related studies in SA today is slowly increasing, compared to the apartheid era, which is due, among other factors, to the opportunities that the government provides for South African learners. However, the pace is recorded to be very slow considering the number of legislations and regulations that were put in place to support the move (Elan, 2012). Elan (2012:14) is of the view that legislations and regulations are not enough to deal with the problem, and a multidisciplinary approach that will incorporate various stakeholders and institutions is required to make the desired impact.

This means that the problem is more complicated than meets the eye and involves various strands that need to be probed for technology to be institutionalised and loved by the majority of youth in South Africa, especially the girl child. This will ensure its effective contribution to the economy and the wellbeing of all South Africans. It may also mean that the actual learning process and gender-related perspectives on learning technological concepts need to be put under the spotlight to gain more understanding of them. Makgeru (2016: 97) posits that a fundamental mind-set shift across all sectors of the economy, including the way households raise their children, may assist in changing perspectives and attitudes, which may lead to equality in learning these subjects. Seemingly, the disparities are visible initially in the learners' homes and then manifested in other contexts of their lives, including the type of subjects they choose at schools (Van der Vleuten et al., 2016).

Therefore, inequalities are not only at schools where learners are presented with options to choose subjects, but they also manifest themselves in a myriad of ways, including the expectations of society from its offspring (Hsieh et al., 2017). In schools, learners are subjected to teachers who come from the same environment and, at times, their orientation is a microcosm of what society believes learners should do for their future (Mapotse, 2015; Makgeru, 2016).

Society is, therefore, an important aspect to consider in dealing successfully with the inequalities in the opportunities that learners are presented with at school. The government with its legislation attempts to give expression to what is progressive in the context of global economic development. However, society should change its outlook in keeping with this ideal so that the gap is successfully bridged, especially as it relates to girls at schools and in society at large (Elan, 2012).

According to Makgeru (2016:97), the patriarchal socialisation of both girls and boys leads to fewer girls pursuing technological studies than boys, which creates inequalities in the way career opportunities are distributed. Apparently, the challenge starts with the manner in which boys and girls experience the subject of Technology in grades 7-9 of the South African schooling system, which depends on how it is taught, the teachers' skill levels and the extent to which they push learners to perform in it (Mapotse, 2015). Essentially, societal expectations of the envisaged role of girls in society are associated with these gender imbalances (Hsieh et al., 2017). Moreover, few female teachers teach Technology, and learners tend to associate the subject with males, which affects their self-efficacy levels and leads to poor performance (Elan, 2012). Female teacher's participation in teaching STEM is 30%, compared to male participation in teaching languages and hermeneutics, which is 50 (Elan, 2012).

In other words, societal values and expectations concerning the roles of boys and girls in the context of work are more inclined to inculcate biases in the way they choose and pursue technological subjects. In addition, these expectations influence the perspectives of both boys and girls on how they study and succeed in learning technological concepts (Reddy, Visser, Winnaar, Arends, Juan, Prinsloo & Isdale, 2016). Even if girls attempt S&T streams at schools and in work settings, not much is expected of them because it is believed that very few can rise to the level of the competency of their male counterparts (Elan, 2012: 23). In the South African context, the damage is actually done at both the Intermediate and Senior Phases, as less female learners, approximately 30%, exit the Senior Phase to do S&T at both the FET and HET level, compared to 70% of boys (Reddy et al., 2016).

Thus, if a learner is discouraged from excelling in technology as opposed to subjects such as languages and social sciences, to mention a few, there is a strong likelihood that the child would be more inclined to succeed in these subjects. All the same, not all girls perceive technology in that light. Some do and succeed in STM at the FET and HET levels of the South African education system (Reddy et al., 2016); hence, there are female doctors, engineers, miners, technicians, artisans and dentists, for example.

However, the teaching and learning of S&T has been a challenge since the advent of democracy in SA, which is still plaguing the education dispensation, amidst many attempts to reverse it (Makgeru, 2016). The TIMSS revealed extremely poor performance in S&T by grade 9s in the SA schooling system, and the reasons include an inadequate teaching corps, a lack of proper didactic approaches, negative attitudes and unqualified teachers (Reddy et al., 2016). Nevertheless, the TIMSS and other studies have not investigated the perspectives of those involved in the learning occurrence. The study, therefore, assumed a unique approach in endeavouring to understand the perspective of boys and girls so that various angles could be utilised in investigating observable disparities.

Measures that have been taken in South Africa, which are comparable to those taken in other countries, are clearly not enough for the effective and successful learning of technological concepts. For instance, the HSRC (Reddy et al., 2016:26) has recently established that SA has made some improvements around S&T, but this has not removed it from the category of lowest performing countries, especially with regard to female learners (Reddy et al., 2016). Underperformance in SA varies in terms of quintiles, which is the measuring stick against which schools in SA are categorised according to the socio-economic factors of a given area (Reddy et al., 2016). For example, schools in quintiles 1 and 2 are relatively impoverished, compared to quintiles 3, 4 and 5 schools (DBE, 2006). Therefore, quintiles 1 and 2 schools predominantly service the low-income group of the South African population that is mainly found in townships.

Furthermore, the HSRC (Reddy et al., 2016:28) found that the socio-economic status of learners in each quintile has a bearing on their academic performance in S&T across the schooling system. In other words, learners who come from well-to-do families are more inclined to study and succeed in S&T than those from poor socio-economic backgrounds. This may be attributed to parental expectations of learners, parents' involvement in learners' academic tasks, the availability of learning media at home and the motivations to which the two worlds subject their children (DBE, 2006). Thus, children from high-income groups are generally provided for, and their parents expect them to perform in subjects relevant to their chosen careers. However, poor children are left to fend for themselves, with little support from families that cannot afford extra learning materials and private classes (Reddy et al., 2016). Their home environment is not conducive to learning as it is characterised, for example, by absent parents, a lack of learning aids, insufficient motivation, the unavailability of required resources, limited involvement of parents in the learner's academic life, child-headed homes, drugs and various forms of abuse (Reddy et al., 2016).

The HSRC findings contribute to an understanding of the factors that are critical for the successful learning of any subject by learners; however, they do not actually provide valuable information as to how girls and boys view their learning of subject-related concepts. They simply conclude that, if learners are not provided with the necessary support, their academic work is prone to suffer, and subjects like STEM require conducive learning environments, which may account for the low enrolment in these subjects of learners from quintiles 1, 2 and 3 (Reddy et al., 2016).

However, the low socio-economic standards typical of quintiles 1, 2 and 3 do not affect boys and girls equally. Girls are affected the most because of the effects of patriarchy and consequent socialisation (Kimani & Mwikamba, 2010). According to Kimani and Mwikamba (2010:71), this disparity is observable at tertiary institutions, where few female students are found in technology classes, which accounts for the number of female graduates in technology-related fields. For instance, only 3,7 % of males, compared to 2,7% females were enrolled in STEM-related subjects in SA (STATS SA, 2017). This picture reflects the low turn-up rates in these subjects at secondary schools in the South African schooling system (Kanafiah & Jumadi, 2013).

Many countries suffer the same fate. In fact, Elan (2012: 14) argues that leading knowledge-based economies, such as the United State of America (USA), Ireland, the United Kingdom (UK), Brazil, India, Korea and Indonesia record inequalities in the number of learners who pursue and pass technology-based studies at universities. Kimani (2004: 10) is convinced that the socialisation of both boys and girls in most African countries contributes to the level of enthusiasm with which they pursue and persist in studying technology-based subjects at primary, secondary and tertiary educational institutions. Therefore, subjects like S&T are viewed globally as a preserve for males, which leads to disparities in the distribution of those who pursue them. Even if girls do attempt these subjects, they become frustrated because of the minimal support and encouragement given to them. Kimani, (2004:11), views this lack of necessary support as a major contributory factor in lowering learners' self-esteem and efficacy, leading to minimal effort expended in the face of the real and/or perceived difficulties of these subjects

According to Makgeru (2016:97), factors, such as the teacher's characteristics, instructional strategies, the teacher's professional training, the teacher's gender, the availability of resources and the role expected by parents of both boys and girls, have a direct bearing on the success ratio of girls and boys in S&T studies. In this regard, patriarchy and traditional beliefs about the expected role of males and females figure prominently. These factors affect learners' choice of subjects for the FET phase and tertiary education. In addition, they affect the performance levels of learners at the GET level (Sjøberg, 2002).

Despite the DBE's attempts to promote and support MST at both GET and FET level, the learning and teaching of technology is still a significant problem in the system. Bantwini (2017:21) and Makgeru (2016:97) identified teachers' lack of necessary expertise as having a direct bearing on learners' attitudes towards the successful learning of MST in SA. Moreover, the perspectives of teachers and learners regarding the successful learning of MST in South African schools are affected by the following: issues of infrastructure; classroom size; the number of learners in a classroom; the availability of desks/chairs/chalkboards; and the non-usage of technology in teaching. This accounts for the low numbers of South African tertiary students who enrol for STEM and the poor success rate of those who do (Bantwini, 2017).

It seems that many factors contribute to the low turn-up rate of learners in S&T, which is a phenomenon studied by many academics. Most of them agree that socialisation and patriarchy play a major role in boys' and girls' subject choices, although many factors may determine their perspectives on learning technological concepts. According to Ankiewicz (2017:49), attitudes have been identified as one of the key elements that influence the leaners' and perspectives on learning technological concepts because they entail various elements that interact to evoke a certain perception in learners (Kőycű & De Vries 2016). According to Kőycű and De Vries (2016:52), attitudes are not only emotional, but also involve aspects of cognition that change a person's behaviour towards a subject or its content. Therefore, boys and girls show different orientations towards technology subjects and their concepts, which may be attributed to the socio-cultural and child rearing practices of different backgrounds, among other factors.

Interestingly, Van Rensburg et al. (1999:72), in their analysis of data collected through the Pupils' Attitudes Toward Technology of the United States of America (PATT-USA) questionnaire, found that in SA, girls had more positive attitudes towards technology subjects than boys and they also viewed boys as more competent and knowledgeable in them than themselves. Girls may have positive attitudes towards technology; nevertheless, this does not necessarily translate to performance in the subject because, they still undermine themselves by believing that boys are more competent and knowledgeable in the subject.

However, the PATT-USA study did not explore the perspectives of boys and girls on studying technology at primary school level. In the study described in this research report, the researcher concentrated on the perspectives of boys and girls on studying technological concepts in selected primary schools of the Gert Sibande Education District.

1.4 AIM OF THE RESEARCH

The aim of the research was to determine the perspectives of boys and girls on learning technological concepts in the Senior Phase of selected primary schools in the Gert Sibande Education District.

1.5 RESEARCH AIM AND OBJECTIVES

It has been indicated above that boys and girls have different perceptions of technology subjects, which tends to influence the manner in which they succeed in learning the diverse concepts embedded in them. These different views are rooted, primarily, in the type of ways society expects boys and girls to behave and how they should relate to each other. It also affects how the different genders view their inherent capacities, abilities and capabilities to do certain school subjects. To understand the perspectives of both boys and girls on learning technological concepts, the following objectives were pursued:

The overall aim of the study was as follows:

- To identify the perspectives of boys and girls on learning technological concepts at the Senior Phase, particularly in grade 7, of selected schools in the Gert Sibande Education District

The supporting objectives were as follows:

- To determine the type of perspectives of boys and girls on the effective learning of technological concepts

- To ascertain the way boys and girls could develop appropriate perspectives on learning technological concepts, based on the data presented in Sections 1.2 and 1.3 of this chapter

- To determine the way boys and girls address negative perspectives learnt from society members and their educators affecting their effective learning of technological concepts, with the aid of in-depth interviews and observation cues

- To identify the extent to which certain perspectives influence the effective learning of technological concepts.

- To suggest strategies that could be considered in helping learners develop effective perspectives for the successful learning of technological concepts, after the analysis of the collected data.

1.6 RESEARCH QUESTIONS

1.6.1 The main research question

- What are the perspectives of boys and girls on learning technological concepts at the Senior Phase of selected schools in the Gert Sibande Education District?

1.6.2 Sub-questions

In an attempt to find answers to the above main question, the following sub-questions were asked:

- What are grade seven learners' perspectives on strategies for the effective learning of Technology?
- How do boys and girls perceive the development of certain perspectives on learning technological concepts?
- How do grade 7 learners experience societal biases towards the effective learning of technological concepts?
- How do certain perspectives influence boys and girls in the effective learning of technological concepts?
- What strategies could be suggested to help learners develop effective perspectives for the successful learning of technological concepts?

These sub-questions divided the main question into subunits so that the researcher's attention would be drawn to the important aspects of the study. As a result, the first sub question sought to determine the actual perspectives that learners may have on learning technological concepts. This question dealt with the current challenge with which learners are confronted in learning concepts. This was followed by a question that tackled the possible reasons for the development of the different perspectives. This question drove the researcher to determine the reasons for the different perspectives. The third question dealt with the way negative perspectives of society and teachers are dealt with by both genders. This question motivated the researcher to deal with the possible negative perspective that may be responsible for the ineffective learning of technological concepts. The last question dealt with the identification of useful strategies to help learners to learn technological concepts effectively. It did not serve any purpose to deal with the challenges of technological concepts without exploring possible solutions to the problem. Therefore, these sub-questions were related to the main questions as they approached the theme of the study from different but related points of view. The intention was primarily to understand the complexity of the problem before attempts were made to solve it.

1.7 RESEARCH PROBLEM

The NDP of SA identifies great shortages of technology-related expertise in the country, which leads to the constant and continued procurement of such skills from other progressive countries (NPC, 2011; Makgeru, 2016). SA also witnesses disparities in the number of boys and girls who pursue technology-related careers at tertiary education institutions, which is a trend attributable to the socialisation of the South African society that seems to entrench patriarchy and perpetuate inequalities (Kimani, 2004). Moreover, not all boys attempt and succeed in technology-related subjects, and the same could be said of girls, as not all of them fail S&T subjects (Makgeru, 2016). There are girls that outperform males in learning technological concepts in some schools, which proves that girls could succeed in learning these concepts as much as (and even more than) boys do, provided that an appropriate environment is created for their learning (Chan & Cheung, 2018).

However, the above view does not illustrate, for example, how boys and girls differ in their actual learning of the concepts or their perspectives on learning the content. Furthermore, it does not show how socialisation actually teaches them how to approach a learning task. All it suggests is that both boys and girls have different perspectives and attitudes towards choosing and pursuing careers in these subjects. The following question then arises: Does the difference between the perspectives of boys and girls towards STEM influence the manner in which they apply their skills in learning the concepts? That gap in the literature prompted the researcher to be keen to unravel learners' perspectives on the learning of subject-specific concepts, particularly those in the Senior Phase subject "Technology".

Many studies have explored the differences of perspectives on STEM and, although they differ, they support each one another in the view that males and females have different perceptions. Moreover, the compelling idea remains that more males than females pursue technological careers as artisans, engineers and quantity surveyors, for example, which is partly because they are socially supported in these careers (Elan, 2012). They have developed positive perspectives on learning technology at the Senior Phase of the South African schooling system (Reddy et al., 2016). However, according to Van Rensburg et al. (1999:173), learners' perspectives on STEM subjects are generally negative, which accounts for the low enrolment levels and success rates in these subject areas on the part of both boys and girls who attempt them. Van Rensburg et al. (1999:169) touch on the general perspectives of learners on STEM but do not refer to the differences of perspectives between boys and girls on learning technological concepts at primary school level, as the study sought to understand. Other studies have explored the differences in the performance levels of both boys and girls, without studying the actual role of perspectives in pursuing such subjects (Reddy et al., 2016) Therefore, the study assumed a different angle by focusing on the perspectives that the two genders have towards the learning of technological concepts.

Recently, the DBE (2012:13) introduced the MST strategy because of the realisation that learners in SA are not adept at pursuing these subjects, which prevents the realisation of the goals and aims of the NDP. To confuse matters further, the MST strategy does not deal much with technology subjects. It refers to specific subjects, such as Mathematics, Mathematical Literacy, Life Science, Physical Science and Agricultural Science and technology-related subjects are often disregarded (DBE, 2012). That may aggravate the perceptions and attitudes that learners, educators and education authorities have towards technology-related subjects because at FET level, there is no subject called "Technology". It is rather considered part of specific school subjects such as Information and Communication Technology (ICT), Engineering Graphics and Design (EGD), Mechanical Science and Electrical Sciences, among other related subjects (DBE, 2011b). That alone may also aggravate the negative perspectives and attitudes that learners at the primary school level may have towards Technology, which may affect the way they apply their learning skills to understanding the concepts embedded in the content at the different grades.

Therefore, the manner in which technology-related subjects is treated by the DBE may also generate negative attitudes and perspectives towards the subjects in learners and society. This dimension, together with aspects of socialisation, creates many challenges in the learners' effective learning of technology-related subjects in the South African schooling system. This could account for the poor performance in STEM (STATS SA, 2017; Kanafia & Jumadi, 2013). The negative attitudes and perspectives towards these subjects, as engineered by societal inclinations and negative beliefs, may also affect the learners' abilities to study and do well in these subjects. The angle that the study described in this research report assumed was to understand the grade 7 boys' and girls' perspectives on the learning of the concepts in their subject "Technology".

Partly in line with the above, Van Rensburg et al. (1999:171) agree that the negative perspective on STEM is generally attributed to how society perceives these subjects. Moreover, learners' academic success could be attributed to how the education system treats these subjects and the manner in which encouragement and support are dispensed (Makgeru, 2016). Therefore, it is important to understand the perspectives of learners on learning technological concepts if the ideals of the NDP are to be realised in the South African context. In the study, therefore, the researcher sought to understand the perspectives of boys and girls on learning the technological concepts embedded in the South African education system's CAPS for Senior Phase Technology document. For purposes of the study, the design processes (concepts) that require the development of the SKVs related to investigation, design, making and evaluation, which were stated in the CAPS, were used for illustration (DBE, 2011a).

1.8 SIGNIFICANCE OF THE STUDY

The researcher is of the view that studying the perspectives of girls and boys on learning technological concepts at the Senior Phase of selected primary schools in the Gert Sibande Education District will help in the following manner:

- It will enable education role players to understand the perspectives of boys and girls on learning technological concepts.

- Moreover, it will broaden education practitioners' understanding of how to develop appropriate tactics and policies for girls and boys to learn technological concepts.

- Additionally, it will allow educators and other stakeholders an opportunity to gain an understanding of how girls and boys address negative perspectives on the effective learning of technological concepts.

- Lastly, it will assist all education role players to develop and implement appropriate strategies for the development of effective perspectives for the successful learning of technological concepts on the part of both girls and boys.

1.9 FORMAT OF THE RESEARCH REPORT

The research report follows the following format:

Chapter One: Introduction to the Research

In Chapter One, the topic of the study was introduced so that it would be understood in context. Furthermore, it provided the background and orientation to the study. The aim of the study, research questions and objectives were given. The significance of the study was also outlined.

Chapter Two: Literature Review

In Chapter Two, concepts related to the study are defined. The literature on the topic of the study is reviewed so that different perspectives can be evaluated. This is aimed at gaining an understanding of the extent to which the topic has been studied by previous researchers.

Chapter Three: Research Methodology

In Chapter Three, the applicable and appropriate research paradigm, methodology and design are discussed.

Chapter Four: Results, Discussion and Interpretation of Findings

Chapter Four discusses the collected data, mechanisms for data analysis and the interpretation of the findings.

Chapter Five: Conclusions and Recommendations

In Chapter Five, an overview of the study is presented in the light of future research.

1.10 CONCLUSION

In this chapter, the researcher gave a background and orientation to the study. The rationale of the study on the perspectives of boys and girls in studying technology-related concepts was discussed. The background and orientation to the study allowed the researcher an opportunity to understand how perspectives and attitudes affect the ability of boys and girls in studying technology education concepts. Lastly, the objectives, the main question and sub-questions as well as the significance of the study were outlined. In Chapter Two, a review of the selected and relevant literature will be done.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the researcher reviews the varied and related literature on the perspectives of boys and girls on learning technological concepts in selected primary schools of the Gert Sibande Education District. Moreover, the researcher explores local, regional and international practices related to this subject.

The literature review helped the researcher to gather past and present knowledge on the nature of perspectives that both boys and girls have developed towards learning technological concepts in different epochs and for different purposes. In addition, such knowledge equipped the researcher with the necessary research tools and instruments used in conducting the study and unravelling the phenomenon being investigated. The multitude of data derived through the literature review helped the researcher to gain a better understanding of the factors involved in the learning of technological concepts at various levels of the school system in different contexts. This enabled the researcher to understand the dynamic nature of Technology as a South African Senior Phase school subject and the way boys and girls perceive and learn its underpinning concepts.

Technology is one of the compulsory subjects that learners are supposed to do at the Senior Phase of the South African education system in accordance with the NCS as articulated in the CAPS document for the Senior Phase, grades 7-9 (DBE, 2011a). At the Intermediate Phase, learners must study NST that is split into Technology and Natural Sciences at the Senior Phase, articulating to Life Science, Physical Science, among other optional subjects, in the FET band (DBE, 2011a). The inclusion of S&T is based on the belief that the world is increasingly becoming scientifically and technologically savvy (NPC, 2011), which is critical for continuous economic development in the 21st century and preparation for the demands and challenges due to the 4IR. It is, therefore, important for learners to keep abreast of the S&T advances of global communities. Furthermore, South African schools have a responsibility to teach S&T-related subjects so that its population can participate, compete and benefit from the trajectory that S&T have brought to bear in the world.

While it is important for schools to teach S&T, the process towards teaching these subjects is not easy because there are many factors that influence the perspectives and attitudes of learners towards them and determine the extent to which learners pursue STEM-related careers at tertiary education level (Makgeru, 2016). Most importantly, studies have attributed the differences between girls and boys in their choice of S&T to socialisation that manifests itself in traditional beliefs of the envisaged roles of men and women in society (Reddy et al., 2016). Both traditional and modern societies have had a propensity to practice and exercise the antiquated belief system that places both males and females at different positions along the global economic trajectory, which could influence the manner in which they approach these subjects. Most often, men benefit at the expense of females because of this tendency. Moreover, society entrenches and normalises it with negative repercussions on girls, who are perceived as being less equipped to tackle the demands of S&T (Muller, Gumbo, Tholo & Sedupane, 2014).

The above view seems to place its focus on the general perspectives and attitudes that society may use to guide or inform learners to prefer certain subjects to others. It, however, does not indicate how girls and boys differ in their perspectives on learning the content or concepts of technology-related subjects. Societal perspectives may influence learners' subject choices and their rigour in learning based on the perceived value attach to particular subjects; however, how they actually learn the concepts is not clear. This important aspect should be explored so that a comprehensive picture of what really happens in the actual learning of the concepts can come to the fore.

It is, however, true that different gender-based perspectives and attitudes are developed, which may influence learners' zeal and self-efficacy in learning S&T. In the study, the researcher sought to understand the perspectives of both boys and girls in studying and learning technological concepts in grade 7 of the Senior Phase of the South African education system. This angle may shed light on how these learners learn technological concepts; lead to an understanding of how and where they differ; and eventually determine what can be done. According to Muller et al. (2014:34), perspectives and attitudes have a direct bearing on the manner in which learners and students attempt and succeed in certain tasks, including their choice of subjects. It is, therefore, vital that the concepts “attitudes” and “perspectives” are defined in the context of the teaching and learning of technological concepts. Moreover, these concepts will be used throughout this chapter as a way of understanding how technological concepts are studied by boys and girls.

To that effect, the researcher arranges the chapter in the following manner:

i. Important concepts: technology, perspectives and attitudes
ii. Theories of learning and their relevance to learning technology-related concepts
iii. The significance of the different theories of learning for the learning of technological concepts
iv. Technological concepts in the context of the NCS and the CAPS (grades R-12)
v. The structure of the curriculum in some Sub-Saharan African countries in relation to technology-related subjects
vi. The role of attitudes in learning STEM

2.2 IMPORTANT CONCEPTS: TECHNOLOGY, PERSPECTIVES AND ATTITUDES

2.2.1 Technology

In its simplest and broader form, technology is viewed as the manner in which people modify the natural world to meet their own personal needs and wants (Heymans, 2007). According to the International Technology Education Association (ITEA) (2001), the term “technology” is derived from the Greek word “techne”, which refers to an art or artifice or craft. Therefore, technology refers to acts of making/crafting and to the many different ways of collecting processes and knowledge that people use in extending human abilities to satisfy human needs and wants. Clearly, this definition leans more towards viewing technology as a means to do something in a progressively better way. This comes closer to the definition of technology as a mode of creating objects, as opposed to a subject with which learners are presented in order to understand the reasons behind the emergence of such gadgets. Rather than viewing technology as a mechanism, the study focussed on the subject “Technology”, which is both part of the Senior Phase school curriculum and embedded in the learning area of technology.

In the specific context of being the above-mentioned school subject, Technology can be essentially defined as a subject that enables learners to acquire and develop their knowledge and skills to be able to engage with technological processes. Moreover, the subject enables learners to acknowledge the impact of technology on both the individual and society and promotes their capabilities to perform effectively in the technological environment in which they find themselves (Heymans, 2007). According to Makgato (2014:3688), Technology is one of the eight (8) subjects that were introduced at the Senior Phase, i.e., grades 7-9, of the South African schooling system. One of its purposes is to instil competitive technological literacy in young South Africans so that they may become globally competitive and responsive to global technological, human and environmental needs.

Technology, just like the other new subjects that came into being in 1994 because of the democratic project in SA, is one of the subjects that seeks to offer all South African learners, regardless of the disparities of the past, opportunities to participate in shaping the economic contours of South Africa within global communities (Chisholm, 2012). According to Isman (2012:207-213), people generally think of technology along the lines of artefacts, such as machines, electronic devices, scientific hardware and/or industrial manufacturing systems. However, it moves beyond that limit and includes the practical application of knowledge or the manner and/or mechanisms used to accomplish a task. It involves various concepts that embody the actual processes of making life easy for people, to which learners need to be exposed so that life could be more meaningful (Isman, 2012).

Makgato (2014: 3689) concurs and views Technology as a subject based on a scientific way of looking at the world and characterised by technological concepts that embody technological content in terms of its SKVs and attitudes that learners ought to adopt to contribute and participate effectively in the global technological arena (Makgato, 2014:3688). Therefore, technology-related subjects are an attempt by human beings to provide content that would enable society to alter and modify the natural living environment and its constituent elements responsibly in society’s quest to satisfy its needs, interests and demands (Ardies et al., 2013). Adaptation in the current epoch of time requires, amongst other elements, continued learning and application of locally and globally conceived ideas of how reality or knowledge systems are evolving and affecting human beings (Isman, 2012). In that light, society should be at a particular level of understanding to effectively embrace and promote appropriate education that prepares learners for their continued survival in the world, as content in the different subjects is informed, inter alia, by the needs of society interacting with global communities (Nokwali, Mammen & Maphosa, 2015).

As a result, society's current feelings/attitudes/perspectives related to different school subjects seem to be largely influenced by those that society has developed and adopted overtime, from one epoch to the other (Majumder, 2015). These feelings/attitudes/perspectives have varying effects and influence the manner in which learners choose, persist in and learn certain subjects over others. Moreover, it has been found that socialisation and earlier predispositions regarding the manner in which society views and values certain aspects of life have an impact on the way learners conduct themselves in certain subjects (Muller, et al., 2014).

Thus, their views/feelings about subjects such as STEM may be influenced by those of society in general. For example, the societal narrative that these are difficult subjects and need to be done by males because of the perceived value associated with being male, society and learners (boys and girls) will adopt a self-fulfilling prophecy that may determine how they tackle the content in these subjects (Nokwali et al., 2015) However, the extent to which this influences the actual learning is not clear. The learners' perspectives and attitudes influencing their choice of subjects may not explain the perceived differences in the manner they learn the concepts. Other factors may be involved, which the study sought to understand by investigating the perspectives of the grade 7 boys and girls on learning technological concepts.

In simpler terms, although there is an association between learners' perspectives/attitudes and their subject choice of subject, it does not necessarily shed light on the actual process involved in male and female learning. It does not begin to illustrate the inner processes involved in the actual learning process followed by the different genders. Therefore, in line with the problem statement stated in Chapter One, the researcher sought to understand how boys and girls learn the technological concepts underlying Technology as a school subject in the SA curriculum. This needs to be clearly defined so that the actual elements of their learning are revealed, which may lead to an understanding of the way learners master them. This may help in identifying the unique strategies that each gender utilises in grappling with each aspect of the subject content and determining the main reasons behind the differences.

Mehrotra, Khunyakari, Natarajan and Chunawala (2009:14) define the general concept of technology in terms of a varied and contemporary scientific phenomenon to which the world is exposed. To scaffold ongoing adaptation and living, this phenomenon requires a learning subject, which entails a body of SKVs and attitudes influencing current modes of communication; the way people live their lives in the 21st century; the mechanisms used by companies for production; the way that the world is shaped; and how people relate to it. According to Mehrotra et al. (2009:18), people need particular SKVs and attitudes to use and benefit from various technological devices in keeping with human needs. Examples of these devices include cell phones with varied applications, television, Internet search engines (Google, Firefox and Microsoft Edge, for example), iPods, iPads and GPSs. These SKVs and attitudes are packaged in a form of a subject that aims to orientate learners so that they keep pace with, and contribute to, the changes happening in their living environment.

People worldwide, in varying degrees, often use these devices and others not mentioned above for social interaction, business and economic development, which could be mediated through a subject termed “Technology” (Nokwali et al., 2015). The fact that there is continued development of advanced ways and means of living implies, inter alia, that there has to be a curriculum that could bring about innovative and progressive ways of dealing with both the current and future human need for easy adaptation and continued existence (Reddy et al., 2016). In other words, the advancement in the world of technology does not happen by chance. However, an enabling environment does exist to stimulate progress and movement towards better technological infrastructure and its associated knowledge-currency. In other words, technological advancement happens because of an inquiry into better and reasonable ways of doing things, thus changing the world into a better place to live in (Reddy et al., 2016). The contribution that different countries and individuals (males and females) make regarding opportunities for technological development is still largely dependent on beliefs about what is perceived appropriate for males and females in society (Ardies et al., 2013).

For people of a given country to benefit from the devices mentioned above, there must be a development of technological expertise and knowledge (Reddy et al., 2016). Reddy et al. (2016:1) argue that certain countries are consumers while others develop and use technological devices for their own economic development endeavours, which is because of differences in the structure, purpose and aim of their technology education. Competitiveness in the use and application of these devices depends, inter alia, on how the countries concerned view technology and how they respond to the ongoing need for new technological content (Bennett & Hogarth, 2009). In this regard, a positive view would invariably lead to the creation of the necessary environment for technology-related subjects to thrive and develop (Mehrotra et al., 2009).

Education is one of the commodities that these countries target for the preparation of future generations. Thus, they design education systems and curriculums that prioritise S&T and help in their quest for a STEM curriculum (Muller et al., 2014: 36) that will give them a competitive edge. Thus, both consumers and users need a certain degree of technological development, as the world is forever faced by new and dynamic S&T challenges (Bennett & Hogarth, 2009:11) without which life is difficult, if not impossible. The difficultly is not only experienced at a personal level but also because various countries are in a global economic network, and thus interdependent. Moreover, they all need some form of educational technology for the development of their multitudes (Reddy et al., 2016). In other words, technological advancement in one country has the potential to impact on the economic tapestry of other countries with which it has a relationship. For it to be competitive, its education system is forced to incorporate local and international STEM content as a critical aspect of its education delivery (Muller et al., 2014).

Technology is never static, and it keeps changing with time in line with the growing needs of humankind. Technology develops as new challenges emerge and innovative ways of meeting them are needed (Muller et al., 2014). According to Muller et al. (2014:74), technological content evolves according to its relationship with various mechanisms that human beings implement in order to make life reasonable for everyone. In addition, it is mostly understood in the context of S&T, as it has continually been changing the contours of the global economy and social fibre of 21st century communities while being mindful of the environment. Therefore, technology is more about content the aim of which is to develop innovative and progressive ways of relating to the environment while an attempt to meet ubiquitous human needs sustainably is made (Simpson, Seidel, Byrne & Woods, 2001). According to Wahab, Rose & Osman (2012:24) the term "technology" has been given many meanings, which depend on the context and purpose of its use. They view technology as a combination of various facets, which involve a physical component comprising physical phenomena, such as products, tools, equipment, blueprints, techniques and processes. Another component relates to information encompassing knowledge of procedures in the areas of management, marketing, production, quality control, reliability, skilled labour and other functional areas of any business (Wahab et al., 2012). This view conceives technology in terms of procedures, on the one hand, and a subject in a curriculum that ensures the development of needed technological SKVs, on the other.

It seems that the concept "technology" has varied contextual definitions and scholars define it for various reasons and purposes. These definitions depend on the context in which the concepts are used. For instance, the term can refer to technology in the context of technological devices/gadgets/infrastructure or, in a general way, to technology as a school subject, which in the specific context of the South African CAPS document for the Senior Phase curriculum is termed "Technology". The discussion above was more about technological gadgets as opposed to the school subject. In the study described in this research report, the researcher concentrated on the specific subject of Technology that is part of curriculum for grade 7 South African boys and girls. Among other aims, this subject's main purpose is to instil competitive technological literacy or acumen in young South Africans so that they may become globally competitive and responsive to global technological needs (Makgato, 2014:3688). Therefore, the study's focus was to determine the perspectives of the grade 7 boys and girls on learning the concepts underlying Technology as a subject, at the senior phase of the South African schooling system.

The DBE, in its NCS expressed in the CAPS Technology document, defines the curriculum-specific subject of Technology as an academic discipline to which learners are exposed for the advancement of SKVs, resources and mechanisms that address ever-growing human needs (DBE, 2011a). Thus, the Senior Phase subject of Technology seeks to stimulate learners' abilities to be innovative in their application of SKVS in dealing with socio-physical reality and meta-reality for meaningful habitation (DBE, 2011a). The subject teaches them to manage time and material resources effectively, provides opportunities for collaborative learning and nurtures teamwork. These skills provide a solid foundation for several FET subjects as well as preparation for the world of work (Makgato, 2014:3688). In other words, the subject embodies the development of practical ways of ensuring that the continuous needs of society may be sustainably and consistently addressed (DBE, 2011a). Obviously, this content area would require certain perspectives to enable boys and girls to learn effectively.

Many scholars and academics study the school/academic subject of technology in a general way in the context of S&T and or STEM. They mostly adopt this approach because this categorisation is underpinned by subjects deemed difficult but important if a country is to be globally competitive and progressively provide for the needs of its citizens (Van Rensburg et al., 1999). Moreover, S&T affects people's daily lives and through these subjects, the nature and contours of the present and future global development is dependent on continued research for advanced and appropriate procedures (Muller et al., 2014: 34). For example, people need S&T devices for social interaction, health-related purposes, transportation, communication, learning, food production, economic development and so forth (Ardies, De Maeyer, Gijbels & Van Keulen, 2015b). In the same way, they need a technology curriculum to stay abreast of these developments so that new, better and competitive ways of living can be continually explored and applied. Clearly, S&T is important as it affects our lives in both positive and negative ways. According to Muller et al. (2014: 34), our experiences of S&T are positive only if we are able to make sense and keep abreast of the latest developments in that area, which may be negative if we are unable to cope and take advantage of the new possibilities that it provides. Therefore, the advent of S&T has changed the socio-economic landscape, and education is a vital instrument with which such changes could be used to our advantage, as life seems impossible without them.

Clearly, a country needs to be able to steer its economy, be globally competitive and develop SKVs and attitudes that enable it to be innovative on the economic development front. The contribution of consumers is limited to the use of technological gadgets, which does not directly contribute to the economic development of countries needing to take advantage of the ever-changing technological world. People must be able to be innovative and produce technological goods that the world can use for import and export purposes (Reddy et al., 2016).

It is important to understand the concept “Technology” defined above as a specific school subject in the context of the CAPs curriculum to determine how boys and girls learn the concepts that underpin it. In the CAPs curriculum, the broad objectives of the subject are expressed as topics that are streamlined into sub-topics and content areas (DBE, 2011a). Learners are expected to cover these topics/content areas in an attempt to acquire the necessary SKVs and attitudes that could enable them to contribute to the continued socio-economic development of the country.

For historical reasons, subjects such as S&T have been viewed as difficult disciplines accessible only to males, with the result that few females have studied those subjects (Nokwali et al., 2015). (Ardies et al., 2013). The belief that males are better suited for these traditionally masculine subjects has led to them trying to prove themselves in these subjects. Society has sustained this view, which has perpetuated the continued marginalisation of females in S&T/STEM and affected their access and success (Ardies et al., 2013). However, recent changes in the world have meant that both males and females are encouraged to do these subjects, as the requirement is now aptitude, values and interests rather than gender (Makgeru, 2016). However, despite the institutionalisation of technology-related subjects to be done by both males and females, there is still social pressure mounted against women not to consider careers that require these subjects (Reddy et al., 2016). This changes the perspectives and attitudes that boys and girls adopt towards learning technology-related subjects and determines how they learn and succeed in them. In the study, we sought to understand the perspectives of grade 7 boys and girls towards the successful learning of technological concepts in selected primary schools of the Gert Sibande District.

The concept “perspective” is discussed below to enable us understand how exactly it affects the way that technological concepts are learnt by the different genders.

2.2.2 Perspectives

In an article on perspectives, commentary and insights, the word “perspective” is viewed as a new and unique approach to existing problems, concepts, notions and topics with a view to developing innovative ways of viewing and approaching life and/or phenomena in ways that make sense to the beholder, and thus change the usual approach towards them (Majumder, 2015). A perspective is an angle from which a phenomenon is viewed, approached and understood, and it is often dependent on a person’s predisposition to attend to the event being the focus of attention, instead of other similar events or situations (Wallace & Priestley, 2011). People view and understand a phenomenon in a particular way, depending on their vantage point and previous experiences of similar or different events, objects, phenomena or anything that is the object of a person’s observation. Thus, their perspective is mostly based on the value they attribute to the perceptual field, their attitudes and predispositions to view similar phenomena in the context of their previous experiences (Cambridge Dictionary, 2017).

A perspective is a particular and individually nurtured way of thinking and viewing a phenomenon that is often influenced by a person’s beliefs, experiences and values that have developed overtime in relation to the perceptual field (Majumder, 2015). Different people could have different perspectives on the same phenomenon depending on issues such as previous knowledge and experience of the phenomenon being observed. In that way, the object of perception represents different values to different individuals, and the beholders use their frame of reference to make sense of it. The differences emanate from their orientations to, and previous experiences of, similar circumstances (Majumder, 2015).

From the above definitions, the concept “perspective” seems to have three fundamental elements: the beholder, the object and the frame of reference. According to Wallace and Priestley (2011:27), the beholder comes to the scene with different orientations, which tend to influence his/her personal life outlook. These frameworks have the potential to influence the way the person views and interprets the world. However, the world is constant and proffers different meanings to different individuals who use their inclinations, values and attitudes to interpret it. The world does not necessarily change, but the meaning that people attach to it varies, depending on their prior knowledge. These meanings are attempts to make sense of the world and for people to relate to it. The attachment of meaning, therefore, happens in contexts where people encounter one another and reality. Certain value systems that inform how people live stem largely from their experience of the world in previous encounters (Wallace & Priestley, 2011).

Parents learn their parental roles from their forbearers, and thus the way they raise their children depends greatly on how they were socialised in growing up. Thus, nurturing plays a critical role in the way the world is viewed and related to at a later stage. In other words, children view the world through their parent’s eyes. The way that a child is raised has a direct impact on how the learner will view similar circumstances in the future. For example, a child born and reared in a family where the daily household chores are divided according to gender is more likely to view the world through that prism. His/her social construction of social relationships would be according to his/her experiences (Wallace & Priestley, 2011).

In the same way, social and family perspectives on choosing certain school subjects are mostly determined by how the family, community, society and the country view those them. If a learner in each community has a negative perspective on a subject, it has the potential to influence the degree of effort exerted in studying the subject (Wallace & Priestley, 2011). Therefore, perspectives are important in succeeding in any task, including the study of STEM subjects and the senior phase subject “Technology” in particular. Based on the above definitions, perspectives can be defined as ways of viewing and coming to grips with the meaning of a phenomenon, which are predominantly honed by a person’s encounter with similar situations in the past and the values generated from that. Thus, perspectives are reciprocal in that they depend on how a person feels or experiences a situation at a given point in time. Therefore, they are operational constructs informed by certain theories that seek to understand their nature and how they influence certain phenomena.

2.2.2.1 Theories of perspective

Just like worldviews and paradigms, perspectives vary and depend on the background of the person viewing that part of reality in which he/she is interested (CliffsNotes, 2020). Learning theories are not exempt from perspectives, and they harbour the prevailing worldviews, theories, beliefs, and paradigms of what learning is all about (Hood, 2002). Therefore, there are many perspectives that educationists and scholars adopt to understand reality and how people understand its meaning. These different perspectives influence their approach and the manner in which they view and interpret the meaning of learning. For example, CliffsNotes (2020) identifies three major perspectives from which sociologists view and understand the world and the people who live in it. The manner in which sociologists view life and the world is not identical to the way that a religious person, a traditionalist, a psychologist and an educationist representing different schools of thoughts would view and relate to the same reality (Hood, 2002).

Objective reality may stay the same, but interpretations will differ as people try to make sense of its true meaning. Unfortunately, that true meaning is relative and varies from one person to the other, as socio-cultural worlds differ and their content informs the lenses through which a person would look at it (Hood, 2002). Therefore, the foundation of this difference is largely based on a person’s frame of reference, which develops through his/her interaction with the world and its people. Consequently, true meaning is dependent on the individual’s philosophy or worldview of what that objective reality means to him/her and how he/she should relate to it.

As mentioned above, CliffsNotes (2020:27) contends that sociologists use three primary theoretical perspectives to view the world and the meaning that it presents, namely the symbolic interactionist perspective, the functionalist perspective, and the conflict perspective. It is believed that these perspectives offer sociologists theoretical frameworks for interpreting and explaining the way people view reality, interact with it, contribute to its shaping and derive meaning from it (CliffsNotes, 2020).

These three perspectives are explained by CliffsNotes (2020: 28) as follows:

- **The symbolic interactionist perspective, also known as symbolic interactionism,**

This perspective involves the symbolic meaning people attribute to symbols, artefacts, physical buildings and the built environment. These physical phenomena carry different meanings to different people. The differences in their approach tos these objects are largely dependent on historical, cultural, religious and social factors, for example. These values stem from the manner in which people were raised that determines the way they behave and relate to the world. For example, if members of society salute when they pass by a historical statue, children will do so unquestioningly. They will believe the salutation makes them part of society and any behaviour to the contrary will be scorned. The reasons for the behaviour are not important to them, as it is part of society and they believe that they should behave accordingly.

In the same way, if society believes that technology education is a reserve for males, so will its members. Moreover, they will ensure that their offspring adopt the same perspective. The reasons behind such thinking would not be interrogated to the extent that any deviant thinking would not be tolerated. Boys will then enjoy the benefits of learning the subjects because society believes it is their responsibility to do so. Even a learner who struggles with the concepts would exert effort to manage the difficulty that those concepts pose.

- **Functionalist perspective/Functionalism**

This perspective holds the view that society is made of different interdependent elements that contribute towards the optimal functioning of society. Factors, such as the state, government, communities, cultural beliefs, knowledge systems, religions and the educational level of community members, are in constant interaction with one another, and they typify the type of society that finally emerges. For example, government or the state has a role to play in the provision of basic services such as education, but it will not succeed if parents or the community does not take children to school. It cannot succeed if parents do not provide learners with the basic educational necessities. However, learners and parents must have a positive attitude towards school and the curriculum, although society should also participate and support the education of its children. Therefore, if parents and society have a negative perspective on education, that negativity will be shared by their children, whose attitudes will subsequently affect the way they view education and the subjects that are offered.

For learners to choose and persevere in STEM, society must share positive perspectives on these subjects and their usefulness. If society feels that technology subjects are the sole preserve of males, that attitude and perspective will be passed on to the learners, who will behave accordingly. Unfortunately, this may hamper female success in these subjects. Moreover, a negative attitude will determine the perspectives of female learners on the value of these subjects, which they will view has having not value for them. They will eventually be on the sidelines and expect males to do them, while they do the other subjects that are perceived as less important. Therefore, the functional value/perceived functionality of a subject will determine the extent to which learners, both males and females, may choose certain subjects over others.

- **Conflict perspective**

Unlike the functionalist and the symbolic interactionist perspectives, the conflict perspective relies on the notion that society is negative, conflicted, and ever changing. This perspective supports challenging the status quo for social change and holds the view that rich and powerful people force social order on the poor and the weak. From a conflict perspective, education and its subjects might be viewed as something that rich people use to assert authority and maintain their control of the world's economy. Adopting such a perspective may hamper opportunities to provide education for social change and economic development.

The above discussion of the three perspectives revealed how perspectives play a major role in how learners choose, learn and succeed in certain subjects. An understanding of learners' perspectives may lead to knowledge about the learning of technological concepts on the part of both males and females.

In the context of the study, if an individual has developed encouraging perspectives on the manner in which the Senior Phase subject "Technology" is taught, he/she will inadvertently have a positive perspective on the subject in terms of its content, the concepts involved, applicable assessment activities, difficulty levels of the concepts and learning approaches, for example. However, if learners encounter or experience the teaching of Technology as a daunting activity, their perspectives on the subject will change in line with their experiences, which could influence their understanding of the content and related concepts (Wallace & Priestley, 2011).

Perspectives are often confused with attitudes, as the two concepts seem similar. According to Muller et al. (2014:37), the concept "perspective" relates to how a person views a phenomenon, whereas the concept "attitude" refers to how a person feels about the phenomenon. Therefore, attitudes could influence the development of certain perspectives on a phenomenon (Muller et al., 2014). In other words, feelings have the potential to influence the way a person views and relates to the world. For example, a person who likes technological concepts is more likely to have a positive perspective on the subject. Therefore, it is important to interrogate the concept "attitude" for a better understanding of how boys and girls perceive the learning of technological concepts in the study.

2.2.3 Attitudes

According to Cooper & Schindler (200629), the concept "attitude" refers to a person's state of mind in relation to something of value. In other words, the person must first have an encounter with something to develop certain experiences that could shape his/her views and preferences of something over another (Muller et al., (2014). According to Muller et al. (2014:36), attitudes are the learnt and established ways of approaching a phenomenon of value, and they significantly affect the way a person relates to the world and everything in it. Attitudes are learnt behavioural approaches that inform a person's relationship with a phenomenon and are largely based on his/her experiences and knowledge of it (Blazar & Kraft, 2017). Whether a person continues to work on a particular task is determined, to a great degree, by his/her attitude towards it, which is based on its potential value and his/her previous involvement with a similar situation (Blazar & Kraft, 2017).

Therefore, a person who has had unpleasant experiences of a phenomenon, or has been told unsavoury facts about it, is more likely to develop negative attitudes towards it, which will determine the degree to which that individual will persist in relating to it (Cooper & Schindler, 2006). Negative attitudes decrease the likelihood that an individual will carry on performing an action, which may dissuade future attempts to succeed in doing it (Blazar & Kraft, 2017). Attitudes, therefore, determine the extent to which an individual persists in behaving in the same way, which also depends on the feedback the person receives in relation his/her behaviour. Persistence and resilience happen if the object has potential value to the individual engaged with it. In fact, Muller et al. (2014:36) discern a close correlation between attitudes and persistence in learning school subjects or attempting any learning task. The assumption is that, if a person has a positive attitude towards a learning task, the likelihood is that he/she will succeed in it. However, the role of teacher and student variables in the development of certain attitudes is a contested terrain. For instance, Ardies et al. (2013:47b) argue that little is known about teacher and student variables in the development of certain attitudes towards subjects such as STEM. However, this does not rule out the possible role of attitudes in choosing and learning certain subjects.

Therefore, success in learning subjects such as STEM may be associated with the attitudes that learners have generated and developed towards these subjects in the context of interaction with others and the subjects themselves, which that takes time to happen (Muller et al., 2014). Moreover, like perspectives, attitudes towards certain subjects stem from previous experiences with them, and society plays a major role in their development. For example, if a learner grows up in an environment where STEM is continuously complained about, he/she will develop negative attitudes towards these subjects and may not do well in them. The opposite is also true for a learner who experiences positive narratives about STEM. He/she is more likely to develop positive attitudes that are needed for him/her to succeed in these subjects.

Therefore, attitudes have a critical role to play in influencing the manner of, and approach to, successful learning in many academic subjects, including STEM.

Thus, attitudes, just like perspectives, have a significant role to play in the successful learning of any subject. A subject may be perceived to be difficult, but if the learner is raised in an environment where this subject is viewed in a positive light, the propensity for learning success is high, which has inherent benefits to those learners. Thus, attitudes are important for understanding content in various subjects, especially STEM concepts.

In addition, attitudes affect the way boys and girls choose and pursue certain subjects. Muller et al. (2014: 36) maintain that gender plays a role in the attitudes that learners have towards subjects such as STEM. However, the differences are not only related to the genetic makeup of both sexes but also the attitudes, ethos and perceptions engendered by family and societal expectations of the different sexes, which play a pivotal role in both the learners' choice of subjects and the extent to which they are motivated to manage and succeed in them.

Attitudes and perspectives are cardinal in teaching and learning, influencing the way any subject is taught and learnt. Therefore, teachers and society should be mindful of the important role of attitudes and perspectives in the learning of technological concepts. Many authors and scholars, as indicated in Chapter One, have proved that learners' choice of subjects is mostly dependent on the attitudes that society has developed about these subjects, although that finding does not necessarily help in the understanding of the perspectives of grade 7 boys and girls in learning technology concepts. In line with the main question and sub-questions outlined in Chapter One of this research report, the study sought to understand how grade 7 boys and girls in the South African schooling system develop certain perspectives on learning technological concepts and how they experience the effect of societal biases on the effective learning of these subjects

Many studies have investigated the role of certain perspectives and attitudes in choosing and pursing STEM. For example, the Organisation for Economic Development (OECD) has argued that attitudes, cognition, metacognition and perspectives determine learners' choice of subjects, the way they learn them and their persistence with their academic work (OECD, 2004). This point of view is relevant to Technology, which is both an academic and practical subject requiring positive perspectives and attitudes for learners to study it successfully (DBE, 2011a). However, the OECD's (2004) reference to metacognition and cognition imperatives in learning does not shed light on how subject-related concepts are actually learnt. Learners' perspectives on learning subjects remain hazy and these needs to be investigated for a better understanding of the learning processes involved in learning technological concepts.

Therefore, it is undisputed that attitudes have long been identified as an important factor in the learning of technology-related subjects. Moreover, it has been acknowledged that they are generated from the social milieu in which the learner is raised, although contexts may differ (Ankiewicz, 2017). Therefore, attitudes are a critical aspect to be interrogated for a better understanding of the factors contributing to learners' choice of subjects and the extent to which they persist in learning them. A study conducted by Ankiewicz (2017), discovered that attitudes come in various ways and there are both traditional and contemporary views of them.

In terms of the traditional view, attitudes towards an attitude inducing event/episode/experience (such as a technological concept) constitute a person's collection of beliefs about it (cognitive component), experiences of it (affective component) and reactions to it (behavioural component) (Ankiewicz, 2017). Currently, researchers and academics either implicitly or explicitly acknowledge the traditional approach towards attitudes in their definition of attitudes and their role in learning, especially, technological concepts (Metsärinne & Kallio, 2015).

Therefore, the concept "attitude" can have various connotations, such as enthusiasm, enjoyment, antagonism and boredom. Furthermore, in the context of learning, the term can imply an interest in a subject because of its perceived career opportunities, its difficulty and its usefulness in life (Ardies et al., 2015a). Clearly, there appears to be many constructs related to the concept of attitudes, and one single construct cannot lay claim to define it sufficiently.

Perhaps, in order to understand the role of attitudes in the learning of technological concepts, the PATT-USA questionnaire may be used, although it predominantly measures emotional issues (Ardies et al., 2015a). Based on the dynamic nature of attitudes and their applicability in different countries and contexts, the Attitudinal Technology Profile (ATP) questionnaire was developed, which is now primarily used to measure the attitudes of primary school learners in many countries, including SA, holistically (Ankiewicz, 2017). It is preferred mostly because it uses, among other elements., mid to lower levels of technology-laden English, instead of higher levels as is used in the PATT–USA, to measure the attitudes of learners in countries such as South Africa (Ankiewicz, 2017).

The development of English in different countries is at different levels of development, which may make the utilisation of one instrument irrelevant and misleading for the type of learners involved in the testing. The most interesting aspect about the ATP is that it also measures the behaviour of learners towards technology-related subjects, whereas the PATT-USA largely focuses on the emotional content of attitudes (Ankiewicz, 2017). Clearly, the concept “attitude” is not easy to comprehend, and thus the researcher needed to be wary of simplistic stances and approaches when seeking to determine its actual role in the learning of technological concepts of both boys and girls in primary schools in the area of the study. Although there is an association between attitudes and learning, as argued above, specific findings need to be made as to how attitude influences the learners’ perspectives on learning subject content.

The above definitions and the ensuing discussion assisted the researcher in understanding the powerful role that attitudes may play in the learning of different subjects and in locating the study in a proper context. Moreover, they led to an understanding of the particular role of attitudes in leaners’ choice of school subjects. The researcher understood how external factors influence learners’ attitudes, which in turn influence their academic success. In addition, the researcher understood how societal attitudes are developed, how these attitudes affect the types of subjects learners choose and the extent to which learners (boys and girls) may successfully persevere and pursue STEM-related careers. However, the choices that learners and society make regarding school subjects are not attributable to only one factor. A myriad of factors influence both subject choice and learners’ career direction based on it. Attitudes change societal beliefs, people’s outlook on life, philosophies of life, ideologies and the value that societies attach to certain subjects and careers. Furthermore, attitudes affect the expected roles and duties of the different genders in society.

Thus, attitudes and perspectives are powerful constructs the value of which in choosing and pursuing STEM and careers related to these subjects should be well understood so that research can make sense of how boys and girls in grade 7 of the South African school system learn technological concepts. In addition, this could reveal the different approaches and strategies these learners use when they learn technological subjects/concepts.

A discussion follows below on the manner in which the South African schooling system structured the curriculum of Technology at the senior phase of the GET band. The following section will explain the provision of technology as a subject in the curriculum statements of a few countries in Sub-Saharan Africa for comparison. A few European countries will also be studied to understand and determine how the subject is provided and learnt.

2.3 TECHNOLOGICAL CONCEPTS IN THE CONTEXT OF THE NATIONAL CURRICULUM STATEMENT (NCS) AND THE CURRCIULUM AND ASSESSMENT POLICY STATEMENT (CAPS), GRADES R-12

According to the DBE (2011a: 9), Technology at the Senior Phase of the South African education system is a subject that seeks to give learners opportunities to solve problems in creative and critical ways. Moreover, it seeks to use authentic contexts rooted in real situations outside the classroom to apply content; and to combine thinking/doing in a way that links abstract concepts to concrete understanding. In addition to this, the subject gives learners who are completing tasks the opportunity to evaluate existing and their own created products and processes; to use and engage with knowledge in a purposeful way; and to deal with inclusivity, human rights, social and environmental issues. Technology ensures the use of a variety of life skills in authentic contexts, such as decision-making; critical and creative thinking; cooperation; problem solving; and needs identification (DBE, 2011a). The subject further empowers learners to create positive attitudes, develop optimistic perceptions, form aspirations to technology-based careers and work collaboratively with others through practical projects using a variety of technological skills (investigating, designing, making, evaluating and communicating) that suit different learning styles (Stevens, 2006).

In line with the above learning opportunities, Technology is based on four content areas, namely Structures; Processing of Materials; Mechanical Systems and Control; and Electrical Systems and Control (DBE, 2011a). Furthermore, the DBE (2011a:10) packages the topics and core content areas in Technology in the following manner:

- The Design Process (Investigation/Design/Manufacturing/Communication Skills)
- Structures
- Processing of Materials
- Mechanical Systems and Controls
- Electrical Systems and Controls
- Technology, Society and the Environment (Indigenous Technology, Impact Technology and Bias in Technology

Comprehension of the above technological content areas requires in-depth understanding and the application of learnt SKVs (Leahy & Phelan, 2014:377), as they cut across many scientific fields of study and are relevant for the economic development of the 21st century (Yadav, Hong, & Stephenson, 2016). One way of learning the content of these learning areas could involve using an outmoded way of learning as proposed by the behaviourist theory of learning (Mechlova & Malcik, 2012). However, this would not include learning of the steps involved in a complex structure or require deep processing or attachment of meaning to the content. All that it requires is memory of the sequence as opposed to understanding what goes beneath it. Therefore, although surface processing of technological concepts may create a foundation for the learning of more complex technological concepts (Reddy, et al., 2016: 2), deep processing of SKVs will lead to meaningful learning (Schunk, 2012).

In other words, deep processing of technological concepts is required for the understanding and application of knowledge embedded in them, especially, the inherent SKVs. In other words, learners should not only rely on the regurgitation of learnt content to demonstrate their competencies, but also develop concepts, attach meaning and develop nodes of knowledge networks for better understanding of the technological concepts and their application in different contexts. Mechlova and Malcik (2012) argue that a behaviourist learning style on its own does not necessarily lead to meaningful and progressive learning of content in various disciplines. Regurgitation of content with little or no understanding reflects the behaviourist doctrine of learning in which the emulation of certain behaviours and their reinforcement are determinants of learning (Mechlova & Malcik 2012). In other words, learning is judged by the extent to which the learner acts out behavioural patterns in line with the model. This type of learning does not necessarily involve many cognitive processes in learning.

Reddy et al. (2016: 2) argue that effective learning of technological concepts requires learners to develop in-depth understanding of the SKVs before they can be applied, which challenges learners' cognitive functions, as it involves the highest order of cognitive operation (Reddy, et al., 2016). For example, in designing models or structures, learners need to apply their higher cognitive thinking skills in line with the constructivist and connectivism theories of learning.

Subject content requires learners not only to emulate behaviour but also to attach meaning to the content and develop connections between its components. Technological concepts and their cognitive demands provoke society to attach different values and perspectives to Technology that learners find difficult, leading to exclusion of many from pursuing STEM-related careers (Leahy & Phelan, 2014:377). However, despite the perceived difficulty of the subject, it is critical for the economic development of the world (Van Rensburg et al., 1999). As a result, all citizens of a country, regardless of gender and socio-economic factors, must be given the opportunity to learn technology-related subjects for the growth and development of global economies (Leahy & Phelan, 2014:377) because the potential for growth and development is latent in all children (Mechlova & Malcik, 2012).

The DBE enjoins Technology to be a subject that embeds technological concepts that could assist in the development of learners' technological literacy skills by instilling abilities to develop and use technological designs to grapple with and make sense of local and global technological challenges (DBE, 2011a). Moreover, these skills enable learners to come to terms with the key concepts and content areas underpinning Technology, which promotes the responsible use of technology in daily life. Thus, aesthetic values are promoted, which is manifested in the appreciation of the interaction between human beings and the metaphysical world (DBE, 2011a).

This view encompasses all the necessary ingredients to which a South African learner must be exposed for him/her to lead a productive, responsible and developmental life (DBE, 2011a). Thus, Technology as a Senior Phase school subject may lay the necessary foundation for the development of specialised skills at secondary and tertiary education levels as shown in Figure 2.1 below.

In the South African context, and particularly at the GET level, regardless of gender/sex, all learners are exposed to the same subjects, and the intention is to instil the basis for further learning of concepts in subjects, such as Physical Sciences, Mathematics, Agricultural Sciences, Life Sciences, Engineering, Information and Communication Technology, at the FET level. This may be construed as a subtle admission by the DBE that there could be some physiologically based differences between males and females in learning various subject that depend on the manner they learn (Reddy, et al., 2016). Mubeen et al. (2013:41) reckon that girls at secondary school level tend to outperform boys in mathematics and science if the necessary attention is given to them in the previous phases.

In other words, if girls are given support through teaching and assessment, boys seem to lag behind. The implication of this is that boys perform in science and mathematics in the earlier grades primarily because society appreciates and encourages patriarchy. This appreciation puts pressure on boys to do all they can to perform in these subjects. Underperformance by girls is not regarded as a challenge. Rather, it fulfils the societal belief about the nature and life of a girl child in many societies. This, therefore, makes it difficult for girls to practise resilience and persistence in their learning (Mubeen et al., 2013).

However, if boys are also not given attention and support, they might also struggle with the learning of STEM (Reddy et al., 2016). Invariably, the choice and successful learning of the concepts underpinning STEM seem to rely on support, diligence, enthusiasm and eagerness to learn (Mubeen et al., 2013; Reddy et al., 2016). This is evident when boys seem to underperform when expectations and support are removed. In the same way, girls underperform when attention is not given to them at primary and other school levels (Mubeen, et al., 2013).

The failure to learn and understand technological concepts at the Senior Phase is, therefore, associated with the nature of the progression that learners are supposed to go through. For example, at the Intermediate Phase, learners are introduced to NST as a stand-alone subject, which works as a foundation for the learning of S&T concepts at the Senior Phase (DBE, 2011a).

Poor understanding of NST concepts at the Intermediate Phase affects learners' performance in the Senior Phase because the content and concepts become more sophisticated and difficult as they progress through the system (Mubeen, et al., 2013). A poor understanding of STEM subjects is largely related to the attention given to, and expectations made of, boys and girls on the part of family, community, teachers and peers, for example. Plainly put, if all learners, regardless of gender, could experience the same scholastic expectations, a different picture and perception about STEM could be generated. This would also enhance their capacities to contribute to the economic development of their countries (Reddy, et al., 2016: 2) for the benefit of all citizens. Essentially, the attention that could be given in the Intermediate Phase of the South African education system could assist the nation in grappling with the succeeding and continuing content at the upper levels. This is because the content in the South African education system is articulated and progresses from simple to complex levels as the learner proceeds with them. This articulation is shown in Figure 2.1 below.

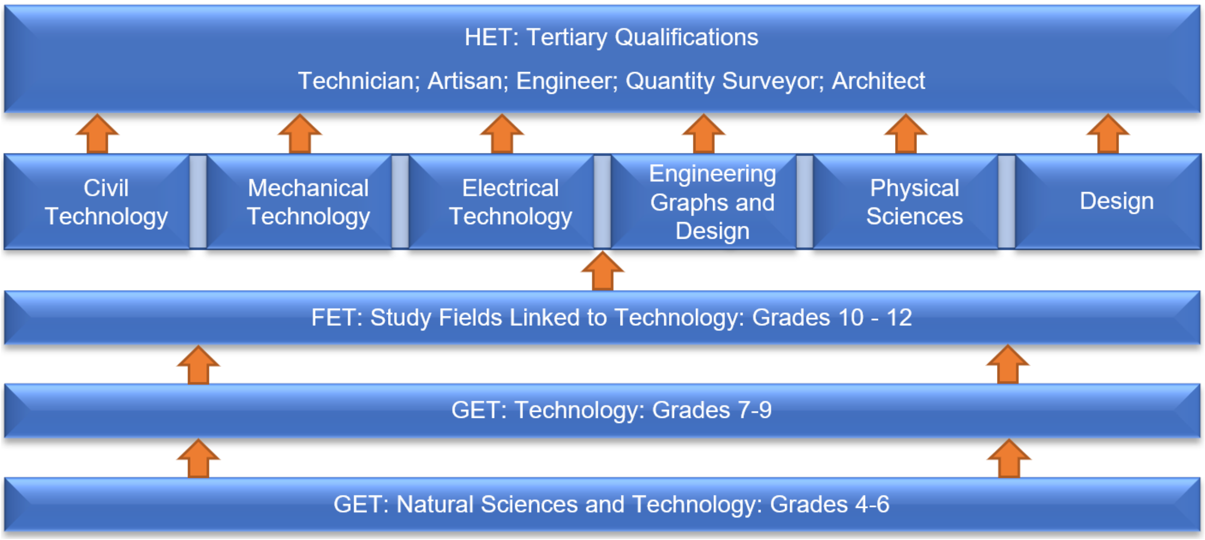


Figure 2.1: Articulation of technology through the South African education system (an adaptation from DBE (2011a: 5).

In Figure 2.1 above, it is evident that what starts as a general subject in the form of NST in the GET band is transformed into Technology in the Senior Phase of the GET band. It is also noteworthy that, at FET level, various subjects are linked to Technology, including Civil Technology, Mechanical Technology, Engineering Graphics and Design, Physical Sciences and Design. These subjects are based on foundational skills that could be acquired at both the Intermediate and Senior Phase of the South African school system. Most importantly, these subjects are articulated to careers such as technicians, artisans, engineers, quantity surveyors and architects, for example. In terms of the NPPPR, a learner who wishes to pursue one of the careers mentioned above should choose relevant subjects at grade 10 of the South African school system, which does not discriminate between males and females (DBE, 2011b).

Currently, SA experiences a need for aspirant engineers, which contributes negatively to the transformation agenda of the country and adds to the increasing inequality gaps that SA is experiencing today (Elan, 2012). Moreover, South African laws are tilted in favour of females, and therefore they should be the ones who populate enrolments in technological subjects, as the trends indicate that males are leading in such fields (Gasant, 2011).

Essentially, it is almost twenty-three years since the introduction of the new education system in South Africa, but the quality of education is still at undesirable levels (Reddy et al., 2016). The teaching of MST is found to be at their lowest levels, yet SA contributes a bigger chunk of its budget to education, compared to the most developed countries in Africa and the world (Reddy et al., 2016) In corroboration with this observation, the TIMSS-2015 revealed that most teachers who teach MST are not effectively qualified to teach these important subjects, and such teachers are mostly found in the no-fee schools of South Africa (Reddy et al., 2016).

Moreover, according to Mnguni (2013:63), most educators who teach NST could not pass the same tests as those that learners are expected to pass. This indicates that the foundational and operational concepts that underpin the easy learning of NST concepts are not adequately being inculcated at the early stages of the South African education system, hence the poor performance in those subjects.

Thus, Mnguni (2013:61) attributes poor performance in NST to a myriad of factors, including the lack of effective monitoring of teachers by educational authorities and the fact that leaners have a perception that NST is a difficult subject. Paradoxically, effective programs are in existence in South Africa, but inappropriate motivation and negative perspectives towards NST are responsible for the poor performance in these subjects (Mnguni, 2013). That may then influence their perspectives on learning the concepts that characterise NST and Technology in the South African school system.

According to Makhubele (2016:34), South Africa's NST is not performing as expected and that is seen by the low enrolment levels at FET in subjects such as Physical Science, Life Science, Agricultural Science and Mathematics. This underperformance, however, is not a unique South African phenomenon because Ghana and Eswatini are at the bottom of the list of countries that do not perform well in S&T (Heymans, 2007). However, Singapore, Ireland, New Zealand, United States of America (USA), Australia and Botswana, for example, are in the list of top twenty performing countries in S&T (Heymans, 2007).

Technology education programs and learning in the performing countries have developed rapidly over the past ten years and profound research, experimental programs and the development of learning materials have been undertaken (Heymans, 2007). Studying S&T education of both the performing and underperforming countries would facilitate an understanding of how their curricula are structured and how learners learn the concepts that underpin these subjects. However, the aim of this chapter is not to conduct a comparative study of these countries, but to understand how learners learn technological concepts. To establish a background towards understanding how learners learn the concepts, it is important to unearth the composition of the curriculum nested in their technology subjects.

However, this chapter will not present a study of all the technology curricula of all the countries mentioned above. In Sub-Saharan Africa, the technology curricula of Eswatini and Botswana will be investigated. Moreover, this chapter will solely focus on Eswatini and Ghana (underperformers), Botswana and Ireland (performing countries) (Reddy et al., 2016). Heymans (2007:29) argues that all countries have their share of challenges as well as both positive and negative experiences in teaching and learning of technological content.

It is, therefore, important to discuss some of the general challenges of teaching STEM, S&T and MST to arrive at a better understanding of how learners in South Africa learn technological concepts. Moreover, tapping into the experiences of countries that are in the same category as SA will lead to an understanding of the nature of its challenges. The identification of areas of strengths in those countries may reveal approaches that can be followed to bolster SA. Performing countries may have different approaches that they utilise, and delving in those will illuminate their winning formula. That formula could be explored and recommended for consideration by South African education authorities. The idea is to evaluate the way learners across the globe learn technological concepts so that SA can strengthen its approaches. Below is a discussion on the curricula of the selected countries.

2.4 THE STRUCTURE OF THE CURRICULUM IN SOME SUB-SAHARAN AFRICAN STATES AND IRELAND IN RELATION TO TECHNOLOGY

2.4.1 The curriculum of Eswatini

Generally, the education systems of most countries offer some form of technology education, which is in line with globalisation and the need to participate in the global technological arena following the 4IR. As a result, these countries are bracing themselves for the challenges that the 4IR may pose, as it challenges the way life was lived before it came into being. According to Macmillan Education Swaziland (2018:23), Eswatini is a small country that coexists with other neighbouring countries. Thus, it depends on these countries for its continued survival and its economic wellbeing. Many Swati nationals use South African services that South Africa and the majority take their children to South African schools (Mthethwa, 2014). This is mostly seen in areas closer to the boundary between South Africa and Eswatini. Some even walk to SA through the border for their daily amenities (Motsa & Morojele, 2016). According to Motsa and Morojele. (2016:23), the fact that SA and Eswatini share a border, makes the two countries interdependent in various important ways, including their education dispensation, although there are unique features in the education systems of both countries in line with their founding philosophies of life (Mthethwa, 2014). Therefore, any development in SA has the potential to affect the way Eswatini manages and runs its economic development trajectories and education system (Mthethwa, 2014).

The similarities between the configuration and content of subjects offered in Eswatini and those in SA are manifested in the curriculum of both countries (UNESCO, 2015). For example, Eswatini divides its education levels into three tiers, namely the Eswatini Primary Certificate level (primary school); the Junior Certificate level (junior secondary school); and the Eswatini General Certificate of Senior Education level (senior secondary school) (Macmillan Education Swaziland, 2018). According to Macmillan Education Swaziland (2018:1), the subjects offered at the different levels of the education system are configured as shown in Table 2.1 below.

Table 2.1: Swaziland educational levels and subjects offered

<table>
<tr><th>Levels</th><th colspan="2">Subjects</th></tr>
<tr><th></th><th>Core Subjects</th><th>Electives</th></tr>
<tr><td>1. Eswatini Primary Certificate (Grades 1-7)</td><td>• English
• SiSwati
• Mathematics
• Science
• Religious Education
• Social Studies
• Physical Education
• Practical Arts</td><td>• French
• Afrikaans
• Consumer Science
• Agriculture</td></tr>
<tr><td>2. Eswatini Junior Certificate (Form 1-3)</td><td>• English
• SiSwati
• Integrated Science
• Mathematics
• History
• Religious Education</td><td>• Additional Mathematics
• Geography
• Literature in English
• French
• Consumer Science
• Design and Technology
• Information, Communication and Technology
• Bookkeeping
• Business Studies
• Agriculture
• Fashion and Fabrics</td></tr>
<tr><td>3. Eswatini General Certificate of Senior Education - EGCSE (Form 4-5)</td><td>• English
• SiSwati
• Mathematics
• Physical Science
• Biology
• Chemistry</td><td>• Additional Mathematics
• Geography
• Literature in English
• French
• Consumer Science
• Design and Technology
• Information, Communication and Technology
• Bookkeeping
• Business Studies
• Agriculture
• Fashion and Fabrics</td></tr>
</table>

Table 2.1 above shows that Science offered at the Eswatini Primary Certificate level (grades 1-7) prepares learners for Integrated Science offered at the Eswatini Junior Certificate level (forms 1-3). Moreover, it is articulated to Physical Science, Biology and Chemistry offered at Eswatini General Certificate of Senior Education level (forms 4-5). Interestingly, two of the electives provided at the Junior Certificate level are Design and Technology, on the one hand, and Information, Communication and Technology, on the other. These electives relate to what the system offers at the General Certificate of Senior Education level, where learners can continue with Design and Technology and Information, Communication and Technology.

However, the subjects that the Eswatini education system provides are not the same as the ones that SA offers. For example, learners in SA are made to do NST at both the Intermediate and Senior Phases (DBE, 2011a). Furthermore, the South African educations system seems more accommodating as learners have a wider choice of subjects (DBE, 2011b). In other words, the Eswatini education system promotes technology only at the junior secondary and senior secondary phase and not at the primary phase. Apparently, technological concepts are embedded in the teaching of science that is offered throughout. However, SA allows a clear and specific choice with regard to the learning of Technology, which is a specific subject at both the Intermediate and Senior Phases of the school system. The South African system does not rely on science for the teaching of technological concepts; therefore, the curriculum is explicit and overt regarding the teaching of technology.

2.4.1.1 Challenges of teaching Design and Technology in Eswatini

One of the biggest challenges facing learners in Eswatini, especially those who live in rural areas, is lack of proficiency in English (Madzima, Dube & Mashwama, 2009: 31).This challenge does not only affect the learning of science and technology, but also all other subjects. For the subject “Design and Technology” to be understood with ease, a certain degree of English proficiency is needed. All the concepts to which learners are exposed in most of the subjects of the Eswatini education system are packaged and mediated in English (Madzima et al., 2009). Difficulties arising from an inability to understand English concepts may be compounded by acute incompetence in grappling with and understand the concepts embedded in Design and Technology, especially in rural areas of Eswatini, and the inability of teachers to mediate the concepts (The World Bank, 2010).

Teachers' lack of PCK has a direct bearing on learners' ability to learn and understand the content of most subjects (Mapotse, 2015). In other words, if teachers cannot teach as expected, the likelihood is that learners will not effectively internalise and learn the concepts as intended. They will then resort to memorisation of content with little or no understanding of its underlying meaning. Therefore, most learners in Eswatini do not do well in learning the concepts in Design and Technology; most turn to surface learning, memorisation, and outmoded approaches towards learning, especially in rural areas (The World Bank, 2010). This experience resembles that of SA that also has poorly trained teachers for MST, NST and Technology, which leads to ineffective learning of technological concepts (Mapotse, 2015).

Similar to SA, Eswatini has a significant number of learners who perform well in learning technological concepts; however, these learners are situated in urban areas. This shows the connection between success in learning and the socio-economic status of learners' parents (Reddy et al., 2016). This is probably because affluent parents have a propensity to expect higher performance from their children, compared to illiterate parents, and they tend to be more involved in the education of their children (Gooding, 2001). However, in South Africa, the performance of learners in NST/MST/S&T is relatively low, despite the investment that the DBE has made to facilitate the learning of concepts embedded in these subjects (Cai et al., 2016).

In Eswatini, most learners also do not perform in S&T, which as indicated above is partially attributed to the lack of qualified technology teachers, even though opportunities are available for their development (United Nations Educational Scientific and Cultural Organisation [UNESCO], 2012). In Eswatini, educators who are enrolled for higher and advanced learning change their careers after being exposed to advanced education opportunities, which mostly affects educators who study ICT, MST and S&T, for example (UNESCO, 2012). This scenario creates challenges in the effective teaching and learning of technological concepts that require properly trained teachers to mediate them (Mapotse, 2015).

Female learners who attempt Design and Technology studies in both the lower and higher grades in Eswatini do not perform, compared to their male counterparts (UNESCO, 2012). This state of affairs is attributed to socio-cultural factors that belittle the status of the girl child in the economic tapestry of the country, which leads to generally high dropout rates of girls in Eswatini schools (UNSECO, 2012). Therefore, the majority of parents in Eswatini have negative perspectives towards the girl child's learning of Design and Technology subject content because it is regarded as unsuitable and irrelevant for them to study due to socio-economic and cultural beliefs about the role of women in the country (UNESCO, 2012). This could be responsible for the general poor performance of learners in MST in general and Design and Technology in particular.

For further understanding of technology as a subject in other countries, the section below interrogates the curriculum structure and delivery of that subject's content in Botswana, the education system of which ranks high in the category of performing countries in Sub-Saharan Africa and the world. This juxtaposition will contribute to an understanding how the country views and implements technology content.

2.4.2 The curriculum of Botswana

Botswana is a landlocked, resource-rich and relatively politically stable country in Sub-Saharan Africa that shares a border with South Africa (Eger, 2016). This implies possible socio-cultural similarities, as the people in the two countries may relate in several ways that influence needs and orientations to life (Majgaard & Mingat, 2012). However, the landscape of Botswana and that of other Sub-Saharan African states tend to differ in various ways, including their socio-economic and educational performance tapestries (Eger, 2016). According to the UNESCO (2017:5), the education system of Botswana places emphasis on the development of broad critical skills to inculcate adaptive and competitive abilities to participate freely in, and contribute to, the ever-changing technological world. Moreover, Botswana seems to be different from the majority of Sub-Saharan African countries as its education system shows consistence performance over the years (Eger, 2016) for many reasons. Eger (2016:13) identifies the usage and promotion of effective progression and articulation systems across the grades as the critical reason for the upward trajectory in the performance of the Botswana education system.

Moreover, Botswana is poised to instil critical, creative, progressive, integrated, competitive, collaborative and other critical skills to prepare its population for the demands of the 21st century (UNESCO: 2017). The trick lies in the effective manner in which these critical skills are included in the configuration of the different subjects and how those subjects are taught (Eger, 2016). Therefore, the Botswana education system subscribes to the prevalent norms, standards and demands of the 21st century, as it bases these critical skills at the centre of its educational dispensation whilst they inform its texture, aims and purpose (UNESCO, 2017). Botswana's educational vision seeks to prepare its population for the unknown world of technological advancement and uncertainty (Eger, 2016). As a result, the foundational skills underpinned by 21st century orientations enjoin and shape the trajectory of the SKVs and attitudes embedded in the different subjects of their education offering (Majgaard & Mingat, 2012).

To realise its educational vision, Botswana bases its 2017 education trajectory on five integrated pillars, namely foundational skills, vocational skills, practical skills, readiness for the world of work and career guidance (UNESCO, 2017). These pillars encapsulate a tapestry of interrelated hard and soft skills that shape and buttress the development of Botswana's education system. Table 2.2 below illustrates the configuration of the interrelated skills.

Table 2.2: The skills promoted by the Botswana education system

Skills (Areas)	Aims of the skills
Foundational Skills	• Decision making and problem solving • Self-presentation • Teamwork • Computing
Vocational skills	• Job-related educational skills • Education about the different jobs in the world of work • The requirements of different jobs • New jobs in the market
Practical skills	• Subjects that promote the understanding and appreciation of technology • Development of the manipulative skills required in technology • Other practical skills required in the world of work.
Readiness for the world of work	• Commercial knowledge for participation in the job market • Exposure to the world of work by part-time engagement
Career guidance	• Development of skills to understand what is offered in the world of work • Development of interests and capacities towards understanding of the labour market

The above table shows that the Botswana education system is vocationally oriented as it seeks to skill the workforce with practical skills and technological expertise to participate in the growth and development of the country. Its inclination to technocracy influences the choice of subjects that schools should offer from the lower classes to higher educational levels. The intention is to ignite and sustain the socio-economic development apparatus so that all people can contribute to the economic development of the country. Therefore, technology is prioritised as a rallying point for all educational and economic development endeavours. However, Makwinja (2017:61) argues that the Botswana education system is not sufficiently pitched to address the ever-increasing technological needs the country continues to face at this epoch of time. In other words, more needs to be put in the curriculum, especially, in the different levels so that the curriculum could assist the Botswana people with the necessary and current skills for vocational training. This, however, does not rule out the observation that the curriculum is fraught with strands of S&T right from primary to high school levels. There could be less emphasis on these subjects, but the curriculum is poised to inculcate scientific and technological skills (UNESCO, 2017). In other words, technology, basically, informs the Botswana's educational trajectory.

In the same way, both the South African and the Eswatini education systems emphasise, in varying degrees, technology as an important aspect of their education systems. Thus, the education systems of these countries are conscious of the importance of technology. The only difference between these three countries (Botswana, Eswatini and SA) lies in the manner in which they develop their educators, service schools and provide learning/teaching support material (Majgaard & Mingat, 2012). These variables are essential for the successful learning of content in the various subjects in the school system (Eger, 2016).

Eger (2016: 37) attributes the success of the Botswana education system to the level of teacher education in the country. Most teachers in Botswana are academically trained for the subjects they teach, and there is a program for continued teacher development (Eger, 2016). However, according to Makwinja (2017:62), Botswana produces more academics than it can use, and the majority of these are white-collar academics who do not assist the country with needed technical skills. In as much as the curriculum makes provision for S&T, it does not necessarily produce enough much needed human resource for the technical needs the country faces (Makwinja, 2017).

However, the education structure of the Botswana education system is configured in the same way as SA's system (Southern Africa Association for Educational Assessment [SAAEA], 2014). The only difference in the configuration of the structure lies in how the two systems regard the levels. For example, in Botswana, the levels are Pre-Primary, Primary, Junior Secondary and Senior Secondary. In SA, the levels are Foundation Phase (Grades R – 3), Intermediate Phase (Grades 4–6), Senior Phase (Grades 7–9) and the Further Education & Training Phase (Grades 10 – 12).

According to SAAEA, 2014: 41, at the Lower Primary school level, Botswana offers Life skills, Mathematics, Sciences, Cultural Studies, Arts, Indigenous Languages and

English. At the upper primary school level, the subjects include Life skills, Mathematics, Sciences, Cultural Studies, Arts, Indigenous Languages and English and only Guidance and Counselling are offered as electives. At the secondary school level, the subjects include Mathematics, Sciences, Cultural Studies, Arts, Indigenous languages and English and many other subjects are offered as electives at this level.

Notably, Science is offered at both the lower primary and upper primary school levels. The content of Science prepares learners for subjects, such as Mathematics, Integrated Sciences and Agricultural Studies at the junior secondary level. Thus, the curriculum seems to be inclined towards S&T-related careers as shown in Table 2.3 below. Table 2.3 depicts the composition of the subjects in the Botswana education system.

Table 2.3: The subjects that are offered by the Botswana education system

Lower Primary School		
Grade	**Core Subjects**	**Other subjects**
1.	Setswana	Cultural Studies
2.	English	Creative and Performing Arts
3.	Mathematics	Cultural Studies
4.	Environmental Science	Guidance and Counseling
Upper Primary School		
Grade	**Core Subjects**	**Other subjects**
1.	Life skills	Social Studies
2.	Setswana	Creative and Performing Arts
3.	English	Agriculture Studies
4.	Mathematics	Religious and Moral education
5.	**Science**	
6.	Cultural Studies	
Secondary Level (Junior Secondary)		
Grade	**Core Subjects**	**Other subjects**
1.	English	Social Studies
2.	Setswana	Agriculture
3.	Mathematics	Moral Education

4.	Cultural Studies	Religious Education
5.	Indigenous language	
6.	Integrated Sciences	

Table 2.3 clearly shows the articulation of subjects across the education system. For instance, mathematics and science are offered at both upper primary and secondary school level. Mathematics is named “Mathematics”, whereas science is offered through Environmental Science, Science and Integrated Sciences. Notably, at secondary school level, Integrated Sciences incorporating aspects of S&T becomes more pronounced, and learners are expected to choose from the different educational options leading to the careers they might want to pursue at tertiary level. Thus, the career-orientated education system in Botswana might have the answer to meeting the challenge of generating a significant output of potential contributors to an economically viable working force, compared to what SA and Eswatini produce.

According to the United Nations Economic Commission for Africa (2014:29), Botswana is at 96,2%, compared to 92,7% in SA and 40% in Eswatini in terms of cellular connection. SA, however, produces and exports relatively more sophisticated products, compared to Botswana and Eswatini, and thus needs a more technologically skilled populace to compete in the international arena (UNECA, 2014). Moreover, the population of SA is more than the joint population of Botswana and Swaziland. It, therefore, requires more technologically aware and skilled individuals to contribute and build the economy of the country. The fact that SA offers Natural Science and Technology at the Intermediate Phase is precisely because it wants to compete and take advantage of the S&T opportunities that many countries are exploiting for their growth and development by building an S&T foundation in its school system (UNECA, 2014).

However, South Africa’s performance in S&T still poses challenges. For instance, the Portfolio Committee on Basic Education reported that South Africa fares worse than Eswatini and Botswana in science, mathematics and English, yet it invests far more in education than those two countries (Parliament of the Republic of South Africa, 2016). Moreover, although its curriculum at both the Intermediate and Senior Phase requires learners to learn NST, this does not necessarily translate to a technologically skilled populace (DBE, 2011a). Yet, these subjects are introduced at early stages of learners’ lives. Therefore, South African learners should be able to outperform both Eswatini and Botswana in S&T, as these countries do not offer S&T as stand-alone subjects at primary school level.

The performance of South African learners may be attributed to the way the teaching and learning of technological concepts takes place, rather than the curriculum offering per se. In other words, a country could have a high-quality curriculum, but that does not guarantee performance in its subjects. Fundamentally, it requires effective teaching and learning of the concepts underpinning those subjects. It is, therefore, important to gain insight into the general challenges related to the effective teaching and learning of technological concepts across various contexts.

Koketso (2015:23) argues that the challenges of S&T in Botswana are mostly felt by girls because of socio-cultural beliefs about the role and place of a woman in the country. In Botswana, similar to Eswatini and related countries, there are strong traditional and cultural beliefs that influence the relationship between males and females. These beliefs are so pervasive that they influence the choice that learners make regarding school subjects, university courses and careers (Makwinja, 2017). These strong cultural and traditional beliefs also affect the way learners learn and succeed in S&T. According to Koketso (2015:24), girls do not compare well with boys in learning and succeeding in learning S&T, ICT and MST, which is related to low expectations of girls, compared to boys. This phenomenon, it is argued, is not based on biological or physiological differences between boys and girls, but societal expectations and the need to entrench culturally biased attitudes and perceptions towards the different genders (Koketso, 2015). Consequently, boys outshine girls in learning S&T, and few girls pursue careers in these streams. Those who attempt these subjects are likely to drop out as they cannot persevere, which reinforces cultural beliefs and tendencies. Girls then accept the fact that they cannot do the subjects against which they were warned. It becomes a self-fulfilling prophesy, which is accepted by society (Koketso, 2015).

Fundamentally, there are no academic or scholastic differences between boys and girls; however, adopted attitudes and perceptions are responsible for the differences between the genders (UNECA, 2014). Therefore, boys may do well in S&T and related subjects precisely because society expects them to do so, at the expense of girls. In this way, girls may not devote the same amount of energy and attention to learning S&T as their male counterparts, which may lead to their poor performance (UNESCO, 2012).

Therefore, girls may memorise the S&T concepts, while boys use deep learning approaches because of the envisaged, prospective value of S&T in the world of work (Leahy & Phelan, 2014). In addition, the difference between boys and girls in learning technological concepts and content depends, inter alia, on the value attributed to the subject by the learner. A negative value attached to S&T leads to inadequate attention given to the subject, which may further contribute to poor performance. Therefore, this poor performance should not be entirely attributed to physiological or biological differences between males and females, but to socio-cultural expectations of each genders. Learning success is directly related to socio-cultural expectations and beliefs about the role of the different genders (Koketso, 2015). Moreover, the perceived usefulness of a subject also contributes to degree of learners' persistence and success in learning the concepts underpinning a subject. In fact, the learning act is related to factors, such as the usefulness of the subjects; socio-cultural expectations; the availability of role models; support; and the academic expectations of the different genders.

In light of the above observations, the sections below will investigate the learning of S&T in the context of the education systems of Ireland and Ghana. It was indicated above that these countries were chosen for analysis because they are at opposite ends of the S&T performance spectrum. For instance, Ghana's learners do not perform well in S&T, compared to those in Ireland, which is an economically advanced country (Heymans, 2007). Therefore, juxtaposing Ghana with Ireland may lead to an understanding of how learners learn S&T subjects, which is linked to the main question and sub-questions underpinning the research study that is the focus of this research report.

2.4.3 The teaching of technological concepts in Ireland

The Irish education system is organised in three levels as follows: The first level (junior education) accommodates learners from 5 to 12 years old; the second level is the post-primary school (senior education) level that accommodates the 12 to 18-year-old learners; and the third level is optional and caters for higher education (Leahy & Phelan, 2014). According to Leahy and Phelan (2014: 377), one of the optional subjects that learners can choose in the junior cycle is the specific subject "Technology" that links up with critical and choice subjects available to learners in the senior phase where preparations are made for tertiary education. Those that choose Technology are preparing for technology-related education/training at tertiary level (Leahy & Phelan, 2014).

The configuration of the school system in Ireland seems to share some important similarities with the South African education system. In SA, there is a three-tier system of education comprising primary, Further Education and Training (FET) and tertiary levels (DBE, 2017). At the Senior Phase of the primary education level, learners do seven subjects including Technology (DBE, 2011b). In Ireland, Technology is a choice subject and learners do it in order to follow the science stream that articulates to careers such as engineering (Leahy & Phelan, 2014). In essence, SA, in terms of subject combination, is similar to Ireland; however, Ireland is ranked 15th, whilst South Africa is ranked 75th in performance in mathematics and science.

Moreover, the gap between girls and boys seems to widen as learners reach secondary school in Ireland, which is attributable to socialisation and the social fibre of the community that favours males over females in technology-related careers (Fegan, 2016). However, it seems that the gap is not that significant at primary school level, the probable reason for which is the developmental levels of learners. The Irish education system may be advanced, compared to South Africa, but the performance of learners in S&T seems similar in several respects.

According to Gasant (2011:2), the South African education system is still battling with gender disparities when learners choose S&T-related subjects, which affects the learning of the subjects' concepts. Like the Irish situation, South African society is still battling with male chauvinism, as society still expects boys to perform in S&T, as opposed to girls (Gasant, 2011). Table 2.4 below depicts the comparison between the education systems of Ireland and SA.

Table 2.4: Comparison between the education systems of Ireland and SA

Ireland	South Africa	
• 5-12 years- Junior education opportunities **(First level)** • 12-18 years- Senior education opportunities **(Second level)** • 19> Tertiary education opportunities **(Third level)**	6-8 years, **(Foundation)** 9-11 years**.(Intermediate)** 12-14years **(Senior Phase)** 15-18 years (FET)	GET

According to Leahy and Phelan (2014:377), technology-related subjects are offered to learners aged from 5 to 18-years-old in Ireland. However, the content and structure of these subjects are adapted to suit the academic development of the learners in various grades. The same approach is followed by the South African education system where Intermediate Phase learners are exposed to NST (DBE, 2011a). At the Senior Phase, learners are made to do Technology as a stand-alone subject, which articulates to the Science stream at the FET phase. In the Irish education system, Technology is offered as a subject at the junior level to learners aged from 13-16 years old and to learners aged from 16-18 years olds (Carty & Phelan, 2006). However, Technology is not a compulsory subject in the Irish secondary schools (Carty & Phelan, 2006). This is contrary to Ireland’s education system where Design and Technology is offered at both foundation and secondary school levels (Carty & Phelan, 2006).

Therefore, the Irish education system is similar to that of SA in that the Technology as a subject is taught at the formative stages of schooling, especially at the intermediate level. However, at the FET phase in SA and the senior level in Ireland, a learner may choose to follow S&T-related or other streams depending on the entry requirements of the various fields.

2.4.3.1 How the technological concepts are learnt in Ireland?

Like other countries, including the ones discussed above, learners in Ireland have their own challenges in learning various subjects, including S&T. For example, the Program for International Student Assessment (PISA) of the Organisation for Economic Co-operation and Development (OECD) indicated that learners in Ireland are plagued by various educational challenges, which affects the way they learn and succeed in most school subjects, notably those in the S&T stream (OECD, 2007). The learning challenges in Ireland are caused and sustained by factors, such the differences in learners' socio-economic status, cultural factors and the performance of boys and girls (OECD, 2007). Clancy (1995:37) argues that the institutionalisation of invidious socio-economic hierarchies in different types of schools from primary to post school reproduces inequalities in the educational achievement of different learners in Ireland. That difference does not end with the different levels of educational institutions; it also cuts across the expectations that Irish society has of its children, both males and females (Clancy, 1995). Clancy (1995:36) identifies socio-cultural issues as a major contributory factor in the differences in the scholastic achievement of learners in Irish schools from primary to post primary level.

Most teachers who teach STEM in Ireland are trained in Biology teaching, which makes them inadequately qualified to teach these subjects confidently. This transfers to the level of S&T competencies of the learners that they teach (Childs, 2014). These low levels of performance in S&T are counterproductive to a country that aspires to bring about rapid economic development for the wellbeing of its citizens (Clancy, 1995).

The Department of Science and Technology (2007:13) in Ireland found that the learning differences between boys and girls contributes to low levels of academic achievement in boys, which leads to high dropout rates for boys, compared to girls. Currently, females outnumber boys in the category of higher education achievers and these disparities increase over the years (Department of Science and Technology, 2007). International studies have confirmed that home background and the characteristics of a community have a major role to play in the academic achievements of the different genders (OECD, 2007).

However, Irish boys outshine girls when it comes to scholastic achievement in S&T, and the main reason for this disparity is attributed to societal expectations of boys and girls (Department of Science and Technology, 2007). There appears to be more demands placed on boys than girls when it comes to achievement in S&T (OECD, 2007). Generally, boys are propelled by the usefulness of S&T in the world of work, compared to girls who regard occupations in S&T as a preserve for boys (Department of Science and Technology, 2007). It has also been discovered that the learning methods of boys and girls differ. Boys demonstrate a greater degree of deep learning approaches than girls who mostly use narrow and shallow methods just to get by (Department of Science and Technology, 2007).

This state of affairs is fueled by the demographic factors playing out in the Irish economic sector where more males are more active than females (OECD, 2007). Therefore, at school girls, do not want to associate themselves with S&T primarily because it is a known fact that females are not important players in the field of S&T. That mentality makes them prone to using less productive mechanisms of studying S&T, leading to poor achievement, which confirms the perspectives and attitudes of the wider community.

Boys use deep methods of learning, including the formation of associations, critical/creative thinking skills, constructive approaches and project-based learning, more than girls do, which contributes to their learning success. However, boys are not more intelligent than girls are; the difference lies in the way that society views the social role of the girl child. There could be socio-economic factors that contribute to differences in the achievement levels of different communities; however, the manner in which these factors play themselves out, affect girls as opposed to boys. Girls demonstrate higher academic achievements in general, compared to boys (Department of Science and Technology, 2007). However, the situation changes when they learn S&T, as boys seem to be more adept and willing in that area than girls. In as much as boys drop out of schools more than girls do, they seem to outshine girls in learning S&T concepts.

Ireland may be regarded as a country with a promising and better education system, but the issues of actual learning of S&T seem to be the same as those of underperforming countries. The degree to which the issues are experienced differs from one country to the next. However, the common factor is that societal expectations of the academic achievement of boys and girls are skewed in favour of boys. That makes boys appear better than girls when S&T concepts are learnt.

Below, this phenomenon will be explored in relation to Ghana that faces various challenges in the teaching and learning of S&T.

2.4.4 Teaching of S&T concepts in Ghana

Ghana, like South Africa and Ireland, has different streams from which learners choose subjects for secondary education in preparation for tertiary level. According to Amoah (2016:21), Ghana has been facing challenges with the teaching of MST. This was revealed by the outcomes of the Science, Technology and Mathematics Education (STME) assessment programme that revealed that teachers use poor didactic and pedagogical approaches, which leads to poor educational outcomes. Moreover, teachers used inadequate and irrelevant teaching/learning materials; and, could not pass the test items to which learners were subjected (Amoah, 2016). The assessment revealed that the syllabi were not complete in several grades, and most of the teachers lacked the communication skills required to impart MST concepts to learners (Donkor & Justice, 2016).

According to Udousoro (2012: 288), Ghana experiences the same challenges as other countries regarding gender inequality in the learning of S&T concepts. In fact, boys in Ghana outnumber girls in S&T classes, and the performance of boys far exceeds that of girls in those subjects. This performance trend mirrors the gender inequalities prevalent in Ghana. Donkor and Justice (2016:13) argue that Ghana is predominantly patriarchal, and social relations are shaped according to male-controlled beliefs and practices. Factors that contribute to this are not genetic, but socio-cultural in the sense that society has different expectations from males and females and favours male over girls (Udousoro, 2012). This differential treatment of boys and girls has an impact on the choice that they make regarding school subjects and their performance in different subjects (Donkor & Justice, 2016). To complicate matters even further, females are underrepresented in the field of MST at schools in Ghana, which may fuel the perception that these subjects are not meant for females (Udousoro, 2012).

From the above literature on Ghanaian education, the following conclusions can be drawn:

- Boys and girls are physiologically different, but learning is buttressed by environmental influences
- Learning is facilitated by the social milieu in which learners find themselves

- Learners' perspectives on learning S&T concepts are based on society's perceptions and expectations of male and female social roles

- The environment determines the extent to which learners can succeed in all subjects

- Society is generally patriarchal, which influences the trajectories that learning follows

- The motivation and zeal that learners expend in studying certain subjects, especially S&T, are dependent on expected male/female social roles

- The laws and provisions that support females are clearly available on paper, but implementation is left unchecked; hence, the continuation of the phenomenon of gender imbalance in STEM education across many states. Moreover, this challenge is not unique to South Africa, as it affects many states, regardless of their position in the TIMSS classification

Based on the above conclusions, it is important to investigate the manner in which males and females learn and understand the technological concepts they encounter when they study technology-related subjects. Donkor and Justice (2016:13) place the blame for disparities between males and females in their academic achievement and learning of different subjects on various issues:

- Textbooks in Ghana consistently present science as a male dominated subject.

- Illustrations in books always depict boys as brave, strong and competitive, while girls are shown as fearful and helpless.

- Science, engineering and medicine at the colleges and universities of Ghana, at all levels, are still dominated by male students and male lecturers.

- The inequalities in educational opportunities have created gender disparities through discriminatory attitudes, practices and policies based on socially constructed beliefs about female roles that limit women's capabilities in education.

These issues suppress females' enthusiasm to persevere and succeed in learning technological concepts, and they place an unnecessary strain on males who find STEM difficult to contend with (Donkor & Justice, 2016). In addition, there is also a significant and apparent lack of relevance of the school curriculum for girls' curiosity and interest, which accounts for the low success rates of females in STEM (Anamuah-Mensah, 2000). The generalised negative attitude towards women's education caused by the dowry system, control of women's lives, male privilege, time constraints and the multiple roles women perform in at home and in society at large contribute to the low numbers of females pursing and succeeding in STEM-related subjects (Tanye, 2008).

Because of all of the above, most girls in Ghana learn STEM because they have to, although society does not encourage and expect them to perform (Donkor & Justice, 2016). Those who eventually make it in these subjects are harassed, insulted and, to an extent, sexually harassed by their male counterparts during and after lessons (Donkor & Justice, 2016). According to Mulemwa (1999:27), these tendencies make the learning environment unconducive for both boys and girls. Subsequently, girls lack motivation and shy away from STEM. However, those who learn them may not learn the concepts as intended. They will simply resort to surface learning without broadening their understanding of the concepts, which contributes to the high failure rate in these subjects (Donkor & Justice, 2016).

Boys, on the other hand, use deep processing approaches to learn the concepts. Their motivation could be the usefulness of the subject, the availability of role models and the support that they receive from the public. Other sources of motivation could be the expectations from society and the availability of jobs after they have attained their qualifications (Donkor & Justice, 2016). According to Jalinus, Nabawi and Mardin (2017:38), deep processing of content in STEM leads to better understanding and ownership of it, which leads to its practical application. If boys are compelled by society to use deep processing mechanisms to acquire knowledge, which they use to solve real life challenges, they will become proficient in the subject content as it makes sense to them. However, girls are not encouraged and expected to develop and hone their high-level learning skills to relate to STEM, which leads to their poor performance (Mulemwa, 1999).

According to Donkor and Justice (2016:28), girls are not even accorded the opportunity to try practical subjects that require the usage of physical and mental skills. All boys are then pushed to exert even more effort to study these subjects. By so doing, they develop certain skills that enable them to study the concepts underlying STEM subjects (Anamuah-Mensah, 2000). Therefore, the difference between males and females in successfully studying STEM subjects does not necessarily depend on biological differences, but on the manner in which society relates to the different sexes is to blame. It lowers the potential of girls to learn the technological concepts successfully. Instead of latent learning styles, skills, methods and approaches contributing to the differences, societal values, perceptions and attitudes towards the different sexes attribute differentiated roles and responsibilities to girls and boys. Therefore, their learning styles are affected by external factors as opposed to their inherent potential to deal with any subject in the school curriculum.

Clearly, attitudes and perspectives change the attitudes of society towards the different sectors of society. Therefore, it seems that they play a significant role in the manner in which learners learn, and succeed in, certain subjects. In the next section, the role of attitudes in learning STEM will be explored.

2.5 THE ROLE OF ATTITUDES IN LEARNING STEM

Many studies have been conducted to determine the role of attitudes in choosing and succeeding in STEM subjects, and most of these studies have proved that girls and boys differ in terms of their choice and performance in these subjects (Muller et al., 2014). However, the differences are not necessarily related to the genetic makeup of both sexes but the attitudes, ethos and perspectives engendered by family and societal expectations of the different sexes. Moreover, these variables influence the extent to which learners exert effort to manage, and succeed in, different school subjects, as they become a thrust that pushes them to confront these subjects (Muller et al., 2014). This challenge is not a unique South African challenge, as many countries suffer the same fate, although the intensity differs from one country to the other (Ardies et al., 2015b).

In a study conducted by Ankiewicz (2017) based on the ATP, it was found that students in general have a positive attitude towards technology subjects, but have an insufficient conceptualisation of the subject, which influences their perspectives on the subject and its concepts. However, the variance in the way that they view technology subjects is mainly attributed to characteristics, such as gender, the technological nature of their families' professions, the existence of technological toys in the home and pre-school environment and facilities at home (Ankiewicz, 2017). This view unequivocally demonstrates the important role of multiple factors that influence the attitudes of learners towards learning technology and the degree to which they may persist if confronted with challenges and difficulties. This view is further elaborated upon by the findings of the PATT-USA that mainly focused on the emotional aspects of attitudes. The findings based on the PATT-USA questionnaire attributed the differences in the way that learners learn technological concepts to factors, such as language barriers, frame of reference, culture and the way questionnaire items were formulated (Solomonidou & Tassios, 2007). There are, therefore, multiple factors that influence learners' attitudes towards, and perspectives on, technology subjects. Moreover, these factors may influence learners' attitudes towards, and perspectives on, learning technological concepts in various ways. In the same way, girls and boys, because of different backgrounds, socio-economic expectations and cultural issues, for example, may have developed different perceptions on technology and its inherent concepts (Sjøberg & Schreiner, 2005). However, this finding does not necessarily reveal the nature of the perspectives that South African grade 7 boys and girls have developed on learning technological concepts in the area of the study. It only refers to differences in boys' and girls' attitudes and perspectives on choosing and learning technology. The focus of the study conducted by this researcher was to determine the perspectives on learning technological concepts of Senior Phase boys and girls from selected South African primary schools.

The section above determined that attitudes and perceptions might have a role to play in influencing learners to study various subjects. This view, which is supported by different academics, may lead to an answer to part of the study's main research question because it deals, amongst other variables, with how learning of STEM might be influenced by attitudes and perspectives mainly due to the way that parents raise their children and parental expectations, which is influenced by socialisation and societal expectations.

The OECD argues that attitudes and perceptions influence both the choice and the rate at which learners succeed in many school subjects including STEM, which accounts for the disparities in the number of learners that do these subjects (Ardies et al., 2015b). To that effect, the OECD has recorded a decline in the number of learners who attempt STEM subjects and a difference in enrolment rates in terms of gender (Sjǿberg & Schreiner, 2005). The reason for these disparities is attributed mainly to variables, such as parental rearing practices, patriarchy, societal expectations from the different genders, societal attitudes towards these subjects and the differentiation of employment opportunities that require these subjects (Sladĕk, Millĕŕ & Benárovâ, 2011). Therefore, a combination of various factors plays a critical role in learners' choice of subjects, which also determines the extent to which they will succeed in doing those subjects (Ardies et al., 2013). For instance, a traditional and patriarchal society would not expect girls to do S&T, as they are the preserve of boys. Moreover, that mentality becomes ingrained in their minds, yielding different attitudes and performance levels in those subjects (Van Rensburg et al., 1999).

Even if a child could attempt these subjects, there would be little encouragement and support from parents, which would determine their performance in these subjects (Ardies et al., 2013). In other words, children follow their parents' expectations that are derived from their socio-cultural milieu. Van Rensburg et al. (1999) pose a corollary in concluding that boys and girls have the inherent potential to study technology, but their environment plays a critical role in their choice of school subjects. Therefore, learners growing up in an environment where technology subjects are regarded highly and where everyone is expected to do it, learn that mentality and eventually do everything in their power to succeed in the subject (Sanders, 2005). There are indications that, apart from society, the teacher also plays a pivotal role in learners' subject choice (Ardies et al., 2013). This is because, learners, who tend to emulate significant others, idolise their teachers whose judgment they value. Therefore, if a teacher demonstrates a love and passion for technology because of its perceived usefulness, learners may adopt the same attitude (Albarracin et al., 2018) and be motivated to study the subject earnestly, resulting in higher performance levels.

However, Ardies et al. (2013: 34) argue that little is known about student and teacher variables influencing the development of certain attitudes towards technology-related subjects. The fact that students and teachers come from the same communities that have certain attitudes towards technology, may indirectly influence their preferences, as the school is a microcosm of society (Sanders, 2005). Thus, teachers who harbour certain attitudes towards a subject may, invariably and insidiously, influence students' choice and pursuit of careers related to a specific subject (Albarracin et al., 2018). However, this finding does not clearly indicate the nature of grade 7 leaners' perspectives on learning technological concepts. Attitudes and perspective might lie in the choice and general learning of STEM, but that is not enough to conclude that we know the nature of the perspectives of the different genders on learning the concepts underpinning the specific South African primary school subject of Technology. It might be true that society and, to an extent, teachers influence learners' attitudes towards, and perspectives on, learning STEM. However, an understanding is needed of learners' perspectives on learning technological concepts, which was the aim of the empirical study described in Chapter Four of this research report. However, the above findings on attitudes and perspectives may facilitate an understanding of the dynamic role of these factors in learning, and enable the researcher to relate to the aim of the study.

As stated above, society plays a pivotal role in the development of certain attitudes and perspectives, which has the potential to influence the approaches that learners may adopt in learning different subjects. Once a society has developed certain attitudes towards a school subject, those attitudes have a tendency to be pervasive even in the face of evidence to the contrary. Ardies et al. (2015: 34a) view the pervasive nature of attitudes as an important aspect in understanding the extent to which learners succeed in learning certain subjects at the expense of others. The implication is that there could be a possibility that the learning process and the way it takes place might be influenced by societal attitudes towards, and perspectives on, certain subjects.

Judging by the apparent low rate of enrolment and success in STEM subjects, it seems that parents and society do not necessarily consider the growing need for them when they raise their children. This affects not only the choice of subjects but also the way they are supported (Muller et al., 2014). If parents see value in these subjects, they will encourage their children to choose and succeed in them. However, the success rate in these subjects does not necessarily correlate with what parents expect from their children who do STEM. Clearly, there could be other factors at play in addition to societal expectations of learners. For example, the issue might be the way that learners learn the concepts underlying technology subjects.

The above could be true for South African learners entering the Intermediate Phase at age 10, which requires a firm foundation of positive and encouraging attitudes and perspectives to succeed in all the subjects. It should be noted that learners at that age do the same subjects so that they are able to choose subjects and their career path when they enter the FET phase. Learners aged from 10 to 14 are regarded as being in their formative years, and their abilities and skills need to be firmly developed for future learning (Ardies et al., 2015a). This indicates that the parents of these learners should be at a particular level of understanding so that proper attitudes and perspectives can be developed to enable learners to embrace different subjects, including technology. Not only parents, but also society and teachers need to embrace positive attitudes for learner success in these subjects (Muller et al., 2014).

It has been proved that societies that cherish certain values have the potential to influence and shape the way certain activities are done, which has a direct bearing on what the education of a given society offers (Albarracin et al., 2018). Muller et al. (2014:34) posit that technology is ubiquitous, and people need to acquire and develop certain skills to stay relevant and adapt to the evolving world of technology. Unfortunately, negative attitudes and perceptions affect the way learners learn technology subjects. The school system may provide for the learning of such subjects, but society has a huge role to play in determining the success that a country may achieve through them (Muller et al., 2014).

The solution might be to develop strategies aimed at enabling learners to cultivate positive attitudes towards, and perspectives on, the learning of the concepts in these subjects for the benefit of everyone. In fact, the following research sub-question was asked: What are grade seven learners' perspectives on strategies for the effective learning of Technology? The sub-question was formulated because of the lack of information on the actual type and nature of perspectives of this category of learners on learning technological concepts. Merely understanding that attitudes and perspectives have a role in choosing subjects is not sufficient to understand the nature of learners' attitudes and perspectives on learning these concepts.

Indeed, Muller et al. (2014:34) posit that people's attitudes towards STEM subjects depend, inter alia, on their perceived usefulness and the ability of the people in society to realise this. Therefore, many factors may influence people's attitudes towards technology-related subjects, such as their experiences, perceptions, culture, interests, their age, sub-culture, lifeworld, exposure to technology, the living environment, geographic location and proximity to technological services (Chan & Cheung, 2018). These factors influence the way they view STEM, which could probably influence the vigour with which they may successfully learn the content of these subjects. (Muller et al., 2014:34).

Clearly, attitudes are developed over time and they may depend on their emotional content in an environment that has the potential to influence learners in various ways, including subjects to be taken, careers pursued and the extent to which learners exert effort in studying certain subjects (Ardies et al., 2013). Although, attitudes take time to develop, once developed it takes more time to change them (Mechlova & Malcik, 2012). Therefore, communities' attitudes towards STEM may have taken a great deal of time to form, and changing them could take a long time. In the same way, the attitudes that people may have about the ability of a girl child to take STEM subjects may be based on their cultural inclinations and worldviews that developed during many years of their lives, which could take long time to unlearn (Chan & Cheung, 2018).

Those attitudes and perceptions are very difficult to ignore if both boys and girls are to be given equal treatment and opportunities in their learning experiences (Mehrotra et al., 2009). Society is attracted to technology based on its usefulness to their everyday lives (Mehrotra et al., 2009). However, that narrative does not answer the question as to how the different genders learn the concepts embedded in technology-related subjects. There could be a society-based perspective that boys should be the ones who study these subjects, but the question as to how they actually do it, remains unanswered. A learner may have a negative attitude towards a subject, which may influence his/her diligence and enthusiasm in learning the concepts, but this does not explain the mechanics of the actual learning. The study that is the focus of this research report aimed to answer this question.

Accordingly, if society views girls as individuals who do not need technology in their everyday lives, they would be discouraged to pursue careers in technology. That would inadvertently benefit the boy child who may be perceived as an individual who needs it for everyday living, more than girls do (Mehrotra et al., 2009). Therefore, it is important for society and schools to inculcate positive values and attitudes in both boys and girls in terms of pursuing STEM subjects, which could probably enable them to use appropriate and effective methods and strategies when learning technological concepts (Bennet & Hogarth, 2009)..

Years 12-16 are formative years, and learners need to be exposed to appropriate technological values and attitudes if they are to succeed in technology subjects (Bennet & Hogarth, 2009). Society needs a mind-set shift to allow boys and girls to pursue these subjects in the same way. Importantly, avenues need to be created for girls to pursue STEM, notwithstanding the opportunities given to boys (Bennet & Hogarth, 2009).

The different treatment of boys and girls contributes to their attitudes and values regarding technology subjects (Mechlova & Malcik, 2012). That extends to their ability to do and pass these subjects at schools. In other words, both boys and girls could learn these subjects in the same way if society and schools accord them same attention. That attention would encourage them to make a greater effort in learning technological concepts, the success of which does not necessarily depend on gender. Instead, it depends on societal perceptions, expectations and perspectives on learning STEM subjects in a given environment (Bennet & Hogarth, 2009). Thus, the research study aimed to determine the perspectives of the grade 7 boys and girls on learning technological concepts and to determine whether there are gender differences in this, with a view to developing strategies to empower not only learners, but also schools, parents and education authorities in facilitating learners' successful learning of the concepts.

If these strategies are applied at primary and secondary school levels, learners might be more inclined to follow technological careers at tertiary education level (Muller et al., 2014). Eventually, the skills shortage of SA and other comparable countries could be addressed (NPC, 2011). Both boys and girls would view and learn technology subjects in the same light, and society would not segregate them based on gender. Their ability to succeed in such subjects will be the barometer that determines the nature and extent of support that they need (Ardies et al., 2015a).

Clearly, attitudes play a pivotal role in the way society models the preferences of its offspring. Moreover, attitudes affect a person's emotional life and intellectual/behavioural traits (Vishai, 2014). In simpler terms, if a person is influenced to have a particular attitude towards technology subjects, for example, his/her intellectual, emotional and behavioural tendencies would most likely be in harmony with that attitude (Vishai, 2014). A positive attitude towards a phenomenon has the potential to increase the likelihood that a person will successfully engage with in it a meaningful way (Lee, Kozar & Larsen, 2003). Therefore, there seems to be a strong correlation between attitudes and the choice that learners may make in connection with technology subjects, which may also change their belief systems in terms of whether they acknowledge their usefulness in their lives.

It is important for learners to be given equal treatment by society when it comes to subject choices. Societal expectations are largely shaped by their understanding and appreciation of the value that technology subjects may add to their lives. If society values these subjects, learners may become competitive and bring new dimensions to their lives, as well as encourage their future children to do them (Lee et al., 2003). Thus, the usefulness of technology subjects should be clear, and people should identify with them. If learners, regardless of gender, could benefit from learning technology subjects, society would change its attitude, and all could be supported to attempt them, regardless of gender (Lee et al., 2003).

The prevalent beliefs about technology and its usefulness invariably affect the way boys and girls learn and succeed in learning technological concepts (Virtanen, Räikkönen & Ikonen, 2015). Therefore, it is important to understand and appreciate the role played by leaners' attitudes and perspectives in the learning of technological concepts so that an appropriate approach can be adopted to bridge the gap between girls and boys. The above literature review revealed that both boys and girls can learn and succeed in learning technological concepts, provided societal perspectives and attitudes are changed towards these genders. Given equal opportunities, girls may succeed in learning technology-related subjects and the pendulum may shift. Success may then depend on inherent abilities, potential and motivation as well as the perceived usefulness of these subjects.

For a better understanding of the manner in which learners may learn certain technological concepts, it is important to conduct an analysis of theories that are relevant to the learning of these concepts. This may reveal the way different theories approach the learning of content in different subjects, including those related to technology.

2.6 THEORIES OF LEARNING AND THEIR RELEVANCE TO THE LEARNING OF TECHNOLOGICAL CONCEPTS

Learning is defined by many theorists in different ways, depending on their theoretical dispositions and orientations to what constitutes the learning process (Mechlova & Malcik, 2012). Thus, learning theories have evolved from time immemorial, and their intention includes making sense of the learning process for different purposes. In addition, these theories, seek to instil needed skills for problem solving, to build capacity for innovation, to develop knowledge capital for the adoption and use of more relevant learning approaches and to inculcate thinking skills for advanced methods of interacting with others and the human/natural environment (Hill & Smith, 2006). The more the world changes, the more the curriculum of schools is adapted, and new models of learning are required to bring about development in the way learning takes place in different contexts for various reasons (Dočekal & Tulinskâ, 2014). The diversity in the learning environment manifested through many subject disciplines thus requires different theories suitable for different learning needs. Moreover, a change in learning needs leads to the development of learning theories and models often in keeping with changing times (Dočekal & Tulinskâ, 2014).

However, some early theories of learning remain relevant, which depends on the nature and purpose of learning in a given context (Schunk, 2012). Many learning theories base their approaches on earlier theories that they evaluate and modify to provide a different perspective to learning practices in line with prevalent knowledge and the intricacies of learning (Mechlova & Malcik, 2012). Learning practices are, therefore, neither static nor bound to one theoretical school of thought and time. They are developed in line with new findings and discoveries in an attempt to make sense of what takes place during the learning process of learning, how it takes place, how human beings learn and how best they can be assisted to learn (Schunk, 2012).

Mechlova & Malcik (2012:26) argue that not all theories of learning and teaching are relevant to understanding the learning of certain concepts in different subjects. Thus, this section will provide a discussion of the learning theories that seem valuable and relevant to the leaning of technological concepts. This might shed light on how learners, such as those who participated in the study, learn these concepts and answer the main research question and the sub-questions, thus realising the objectives of the study.

According to Mechlova & Malcik (2012:26), studying ICT concepts requires the use of elements of various learning theories, such as behaviourism, cognitivism, constructivism, and connectivism, depending on the nature of the technological content. Technology is viewed as an academic discipline in which learners are exposed to advanced knowledge, skills, values, resources and mechanisms for the continued adaptation to the ever-changing world (DBE, 2011a). It therefore, seeks to cultivate knowledge, skills and values/attitudes whose primary aim is to instil particular thinking skills. These critical, creative, problem-solving, innovative, dynamic and inquisitive thinking skills are expected to make the world a better place to live in. Technology subject content, therefore, challenges learners to apply higher order cognitive thinking skills, which may enable them to grapple with the immediate and future challenges of the world.

A suitable approach needs to be used for the learning of the different concepts and content areas stipulated in the Technology curriculum so that learners may achieve the outcomes elucidated in the subject statement. However, the success of the approach depends on various factors, including the teacher's methodology, parental expectations, the availability of teaching/learning aids, the teacher's theoretical persuasion and the involvement of learners in finding solutions to challenges, for example (Mechlova & Malcik, 2012).

The concepts that learners are expected to learn should stimulate their abilities and skills to be innovative in their application of SKVs in dealing with social/physical/cognitive reality for meaningful habitation, as contained and elaborated upon in the CAPS (DBE, 2011a).

The following section of this chapter unravels learning four theories in an attempt to delineate and determine an appropriate way to approach the learning of technological concepts at the selected primary schools of the Gert Sibande Education District. The theories might shed light on how the learning process enabled by teachers unfolds and how learners perceive their learning of such concepts. That might lead to knowledge and understanding of how South African primary school boys and girls learn technological concepts. Moreover, the basic tenets of these theories will be aligned with an example of content taken from the DBE's Annual Teaching Plan of the Senior Phase, Technology CAPS document (DBE, 2011a).

The theories are discussed below and their value in learning technological concepts will be discussed.

2.6.1 Behaviourism

Behaviourism focuses on a person's observable behaviour after some form of stimuli has been administered. It does not consider the role played by feelings, thoughts, orientations and knowledge in the learning process (Watson, 1928). This theory reduces the status of a human being to that of an object or an animal that reacts and behaves in a predetermined manner following a stimulus in the environment (Boeree, 1998). Mechlova and Malcik (2012:47) agree that behaviourism is one of the earliest learning theories that views learning in terms of stimulus and response, which relegates human beings to the status of unthinking organisms who do not use cognition. The many perspectives and derivatives of Watson's (1928) original theory attempt to seek answers to the questions raised by this apparent human-reductionist theory of learning (Mechlova & Malcik, 2012).

The theory of behaviourism has long been associated with B.F. Skinner who tested Watson's theory. This led to a more liberal theory of operant conditioning that recognised that human behaviour is a result of past experiences of similar situations, which is an acknowledgement of the role of cognition in the learning process (Boeree, 1998). In other words, the behaviour that human beings exhibit is the result of responses made in similar situations that inform current and future behaviour (Boeree, 1998). Thus, human beings learn through their previous experiences of what began as a trial and error exploration of the environment. Before Skinner, there were other theorists who adapted the theory.

Derivatives included theories by Thorndike, Tolman, Guthrie, Hull and others (Mechlova & Malcik, 2012). They all attempted to explore behaviourism in ways that evaluated the veracity of the original theory by refuting, amending and adapting it for various purposes. All the derivatives agree in varying degrees that learning is seen in the learner's change of behaviour. Although they may differ in important aspects, they all agree that behaviour and the environment are important determinants of learning. To make sense of the behaviourist theory of learning, academics agree on a set of assumptions that typify the hallmarks of this theory. Some vary on certain assumptions while others prefer to prioritise other assumptions.

Mechlova & Malcik (2012: 25) acknowledge three basic assumptions according to which the learning process takes place. The assumptions are explained below:

- **Firstly**, the observable behaviour is an important indicator that learning has taken place, although it does not include internal cognitive processes as espoused by the proponents of cognitive learning theories. If learning has taken place, there should be a change in behaviour. Outer behavioural change is regarded as an indicator that learning had taken place. If there is no change in behaviour, it means learning has not taken place. The determining factor for effective learning is the change in behaviour of those involved in the learning process.

- **Secondly**, the environment shapes behaviour that represents or typifies the environment it comes from. In other words, the environment is the sole instigator of learning. Questions of inner drive and motivation are not considered as drivers of the learning process. The human being is reduced to a mere responder to environmental stimuli. Human behaviour is the result of environmental stimuli without which no learning can take. Essentially, environmental stimuli must lead to behavioural change.

- **Thirdly**, principles of contiguity (learning happens because of stimulus) and reinforcement (learning from feedback to further exhibit a certain behaviour) are of cardinal importance in explaining how learning takes place. According to this principle, a learner must be stimulated to act in a particular manner, and this behaviour could be replicated if the environment continues to stimulate the learner in that direction. Therefore, the environment must always present some form of stimuli in order for learners to learn continuously. In addition, behaviour is reinforced by the environmental response provoked by the behaviour.

The tenets of behaviourism could be applicable to present day learning because one of the aims of education is to ensure that individuals continue to adapt and survive (socially and culturally) amidst challenges that they face in everyday life (Mechlova & Malcik, 2012). In this regard, the teacher's role is to provide the environmental stimuli that will help prompt learning for human survival. In other words, the manner in which the teacher organises the learning environment could determine the success that may be achieved through learning. Put simply, if the teacher is able to use the environment (learning aids, charts, instruments and support material, for example) to demonstrate expected learning experiences/outcomes, learners may emulate the teacher. However, the success of such an encounter is dependent on how the environment is manipulated for effective learning.

Behaviourism may be relevant to the learning of technological concepts. Mechlova and Malcik (2012:29) argue that the systematic design of instruction, behavioural and performance objectives, programmed instruction, competency-based instruction and instructor accountability are the hallmarks of the behaviourist approach towards learning. This could be applied to the learning of most subjects, including those related to technology, because the teacher plays a pivotal role in selecting, organising, planning and identifying appropriate teaching approaches. Interestingly, the experiments that need to be done may require practical demonstrations by teachers, which may reveal the meaning of technological concepts. In this way, learners will learn by emulation and repetition until the required outcome is yielded by the experiments.

Many technological concepts need a teacher to demonstrate them before learners can use other learning processes of learning. The DBE's (2011a) Senior Phase, Technology CAPS document, especially section 3.1, requires learners to deal with content, concepts and skills related to *"design process skills in which they need to grapple with investigation, design, making and evaluation processes."*

To meet this requirement, the teacher could begin by showing the finished products before demonstrating the processes leading towards their development. The demonstration of the finished product might serve as a stimulus for them to perform the process and repeat their steps in continued replication of what the teacher has demonstrated. Their success in doing so will demonstrate that they have learnt the process. In essence, they would learn to use the process in the development of similar products.

The teacher would have used the environment to stimulate the learning process, resulting in a change of behaviour towards the technological processes. The change of behaviour may come with changes of attitudes and perspectives in learning the concepts. Learners may be reinforced to repeat the behaviour following successes in previous attempts. The positive outcome will then serve as a stimulus to replicate the behaviour. Further replication of the behaviour, therefore, would depend, inter alia, on the perspectives and attitudes that they may have developed because of the stimuli. In essence, that means further exhibition of the behaviour would depend on the nature and value of the stimuli.

In the above scenario, the teacher would have used systematic design instruction, determined behavioural and performance objectives, programmed instructions and competency-based instructions. Moreover, he/she would have been accountable for the desired behaviour exhibited by learners at the end of the lesson (Mechlova & Malcik, 2012). Clearly, the teacher assumes a critical role in the learning process. The teacher is the one who needs to identify the teaching and learning aids and determine the purpose and aim of learning.

Although, according to behaviourism, learners are mere parrots who respond when called to do so, which is related to their exhibiting behavioural traits expected by the teacher, the theory may facilitate learning to perform certain experiments that the teacher may demonstrate. Deviant behaviour would be discouraged while a positive exhibition of behavioural change would be enforced. That reinforcement would explain the type and extent of the learning outcome to be achieved. Therefore, learners would develop a perspective that could enable them to memorise and repeat content for the acquisition of the concepts. However, in itself, this would not convincingly translate to effective learning. The perspective, therefore, would be to memorise and regurgitate content as required by the teacher.

Nevertheless, certain technological concepts require the memorisation of processes before meaningful learning can take place (Mechlova & Malcik, 2012). For example, a learner may be required to memorise the processes involved in certain design features before the inner operations could be learnt in detailed. Obviously, that type of learning may be unpleasant to some learners and would depend on the meaningfulness of the processes that they are learning. Memorisation of processes may assist them to learn certain aspects of the content and if it does, learners may develop positive attitudes towards it. However, if it does not help them, they may not view it fondly. This type of learning could change learners' attitudes, as it does not necessarily accommodate thinking processes that learners may use in learning. The fact that learners are merely expected to replay certain behaviours that they do not understand may influence their attitudes towards, and perspectives of, the concepts and the teacher concerned. It could also inform the type of learning that takes place in that learning space. Most probably, the learning act would not be effective due to the perspectives that may have developed following their feelings and experiences of the learning process.

Therefore, this approach might not necessarily assist learners in acquiring the necessary SKVs because the approach focuses on an external exhibition of behaviour as a measure of effective learning, and it does not value the role of internal cognitive processes in learning. For effective learning, learners would also be required to use their internal cognitive power and processes to make sense of what is being displayed. They will be needed to attach meaning to what is observed in ways that will enable them to understand the content rather than display mundane behavioural traits. Moreover, they would be required to make associations between pieces of a knowledge system, which requires higher order thinking skills that behaviourists do not value. They would also be required to apply learnt knowledge to solve everyday problems, which requires critical, creative, collaborative, communication and problem-solving skills. They may perform and reproduce the routine steps automatically, but that does not mean that they have understood the processes involved. That is why replication may be a problem, as cognitive understanding is not realised. Therefore, behaviourism cannot be regarded as the only theory that could be used for learning of technological concepts. It negates cognition as an important aspect of effective learning.

The process of cognition and its importance in learning is discussed below.

2.6.2 Cognitive learning theories

Mechlova and Malcik (2012:41) maintain that learning does not only take place as a result of external stimuli, but there are also internal mental/cognitive processes involved, which include content organisation, storage, retrieval and the establishment of relationships between the content area learnt and previous knowledge accumulated over time (prior learning). This view simply means that, instead of being passive recipients of knowledge or copycats of what is being demonstrated, learners are active participants in the learning process. In other words, they do not merely emulate or respond to an environmental stimulus; they have a brain that processes information, leading to a certain degree of learning. Moreover, learning takes place because of the interaction between internal mental processes and environmental factors (the child’s social milieu), leading to different forms of learning and results

(Mechlova and Malcik, 2012). The cognitive learning theory moves a step further from behaviourism in that it promotes internal mental capacity in processing learning content rather than mere reproduction of demonstrated behaviours following a stimuli (Schunk, 2012)

In this regard, learners are perceptual human beings who have the capacity to perceive, receive, organise, interpret and store information brought to their attention (Schunk, 2012). Previous knowledge systems are retrieved when new content is learnt, which makes learning unique to an individual because experiences differ (Schunk, 2012). Therefore, the cognitive theory of learning is buttressed by the notion that learners have the ability to use previously stored knowledge patterns when processing new information, memorising it (based on its nature), thinking about thinking (metacognition) and transferring learnt knowledge to solve problems in different contexts. Moreover, the theory accommodates the use of artificial intelligence as an innovative way to make sense of the world as well as computer simulations to represent the world with its challenges and develop mathematical learning models to understand learning material and the world better (Ouyang & Stanley, 2014).

However, the usage of internal mental processes for learning is limited to the mere processing of information and that does not necessarily value learners' higher order and complex thinking capabilities (Mechlova and Malcik, 2012). Therefore, this theory reduces a human being to an information-processing organism, which negates the role played by creative and critical thinking, motivation, feelings and choice in the learning process (Schunk, 2012). It regards a human being as a mere mechanism that processes information as a way of learning.

The view of a learner as an information-processor might be responsible for negative perspectives and feelings about being compared to as a machine when learning difficult technological concepts, which may be demeaning and discouraging. If those perspectives and feelings are generated, learners may adopt a negative view of the concepts and the subject, which will determine the extent to which they persevere in learning those concepts. Learning needs to be meaningful to learners if they are to continue with enthusiasm. Their perspectives on, and attitudes towards, learning concepts are moulded by the way they are made to experience the assimilation and accommodation of the critical subject-related concepts in the subject. Nevertheless, the cognitive learning theory and its models may be helpful in learning certain aspects of subject content as shown in the discussion of theoretical assumptions below.

The following are assumptions of the cognitive/information processing theory of learning:

- Each individual learner learns (processes learning content) in a particular way because learning is unique to the individual.
- Leaners come to a learning environment with their own unique understanding of the world, which yields unique ways of processing the learnt content.
- Learners play an active role in their learning.
- Learners are regarded as processors of information.
- Learners use internal mental capacity to process incoming information.
- Learning includes the development of mental schemata within which further learning material could be encoded and decoded, as content is processed.
- Learning could not only be accounted for by external characteristics, as is the case with the behaviourism. External stimuli may be present, but learning is achieved through demonstrable outcomes and not predetermined exhibitions of certain behavioural tendencies.
- Learners are actively engaged in the learning process that is not only based on external stimuli.
- Previously learnt material plays a critical role in learning new material in the learners' perceptual field.

The cognitive learning theory regards learning as an automatic process that takes place mechanistically when learners are presented with learning material (Schunk, 2012). However, it neglects the complexity of the learning process and does not acknowledge that individuals learn in different ways and have varied learning styles

(Schunk, 2012). The individual with his/her unique abilities is not appreciated by the cognitive theory. The human being is appreciated to the extent that he/she processes the learning content as determined by the teacher and the environment. Instead of learners being viewed as having the potential to learn content in a different ways, they are regarded as processors of learning content (Schunk, 2012). The cognitive theory does not recognise that the learning activity is unique, and individual learners attach different meanings to the same content informed by their previous knowledge of the similar or different content in other contexts.

Despite its shortcomings, the cognitive theory may be relevant for the learning of some technological concepts. Based on the technological content stipulated by the DBE (2011a) as stated above, the following section explains how learners could be helped to learn it in terms of the cognitive theory of learning. The same content was used earlier in the chapter to explain how it could be learnt in terms of behaviourism. The DBE (2011a) stated that learners are required to learn *"design process skills in which they need to grapple with investigation, design, making and evaluation processes".*

Upon the instruction by the teacher, learners, for example, could do the following:

- **Investigation**: Learners could explore various technological processes that have helped in resolving every day technological challenges. For example, they could investigate the reasons for structural failures. This approach would require that they get to grips with what contributes to that state of affairs. In this investigation, they could make use of their knowledge of structural failures in their environment to make sense of what they observe as structural failure. By so doing, learners would use their cognitive skills to observe, interpret and explore various sources of information related to the problem at hand. In this way, the observable environment would prompt them, not only to respond, but also to apply their information processing skills to determine answers to questions such as "why", "how" and "what" regarding the structures. In this way, they would use simple thinking skills that would not challenge them to think abstractly and view the problem from different angles (Schunk, 2012).

- **Design**: Here, learners would be required to use the knowledge gained during the investigation to proffer workable designs in order to address the problem of structural failures. Learners would be guided by the teacher only on what contributes to the strength of structures. Learners would then use their cognition to process that knowledge so that it could be used for the current problem. Thus, the teacher would play a critical role in giving information to the learners. Moreover, their thinking skills would be limited by the parameters provided by the teacher. Creative and analytic skills would be used reservedly because they would need to process what is given within the limits of the learning environment.

- **Making**: This is where learners would implement their designs. Based on their design, they would come up with models that deal with the challenges posed by previous designs, or they would create new progressive models dealing with everyday life-related problems as demonstrated by the teacher. Making is not, necessarily, something that could easily be done after observation, as it requires experimentation and learning from mistakes that the teacher would illustrate. As promoted by the cognitive learning theory, learners would use their thinking skills, contrary to what behaviourism advocates.

- **Evaluation**: After making has been done, the finished product would have to be tested to determine its fitness for purpose, under the teacher's direction. The processes of evaluation would be tried and demonstrated by the teacher. Learners would then be guided to understand these processes and apply the principles in testing the strength of the structure in question independently. Therefore, evaluation of the mechanisms themselves would be a precursor to the actual evaluation of the design. The evaluation would indicate whether the structure was fit for purpose before actual usage in the public arena. Structural failures are the result of poor evaluation mechanisms and processes (DBE, 2011a).

Clearly, the cognitive theory of learning seems suitable in the learning of some technological concepts. It offers learners an opportunity to think, explore different ways of performing a task, use previous knowledge of similar or different experiences to make sense of current academic content, think about thinking (metacognition), proffer solutions to existing problems and suggest better ways of dealing with current and future problems. In addition, learners learn to evaluate suggested solutions and go back to the drawing board if models do not yield the desired outcome and/or output within the confines of what the teacher provides for processing.

Even though the thinking capacity it promotes is limited, the cognitive theory of learning is preferable than behaviourism that reduces learning to a mere stimuli-response process where thinking is not given the attention it deserves. Behaviourism envisages learners as meekly responding to environmental stimuli, which is regarded as learning. However, the cognitive theorists do not appreciate the role of cognitive processes in the formulation and attachment of new meaning to existing content through the usage of previously stored knowledge systems. It does not value attachment of meaning as a contributory factor to effective learning. The challenges of a shallow and simplistic conceptualisation of learning as an automated process is corrected by the advanced cognitive theories explained below.

A biased approach to learning may not assist learners to develop positive attitudes towards the meaningful learning of concepts. If learners do not understand the concepts, their attitudes towards, and perspectives on, them may be negative, which could further negatively affect effective learning. This may lead to surface learning, which does not typify effective and meaningful understanding of the concepts, which may lead to failure and subsequent development of negative attitudes and perspectives. Learners' negative perspectives on their failure may lead to more failure, which could be generalised to mean that the subject is difficult. The conclusion would be that it is meant for strong members of society, and most often males fall under that category. A vicious cycle may then develop, which could lead to confusion about what causes learners' failure in the subject.

Most females, because of societal expectations, may feel left out of the learning process, which may have negative consequences for the success of the learning activity. For meaningful learning to take place, learners need to be in charge of their learning activity. They should be propelled by feelings of self-efficacy, self-regulation, eagerness, and determination (Schunk, 2012).

Therefore, it is therefore important to take stock of what really happens when deep and detailed learning takes place and to ascertain whether such learning could be applicable to the learning of technological concepts. The section below presents an evaluation of constructivism and an explanation of how this theory of learning might change learners' perspectives on the effective learning of technological concepts.

2.6.3 Constructivism

Constructivism recognises that learners construct their own meaning when they are presented with new learning content (Schunk, 2012). It acknowledges the fact that each individual learner has the potential to learn content in a different way, for different reasons and communicates the information learnt differently (Ouyang & Stanley, 2014). Therefore, constructivists subscribe to the notion that learning is an active and interactive process unique to the learner. It involves the construction of mental relationships between what he/she already knows and the knowledge presented in new content, which leads to the development of new knowledge networks (Schunk. 2012). In other words, learners use their existing knowledge systems to interpret and attach meaning to new knowledge systems by developing more advanced knowledge patterns that will develop even further when more knowledge is encountered. Thus, constructivism acknowledges the thinking of social cognitivists in that it promotes the notion of learning through interaction with the living environment (Schunk, 2012). According to Ouyang & Stanley (2014:28), learners develop a repertoire of knowledge that is used for the development of further knowledge systems. This repertoire becomes the frame of reference for leaners' construction of meaning when exposed to new learning content.

Constructivism appreciates the role played by social interaction in the development of new knowledge systems. It is believed that learners construct their knowledge systems individually in social contexts (Schunk, 2012). This brings an element of social learning into learners' construction of their own interpretive knowledge systems when interacting with their environment. Therefore, constructivism does not promote the timid processing of information in response to environmental stimuli, as is the case with behaviourism and the information-processing theory (Schunk, 2012). For constructivism, learners construct knowledge by attempting to interpret reality and not merely representing it. Thus, learners' interpretations and knowledge are unique and they are applied differently for different purposes (Ouyang & Stanley, 2014). The learning of technological concepts may require a certain degree of attachment of meaning, which could assist both boys and girls to develop a different approach enabling them to learn effectively. This may eventually change their perspectives on learning technological concepts. To develop a clearer idea of how constructivism could be helpful in learning technological concepts, an elaboration of the basic principles underpinning it is presented below.

The following basic assumptions of the constructivist epistemology or philosophy are identified by Schunk (2012):

- Learners are active participants in the learning context, as they interact with the learning content to develop knowledge for themselves.
- An enabling environment must be created wherein learners become actively engaged with content through the manipulation of materials and social interaction.

In agreement with the above, but put differently, Ouyang and Stanley (2014) posit the following assumptions as hallmarks of the constructivism:

- Students come to the learning environment with their unique worldview.
- That worldview is used to interact with the learning content in that environment. It actually filters experiences and incoming observations.
- Construction of meaning involves, inter alia, working on the established worldview.
- Learners learn from social interaction with others.
- Leaners must be engaged with the learning content in order for effective learning to take place.
- Leaners must have a voice in their learning so that new ideas can be developed and promoted.

Drawing from the above summary of what constitutes constructivism, it is apparent that some assumptions are radical while others relatively mild. What is striking in this theory is the way it lessens the role of the teacher and assumes that learning will take place as long as the learning environment is conducive (Schunk, 2012). However, the teacher should create an enabling environment for effective teaching and learning to take place. Therefore, it is assumed that learners could effectively learn on their own if the teacher supports them by providing the scope of the learning content, the objectives/outcomes of the lesson, the required assessment activities, the learning support material, and so on. (Schunk, 2012).

In other words, according to constructivism, deep learning can take place in a conducive environment. This could be true for the learning of technological concepts when support infrastructure like laboratories, equipment and knowledgeable teachers are provided. However, it may be not be true that learners can attach meaning on their own. There is a risk that poor and shallow learning of concepts may take place, which may lead to the development of certain perspectives on, and attitudes towards, the learning of these concepts and the subject in general.

Even though the teacher may not be an active participant in the learning process, he/she is needed to guide it towards the accomplishment of predetermined learning objectives/outcomes. The teacher may know the type of the learner the Technology curriculum seeks to produce, and he/she may also be aware, through his/her experience in teaching, of the challenges that most learners encounter in dealing with technological concepts. Therefore, for learning to be informed, the teacher is equally important to the learners' interaction with the concepts. Constructivism has its own shortcomings in its view of how effective learning could take place. In other words, according to the theory, teachers are not necessarily needed to help learners learn. It assumes that learners are self-regulated, motivated and self-sufficient, and that they have an inner locus of control when using their abilities to navigate subject content, without needing a teacher to provide guidance with regard to the required approaches that will enhance effective learning. The role attributed to teachers is minimal and unclear, which may then contribute to negative views and feelings about the concepts and the subject.

However, this theory may not be entirely rejected, as it could work in learning certain technological concepts. To demonstrate this, the same subject content used in the sections on behaviourism and the cognitive learning theory is used. As stated in the DBE's (2011a) curriculum statement, learners are expected to learn *"design process skills in which they need to grapple with investigation, design, making and evaluation processes".*

To achieve this outcome, the following could be done:

Investigation: To explore various technological processes that have helped in resolving every day technological challenges, learners could be given different scenarios (case-based studies/source-base studies/models) where some structures have collapsed, while others have been resistant to the environmental elements. The reality is that certain structures are properly planned, built, and proper material has been used for their construction. Others, are found wanting, as they collapse immediately after they have been constructed. For others, unskilled and unqualified people are used, which leads to poor workmanship. Appropriate human resources need to be used for structures to stand the test of time. In this regard, properly trained, qualified and experienced engineers, artisans and planners, for example, need to be used. If that is done, such structures are likely to withstand the adverse effects of environmental elements. Others collapse on their own for various reasons, including poor workmanship and material.

Therefore, the brief would be for them to investigate and determine why some structures fail, while others remain for a long period. For learners to approach this challenge in an informative way, they would have to be reminded of examples of structural failures in their immediate environment or any other experience. Learners would then use this experience to determine the factors that contribute to structural failures in general. To that effect, learners would bring to class their prior knowledge and experience of structural failures to understand the scenario presented to them.

That knowledge would serve as schemata onto which new knowledge systems could be built. In this way, that information would assist them in grappling with the factors involved in structural failures as portrayed in the scenario(s). In doing so, concepts such as design features, different designs/shapes of structures for different purposes, structural plans, shapes and compactness of structures, are learnt. These elements would be the criteria against which the evaluation of the structures would be made.

Design: At this stage, learners would be required to come up with robust designs for consideration when structures are developed. They would design the structural frameworks of models. In designing the models, learners would need to consider the effects of environmental factors on existing structures. They would use their prior knowledge as they did during the investigation phase. In other words, previous knowledge of similar experiences would need to be used for understanding what is presented to them. The designs must be robust so as not to succumb to the devastating effects of severe environmental events (elements).

Learners would have already been exposed to the various factors that lead to the failure of structures, which would be used as baseline knowledge (schemata) when they begin to design their model structures. All the necessary and relevant material would have been given. They would work in groups (collaborate) to ponder the needed tools and equipment. Moreover, they would agree on the nature of the structure to be designed before the actual model is developed.

Thus, learners would be given the material and instructions to work on their own, which is in line with the epistemology of constructivism that emphasises the idea of learners working on their own with little or no involvement of teachers. If a teacher were involved, it would be to offer guidance and support. The active role would be played by the learners themselves who would be responsible for their own learning. The idea would be for them to construct and use their knowledge and skills during the learning period.

Making: After the designs have been developed, learners would have to be engaged in the process of making structures. All the needed material and equipment would be given by the teacher. Learners would begin by revising the issues discussed in the two previous steps: how structures fail, what factors are involved, what can be done to avert structural failures, which material can be used, what testing mechanisms can be used to determine the sturdiness of such structures, and so on.

In groups, learners would explore and test the building material, which would be accompanied with some testing, as the sturdiness of the building material would need to be assured throughout the process. At this particular stage, learners would be required to come up with a structure in keeping with the chosen design, thus executing the design.

Evaluation: After making the structure, learners would have to test its effectiveness to address the issues for which it was designed. Moreover, the sturdiness of the structure would need to be determined before it could be utilised. Leaners would then use evaluation criteria to determine whether the structure met its intended purpose. The criteria might include factors, such as shape, rigidity, firmness, triangulation and suitability. These criteria would be used to investigate the model structures presented in the case study. In other words, learners would be made to test the model they have developed based on the criteria used at the investigation stage.

Evidently, the constructivism seems applicable to the learning of some technological concepts as shown above. Interestingly, this knowledge accords learners the liberty to explore any technological concept with little involvement of the teacher. For example, the teacher simply provides material and the environment within which learning takes place. Moreover, the teacher issues instructions in terms of the objectives/aims/outcomes of the lesson. Learners then carry on while the teacher walks around to offer assistance and guidance where such is warranted. However, merely walking around may not necessarily constitute effective and interactive instructional learning. Some learners may struggle without the teacher noticing them. For example, learners who come from environments where males are expected to be strong in the face of adversity may not come up for assistance, which may develop negative feelings towards both the subject and the learning act. That degree of autonomy may be suitable to learners who have developed certain qualities, such as self-regulation, an inner locus of control and communication/independent learning skills.

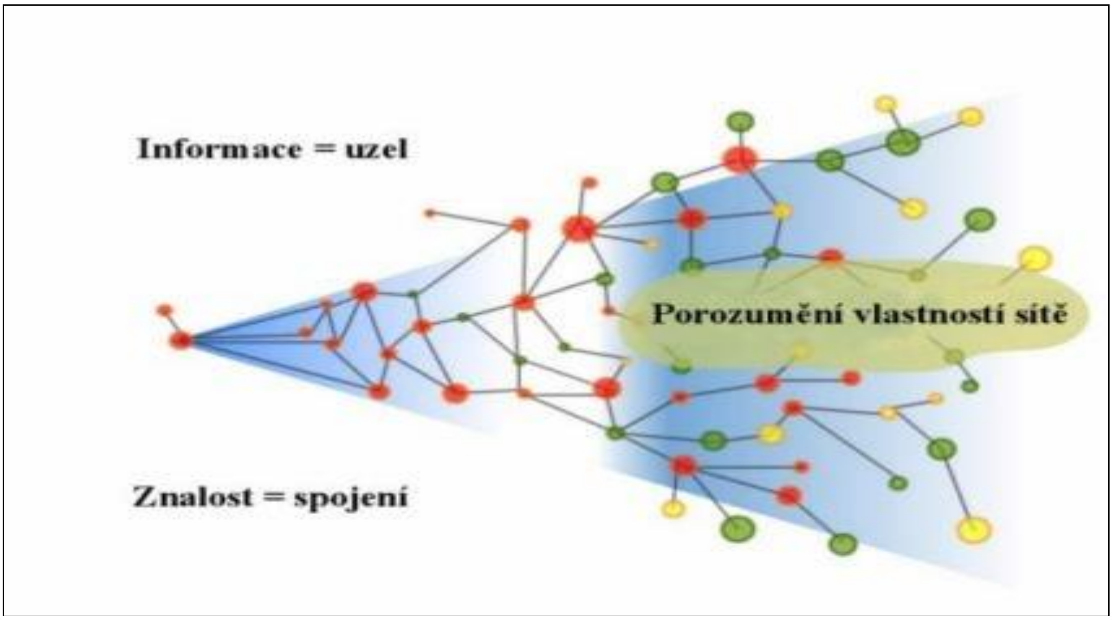
Clearly, constructivism has benefits and shortcomings; furthermore, the theory is dependent on the nature of learners' early exposure to the learning environment. The society where they are raised determines their future engagement with learning in different contexts. Therefore, their perspectives and attitudes ostensibly stem from these and other factors.

2.6.4 Connectivism

According to Ouyang and Stanley (2014:27), connectivism is based on the premise that knowledge exists in the world, which is external to the individual, rather than in his/her head. Moreover, the individual needs to venture into the world for knowledge to be acquired or developed. This sounds like the view of Vygotsky (1978) whereby knowledge is viewed as a phenomenon that exists in the individual's realm in which he/she is required to participate for it to be known. This learning theory is underpinned by Bandura's (1986) learning theory that identifies with the idea that people learn through contact and interaction with the world, which indicates that knowledge exists outside the world. The existence of knowledge outside the individual led to Siemen's (2005) theory that peoples' communication, learning, and interaction are largely influenced by the type of knowledge their living environment presents to them.

To that effect, connectivism proposes the use of knowledge network nodes and connections as main thrusts for learning in the digital age (Ouyang & Stanley, 2014). According to this view, a node is any piece of knowledge that could be connected to another piece of knowledge in the form of a network that could contain knowledge about information systems, data, feelings and images, for example. Therefore, connectivism view learning as the process of developing connections and networks that differ in their nature, importance, purpose and strength. In this way, knowledge is distributed across a network of nodes that involve different networks and pieces of knowledge systems. These can be developed by establishing further nodes of information, which has a domino effect in the development of knowledge. Thus, the networks signal the direction in which the process of knowledge development could take, which is directed by the nature of the knowledge being pursued.

In essence, this theory views learning as a process that takes place in an environment that enables the formation of knowledge networks. Furthermore, the individual is continually prompted by the environment to establish further networks to make sense of the world. Therefore, these networks are essential in connecting specialised information sets that lead to connections in other environments. In this regard, the basic knowledge patterns work as anchors for the encoding and decoding of incoming knowledge systems as shown in Figure 2.2 below.



Adapted from **Brdička** (2003)

Figure 2.2: Learning from the point of view of the theory of connectivism.

Figure 2.2 above shows that knowledge development starts with one node that gives rise to various nodes, depending on the nature of the information or knowledge to be developed. As knowledge is developed from the first nodal point, it grows into many connected nodal points that further develop into a myriad of other networks. This proves that knowledge development is a complex process of interwoven networks and patterns that move in different directions. The initial node is critical for the further development of related nodes. It is where the other nodes and networks find their inspiration. It is, therefore, important that the initial node is solid and informative so that further nodes can be developed. The life of further nodes is entirely dependent on the strength of the first node. In other words, the first node acts as a springboard for the development of other nodes, without which the knowledge development process cannot be realised.

The basic nucleus of connectivism is that understanding is based on altering or unravelling the foundation to encode and decode new information nodes. As a result, new information is continuously being developed by establishing new nodes and networks in response to prompts from the environment. Not everything that the learner comes across may be valuable; the learner must be able to distinguish between important and unnecessary information (Ouyang & Stanley, 2014). Building new nodes on unimportant information disturbs the nodes, and whatever then comes up will not lead to a strong nodal network. Therefore, it is important that the learner must be critical when knowledge development takes place and must be helped to recognise the veracity of the information that is presented.

Interestingly, connectivism recognises the fact that learning happens in various contexts. By that token, human beings and virtual learning gadgets could interact to enhance learning for practical purposes. In this regard, connectivism appreciates the fact that learning could also take place in organisations, other than traditional classrooms (Kleiner, 2002). This, then, brings a new dimension to the learning process and extends the contexts within which learning takes place. Behaviourism, the cognitive learning theory and constructivism do not subscribe to that view. They regard the classroom environment as the sole context where learning can take place. However, constructivism promotes learning beyond the classroom environment. This provides an avenue for learning to take place in factories/homes/companies and via media/Internet/computers, for example.

Working and social environments require new learning modalities taking place in different avenues, including social networks and digital/virtual learning space (Kleiner, 2002). Virtual learning space includes the use of current and advanced technological communication devices and Internet services (Kleiner, 2002). In addition, it involves hubs of digitally connected people to foster and maintain knowledge development and flow through various contexts. The interconnectedness of the hubs promotes interdependence, leading to an effective knowledge flow and the enhancement of personal understanding of the state of activities in an organisation (Kleiner, 2002).

The starting point of connectivism is the individual with his/her personal knowledge comprising networks that feed into organisations and institutions. This in turn feeds back into the network and then continues to provide learning to individual. Thus, a cycle of knowledge development (personal to network to organisation) allows learners to remain current in their field through the connections they have formed.

Siemens (2005: 24) identifies the following principles as hallmarks of the connectivism:

- Learning and knowledge rest in diversity of opinions.
- Learning is a process of connecting specialised nodes or information sources.
- Learning may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all learning activities.

Based on the above principles, it is clear that connectivism borrows tenets regarding the understanding of learning from early learning theories. For example, the theory values the importance of the environment as an important aspect that stimulates and encourages learning (behaviourism). In addition, the theory values the internal processing of information (learning matter) involving the use of previously learnt content (cognitivism). Furthermore, connectivism promotes the attachment of meaning to available learning content (constructivism) with the aid of existing knowledge and learners' different learning styles. In addition to the above, the connectivism entails the following:

- Learning is not only confined to the learning environment where it usually happens, as non-human devices have the potential to teach and spark learning.
- Learning happens on different fronts, and learning media are numerous and different.
- Current and latest technological devices could be used for learning, and they are informed by people's needs.

- Learning is cyclical and may move from an individual to the virtual realm, which further informs personal knowledge systems.

- The internal learning process is portrayed in metaphors of networks and nodes where one node leads to the development of other connected nodes.

- Maintenance of networks is key to the learning process. The networks could be personal and/or organisational. Hence, learning happens in different contexts.

- The prime focus is on accurate, up-to-date and relevant learning content in appropriate conditions.

- The main intention of learning is the ability to use other modes of learning.

- The individual is in a position to decide what to learn, instead of being dependent on shifting environmental demands.

- Reality is continuously changing; what could be correct today may not be relevant tomorrow. Therefore, learners need to use critical, creative, problem-solving and collaborative learning skills.

- Decision-making is a learning process.

- Choosing what to learn and the meaning of incoming information are seen through the lens of a shifting reality.

- While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate that affect the decision.

Therefore, the epistemological learning approach of connectivism could be used in the learning of technological concepts, as it brings an interesting dimension to which the other three earlier theories did not pay attention. For instance, learning contexts, learning methodology, the purpose and aim of education, didactics and teaching/learning media have changed over time. What worked in the twentieth century does not effectively work in the twenty-first century (Schwab, 2015). This is because epochs experience different challenges and the modes of addressing them are continuously changing, which means that new approaches to learning are needed. Behaviourism, the cognitive learning theory and constructivism have been relevant to the knowledge economies of particular epochs. They have also assisted new academics in the area of learning in formulating their approach while attending to current paradigmatic challenges. In essence, the theories have actually provided a base for the development of the latest compatible theories.

As a result, some aspects of these theories or epistemologies are still relevant in the learning of particular learning content of various subject disciplines in the current educational trajectories of the 21st century, especially at the time of 4IR with its educational demands. However, new educational needs require new educational approaches to make sense of the world (Xu, David & Kim, 2018). Currently, the world is changing, and innovative ways of dealing with it have overtaken old and laborious mechanisms that were once relevant and applicable. The advent of the 21st century and its demands on education requires new curriculum content and new modes of learning (Xu et al., 2018).

The 4IR is evolving at an alarming rate and international communities' linear approaches to doing business are not appropriate (Schwab, 2015). Industries, in all countries, are disrupted, which calls for a change in manufacturing, production, management, educational, financial, economic, infrastructure development and governance systems (Schwab, 2015). If these systems change, the education system should be designed in such a way that it prepares the population for the eventualities that will arise. In fact, the education system should be ahead of changes in the economic arena in particular if it is going to be relevant and equip the population for this (Xu et al., 2018).

Therefore, connectivism seems very relevant for the learning of technological concepts, as it embraces innovative and progressive ways of learning content in the 21st century. This is so because the content of the 21st century education system embeds skills, such as problem solving, collaboration, critical/creative thinking, communication, abstractions, simulations, algorithms, automation, modelling, creativity and originality, which are important in learning technological concepts in the South African education system (Yadav et al., 2016). In its definition of Technology as a specific subject in the curriculum, the DBE (2011a: 29) views it as a subject whose main intention is to instil 21st century knowledge and skills, such as creative, critical, evaluative, problem-solving and practical application of theoretical knowledge skills, which enable people to confront everyday challenges. Based on this definition, connectivism seems most relevant for the learning of technological concepts. Its usefulness, however, needs to be tested.

The section below demonstrates how technological concepts could be learnt through connectivism. The example used for the other theories will be used so that the differences could be seen. As stated in the sections above, learners are required to learn *"design process skills in which they need to grapple with investigation, design, making and evaluation processes".*

In learning this content, the following could be done:

Investigation: The educator would first establish background knowledge that could be used to develop the basic nodal point(s). In developing the basic nodal point(s), learners would be shown a simulation of different structures in which some would collapse, while others would withstand the effects of adverse environmental factors. The term "structural failure" could then be written down, with a view to attaching factors related to it. That would be a connecting idea, which might lead to other ideas that learners could brainstorm. Brainstorming would require them to work in groups to ponder the issues surrounding structural failures. All the ideas would be written down and isolated according to the nature of structural failures. More nodal points would then be created, which would give rise to more connected nodal points.

Design: Once the factors and nature of structural failures have been identified and a picture of related issues described, leaners would now be guided to work out a design for building strong structures. To that effect, leaners would again brainstorm the various designs. To do that, the teacher would make computer-aided three-dimensional (3 D) applications (apps) available for use by leaners. This app would enable them to test and try various 3 D structures. Each group would work on its own simulation. Learners would have to determine ideal designs for the structure that they had in mind. The pros and cons of each structure would be identified and isolated.

Thus, existing knowledge nodal points would further be used as connection points. In other words, new nodal points would emerge from where challenges of structures were identified. That could be done by indicating possible designs that might be considered to mitigate structural failures. Learners could then determine the pros and cons of each design so that the best one could be chosen. Therefore, learners would use 21st century skills to collaborate, engage critically with the design features, use simulations and brainstorm resilient and relevant models and structures creatively.

Making: After the creation of the designs, learners would need to make the actual structures. They would have to use the designs that were developed and tested in the previous step. Thus, the projected structures would be involved in a process leading to the actual development of the structure. For making the desired structures, learners would have to think hard about the pros and cons of the different structural models. For that, they would have to go back to the initial knowledge nodes where the idea was introduced. That will remind them of the factors that could possibly lead to structural failure and those that could make structures strong. In other words, they would work from left to right — left being the initial node leading to the various networks of nodes on the right.

To do the above effectively, learners would need to brainstorm the type of material to be used and the required human resource critically. The simulated 3D structures would inform the choice of material and human resource required. Clearly, learners would have to work back and forth when constructing the model. Checks and balances would be applied to monitor the effectiveness of their plan as conceived in the second phase of the process. Once the models have been created, the next step would to test them the structures.

Evaluation: At this stage, the models would be tested so that their usefulness could be determined. Learners would do so by performing some form of evaluation exercise to determine the models' usefulness in dealing with the challenges that were first identified in the first step. It would not make any sense for the structures to be utilised as suggested because that might lead to structural failure. Therefore, their adoption for use would need to be preceded by certain trials.

Therefore, learners would test the different structural models, which might involve subjecting them to simulated adverse environmental conditions for a specific period to ensure that structures based on these models could withstand most environmental elements for a certain time. The testing exercise would be informed by the reasons for structural failure dealt with in step 1 (the investigation phase). This is important, as the factors that lead to structural failures would have been worked on. Moreover, these factors would have informed the structural models. Therefore, the current knowledge nodes would be related to the initial one and in that way, a network of nodes would have been established, which is how knowledge is developed. Thus, learners would have approached their learning in an integrated fashion, where one facet informed subsequent pieces of knowledge.

Clearly, connectivism seems relevant to the learning of technological concepts because of the following reasons:

- It allows for brainstorming of different concepts in the subject.
- It acknowledges the usefulness of prior knowledge.
- It accords learners an opportunity to do practical activities.
- It acknowledges theory and supports its practical application.
- It promotes critical, abstract and creative thinking skills in dealing with the subject content.
- It equips learners with the necessary skills to make the technological concepts and the content thereof useful for tackling the challenges of daily life.
- It encourages learners to think out of the box and simulate practical solutions to daily technological problems.
- It does not rely on theory, but blends theory with practical demonstrations.
- It enables learners to remember and make sense of the learnt content by using nodes of learning.

- The nodes of learning content enable learners to project (imagery) the content in virtual and real images mentally.

However, connectivism cannot on its own lead to effective and meaningful learning. For example, learners may also need the educator to take an active role in their learning. They may also need a stimulating environment that could initiate and reinforce learning of certain parts of the content. Other means of enforcing and reinforcing learning may also need to be used. In this regard, the tenets of behaviourism may be used in conjunction with other theories. The formation of connecting nodes and networks requires deep thinking skills that are needed for the learning of the complex and technical aspects of Technology. This is important because the subject is practical but imbued with complex concepts the mastery of which requires higher thinking skills (DBE, 2011a).

2.7 THE SIGNIFICANCE OF THE DIFFERENT THEORIES OF LEARNING FOR THE LEARNING OF TECHNOLOGICAL CONCEPTS

Different theories of learning were discussed above, and it was proved that their contribution to the learning of technological concepts could be both negative and positive. Where a particular does not positively contribute to the learning of technological concepts, another theory may lead to the desired results because they all approach learning from different angles based on key aspects of the learning process. The purpose and nature of learning content is not always the same, which requires different approaches to understanding and applying it.

Therefore, not all technological concepts and content may require the approach to learning advocated by behaviourism, for example. Learners may be required to process content in their own unique way with the aid of their cognitive skills, which affords them the opportunity to use information-processing techniques. Therefore, some form and degree of cognition is needed, as opposed to a mere stimuli-response kind of learning. Learners do not only respond to environmental stimuli initiated by the teacher. At some point, thinking skills are required.

While behaviourism may be relevant in learning involving experiments demonstrated by the teacher, the cognitive theory requires learners to think about how such experiments are done, the inner processes leading to what is observable, the connections and why certain processes are displayed in a particular way. However, according to constructivism, learners attach their own meaning to the process, knowledge, skills and values embedded in those experiments, by applying their minds to what they know about such occurrences, the meaning of certain instances and the reasons for the manifestation of certain patterns. Connectivism explains how learners focus on the key aspects of the experiments in order to understand the processes and the inherent intentions. Knowledge is, therefore, developed by forming connections between the knowledge, skills and values' nodes so that the bigger spectrum can come to light.

Therefore, learning cannot be entirely be explained or realised through the application of theory. A combination of various theories should inform and lead to an understanding of the learning process. Clearly, learning cannot only be defined through the lens of behaviourism. A great deal of learning content requires cognitive skills to make sense of it. Leaners need to attach meaning to the learning content and to develop associations between nodes of information, skills and values. Lastly, they need to engage in projects that enable them to engage practically with the leaning content by applying 21st century skills.

Therefore, all the theories discussed above could be relevant in learning technological concepts. It all depends on the nature of the concepts to be learnt. As shown above, the nature of the learning content determines which theory could inform the learning process. However, a combination of these theories could be appropriate in some learning situations. In fact, an integrated application of these theories and others not discussed here might assist learners in learning the technological concepts as envisaged in the CAPS of the South African education system.

2.8 CONCLUSION

The above literature review shed light on the role played by perspectives in the learner's ability to choose and learn technological concepts. The concepts that underpin STEM subjects are often perceived as difficult, and therefore should be pursued by males as opposed to females. This belief favours boys at the expense of girls and means that boys are given preferential treatment and support in learning the concepts embedded in technology. This is done because it is believed boys are the ones who have the physical, intellectual, emotional and behavioural acumen to handle a difficult subject like Technology, which is a specific subject offered to learners in the Senior Phase of the South African education system.

The concepts of STEM subjects may be difficult to learn, but their difficulty is also perceived in terms of societal views of the expected roles of the different genders (Virtanen et al., 2015). That leads to a self-fulfilling prophesy that could either refute or confirm preconceived ideas about boys and girls learning Technology. Regardless of its perceived difficulty, Technology could be learnt by both boys and girls who are able to deal with the difficult concepts.

The literature review also demonstrated how different theories of learning could be used to learn technological concepts. Evidently, all the identified theories of learning could be used to learn the concepts, depending on their nature and complexity. Interestingly, no single theory could succeed on its own in scaffolding the learning of the concepts. A combination of these theories would be required to learn the different concepts. Teachers and leaners must be cognisant of the appropriate theory to use when content of a specific nature is to be mastered.

In the next chapter, the researcher will discuss the research approach, methodology, and design that were followed in the investigation aimed at understanding the perspective of boys and girls on learning technological concepts at the Senior Phase of selected primary schools in the Gert Sibande Education District.

CHAPTER THREE

RESEARCH METHODOLOGY, PHILOSOPHY AND DATA ANALYSIS PROCEDURE

3.1 INTRODUCTION

For a study to be directed towards finding the actual and probable truth about the phenomenon under investigation, the researcher should choose an appropriate and relevant research approach. The chosen approach would inform the procedures to be followed in identifying the units of analysis as well as determining the suitable data collection and analysis procedures that would lead to the drawing of conclusions about the phenomenon being studied (McGregor & Murnane, 2010). Therefore, a research methodology is informed by a research approach that details the theoretical framework against which the study is conceived (Wallace & Priestley, 2011). A research methodology informs the approach that the researcher may use to understand the phenomenon under investigation (McGregor & Murnane, 2010). However, research methodologies differ, and they depend on the intention of the inquiry (Kothari, 2004). In this chapter, the researcher discusses the applicable research methodology, philosophy and associated research strategies. Furthermore, for meaningful understanding of the elements of inquiry, the researcher discusses the target population; samples and sampling procedures; the validity and reliability of the study; and the way that bias was eliminated.

3.2 RESEARCH PHILOSOPHY

A research philosophy is a vital component of any research inquiry, as it determines the choice of a research approach, methodology, method, design and data collection mechanisms (Creswell, 2014). A research philosophy, therefore, informs the type of tools, mechanisms and approaches the researcher may employ for the reaching of precise scientific conclusions about the subject of the inquiry (Kothari, 2004). The suitable approach for an inquiry influences the choice a researcher needs to make about the applicable research methodology (Creswell, 2014). The methodology is the exact operations that the researcher will undertake to identify, collect, analyse, interpret and understand the phenomenon under investigation, and it is based on the philosophy the researcher has adopted for the study (McGregor & Murnane, 2010).

Therefore, the choice that the researcher would make is contingent to the philosophical predispositions the researcher would use in the study.

Philosophical dispositions influence the general approach the researcher would use that characterises the nature of the study (Waghid, 2016). Studies, therefore, bear the traits of their philosophical origins, which direct the tone and texture they will take. In the same vein, theoretical dispositions tend to influence the way a study is undertaken, and thus characterise the operations to be utilised and the outcomes to be achieved (Horsthemke, 2018). However, there are many theoretical orientations to choose from, and they depend, inter alia, on the nature, purpose and aim of the study (Jackson, 2013).

Jackson (2013: 54) identifies epistemology, ontology, phenomenography, positivism, post-positivism and relativism as examples of classical philosophical schools of thought that researchers from diverse persuasions and backgrounds have used for a long time; moreover, many are still using them, depending on the purpose and aim of the study. Saunders (2005: 35) agrees that there are many philosophical schools of thought that influence a researcher in his/her endeavour to answer the main question and sub-questions of a study. These philosophical schools of thought include assumptions about human knowledge (epistemological assumptions), the realities encountered in research (ontological assumptions) and the extent to which a researcher's values influence the research process (axiological assumptions).

The above assumptions buttress the philosophical position that informs the approaches that a researcher follows to probe the phenomenon being studied by guiding him/her to understand the research questions, identify the methods to be used in the inquiry and determine how the findings are interpreted (Crotty 1998). However, philosophy is not static, as it evolves over time under the influence of ongoing narratives and new knowledge systems that come to the fore during various epochs (Horsthemke, 2018). Therefore, ongoing philosophical developments are best understood in the context in which events and polemics are manifested (Jackson, 2013).

A contextual understanding of philosophy is, thus, prudent in understanding the world and the development/usefulness of the knowledge economy. Therefore, it is important that studies deal with issues in each environment in ways that enhance a better understanding of peoples' socio-cultural dispositions so that the outcome of science can be meaningful to their continued existence (Horsthemke, 2018). Waghid (2016: 21) argues that there is no one-size-fits-all when it comes to the appropriate philosophical underpinnings and assumptions of a study because studies happen in different contexts, and the prevalent philosophical outlook of a given socio-cultural community may have a direct bearing on the approach that the researcher uses in a given study.

Before, this chapter presents an investigation into philosophical dispositions, it is important that the assumptions that underpin philosophical orientations are explained. Saunders (2005: 35) discusses the following philosophical assumptions.

- **Ontology**

This assumption concerns itself with the way reality is viewed, which in return determines how a researcher approaches a study. There is a great possibility that the way a researcher views reality influences his/her ways of tackling a study, including shaping research questions; the determination of objectives; and the identification and usage of an appropriate research methodology and design. Ontologically, the researcher came to the study described in this research report with his own experiences of monitoring, supporting and developing teachers based on the knowledge he had amassed over years. This included the strengths and weaknesses of approaches used over years; antiquated and new teaching/learning epistemological models; and suggested models by the DBE of what constitutes best approaches towards teaching and learning.

It is obligatory to implement the diagnostic reports that the DBE produces each year, and subject advisors are the critical element in their implementation. Feedback from the implementation of these intervention mechanisms are used for further planning. These experiences may have influenced the way that the researcher approached the study. Thus, prior knowledge helped the researcher to drive the research project in ways that lead to a better understanding of the phenomenon under study. The researcher is not a learner and does not work in an environment where the actual learning of technological concepts takes place. One of the researcher's duty is to support educators and develop their abilities to teach, mould and assess learners. The study was about how selected learners learnt technological concepts. However, only learners have an idea of how they learn these concepts. They are the ones to whom the teaching is directed, and they harbour different experiences of how they deal with the different technological concepts.

Both teachers and education officials are not directly involved in the learners' personal experience. They may have their own individual understanding of the learning process; however, that knowledge and expertise should not negatively influence a researcher's conclusions. In other words, the outcome must not mirror a researcher's own philosophy and general understanding of the phenomenon under investigation. However, in the case of the current researcher, knowledge of the learning process was invaluable when confining the study within the parameters of the elements of analysis. Without such knowledge, the study may have strayed off course and attempted to deal with a variety of unrelated and unhelpful phenomena. This chapter will later discuss how credibility, trustworthiness, dependability, transferability and confirmability were ensured. In that section, the researcher will illustrate how his knowledge was used in the study and how it was prevented from influencing the outcomes.

- **Epistemology**

This assumption, generally, concerns itself with knowledge and how it appears to the eye of the beholder. Its point of departure is questions, such as what constitutes acceptable, valid, reliable and legitimate knowledge, and how that could be communicated to others. In the context of the study, the knowledge that was sought centred on technological concepts that underpin the subject ''Technology". The interest was how learners, both boys and girls, learn these concepts. The outcome was to determine the differences between these genders when the concepts are learnt at schools. Epistemologically, the concepts that learners learn at schools were the primary area of focus and what the study was all about. The researcher monitors, supports educators and develops their knowledge of didactic, pedagogical and methodological approaches to the teaching and learning of technological concepts.

The difference between ontological and epistemological assumptions lies in the fact the former deals with how researchers view/understand reality or the subject of inquiry, whereas the latter deals with knowledge as it appears in researchers' eyes and does not include researchers' perceptions of a phenomenon. In the case of the study, although the researcher interpreted the perspectives of boys and girls on learning technological concepts, he concentrated on the knowledge that was displayed by the participants; the way it was displayed; the factors involved in the display; the way these factors influenced what was observable; and the meaning these factors demonstrated. In this regard, the researcher dealt with the *episteme* (the Ancient Greek word for knowledge) of those involved with the phenomenon and the meaning of that knowledge as it appeared to the researcher.

In the study, the researcher focused on how learners learnt the technological concepts. In other words, the researcher was interested in the learners' perspectives on learning technological concepts. Epistemologically, the researcher used available knowledge about how the different genders learnt these concepts based on their different orientations. The researcher then interpreted these perspectives based on a set of objective criteria to be discussed later in this research report. These objective criteria were used to neutralise the attachment of the researcher's values to the observed traits and patterns. The only value of interest was the one that learners have towards the technological concepts.

- **Axiology**

Axiology is the study of the role of values and ethics in research, for example. It mostly deals with how researchers manage both their values and those of the research participants. The role that researchers' values plays in all the stages of research is of paramount importance as it may either bolster or tarnish the nature of the findings. It all depends on how researchers are able to keep their value systems in check at every step of the research process. Otherwise, they might conduct a study to fulfil their own inclinations, beliefs, understanding and orientations, for example. The study would then become a self-fulfilling exercise to affirm their philosophies.

However, researchers may show their axiological skills by being adroit in choosing the best topics of research based on their understanding and the value they attribute to the study to be undertaken. This would answer questions, such as “what’’ is to be studied, “why” is that studied and “how” is it going to be studied? In other words, researchers might see value in using in-depth interviews and observation cues because they believe that these methods would elicit answers to the “what”, “why” and “how” of the research. The choice of the data collection mechanisms would answer the ‘’how” part of the study because it would refer to the mechanisms that the researchers planned to use in conducting the study.

Researchers may not value questionnaires because they appear impersonal and distant for qualitative data to be collected. The nature of the data to be collected and analysed might dictate that a qualitative research methodology should be utilised; hence, the usage of both semi-structured interviews and observation techniques in collecting data. Therefore, the interpretivists’ philosophy would be used to interpret the values, inclinations, perspectives and attitudes of the participants in a research study.

In the research described in this research report, the researcher did not follow a positivist approach, which explains the relevance of the data collection techniques alluded to in this section that will be elaborated upon later in this chapter. The successful use of both semi-structured interviews and observation cues for data collection depended on the researcher’s values, knowledge and beliefs concerning these techniques. Thus, the researcher’s value system actually helped with the collection of valuable data.

The researcher valued semi-structured interviews and observation techniques to collect the required data for the research study, which will be explained in the next few sections of this chapter. The researcher believed that both techniques could lead to an understanding of boys’ and girls’ perspectives on learning technological concepts because they brought the researcher physically close to the subjects and enabled him to relate to them. This enabled the researcher to understand their perspectives from their point of view, against the backdrop of their natural operational space. Moreover, as the researcher was able to be physically near to (and empathise with) them, data was gathered about certain traits that could not have been derived through semi-structured interviews alone. Thus, the researcher was able to interpret the important variables at play in the boys and girls' learning of technological concepts in the area of the study.

The above assumptions are linked to certain philosophical doctrines. The following section will not explain all the research philosophies; however, those that may shed light on how the researcher conducted this study will be discussed. According to Saunders (2005:36), the following are some of the research philosophies applicable to many research studies.

- **Positivism**

The basic premise of positivism lies in its view of reality from the perspective of natural scientists. This entails dealing with observable and objective reality in ways that produce generalisations about it. Positivism produces an accurate, empirical and unambiguous account of reality and is adept at yielding accurate, undiluted, scientific, pure and factual data about the phenomenon being studied. To do this, it emphasises observable, measurable facts and reality to produce credible and meaningful data. In other words, positivists are concerned about verifiable, testable and measurable data about the phenomenon under study.

With regard to the study, positivists would want to determine the frequencies of responses to a questionnaire in order to understand how boys and girls learn technological concepts based on quantities. For example, the aim would be to understand how many girls use rote learning to study the technological concepts. That could be compared to boys who also use that learning strategy. The conclusion that would be reached may indicate, for example, that 80% of girls, compared to 20% of boys use rote learning in studying technological concepts. In terms of the aim of the study, the finding might be that difficult aspects of technology are memorised by girls as opposed to boys.

In the former example, the researcher would have used a quantitative research design to arrive at a quantitative conclusion about their learning of technological concepts. Quantitatively, the conclusion would have been based on objective and measurable data. However, the researcher used interviews and observation techniques to collect qualitative data. The usage of these mechanisms requires engagement with the participants and the data involved in this kind of an inquiry is qualitative rather than quantitative.

Simply put, the perspectives of both boys and girls were the subject of inquiry, and the research questions stated in Chapter One required qualitative data for conclusions on the perspectives of both boys and girls to be reached. Their responses to the interview questions enabled the researcher to gather valuable information about the way they learn concepts, which required interpretation. Thus, the researcher used an interpretive approach, as opposed to a positivist one, because the aim and purpose of the study required an interpretation of the way both genders learnt the concepts..

- **Interpretivism**

Unlike positivism, interpretivism regards human beings as organisms that differ from physical entities because they attach meaning and value to phenomena. Researchers who use this approach are interested in the meaning that is attached to the object of the study. Interpretivists argue that human beings and their milieu cannot be studied in the same way as the physical world. The argument is that social sciences research is different from natural sciences research, and they need different research approaches and methods. Interpretivism acknowledges that people have unique and different cultural/social backgrounds at different times and embody different knowledge systems that are interesting to study. Its main purpose is to create a new, rich, socially and individually bound knowledge system about the subject of inquiry. Therefore, interpretivists study the complex nature of a phenomenon by engaging with those involved with it so that their feelings, perspectives, attitudes and tendencies, for example, can be better understood. Interpretivists value the importance of language, culture, history, social norms and values in understanding phenomena with which people are engaged in a particular space and time.

Axiologically, interpretivists acknowledge the fact that their interpretation of reality or research data and their value systems play a role in the research process. This is because researchers are involved with the phenomenon in ways that allows subjective meaning to be used for the understanding of the phenomenon under study. This is the challenge that interpretivists face in their endeavour to study human phenomena. Therefore, it is important that researchers indicate how they will prevent subjective perspectives from influencing the outcome of a study. In the subsequent sections of this chapter, the researcher will explain how researcher's bias was dealt with.

The above assumptions and philosophies inform the research methodology, design and the general approach a researcher assumes when a study is undertaken. In other words, they inform the general mechanism that a researcher uses when collecting, processing and interpreting the data (McGregor & Murnane, 2010). The choice between qualitative, quantitative or mixed methods research designs is dependent on these assumptions and philosophies, which are informed, inter alia, by the research problem and general purpose of the study (Maree, 2016).

Below is a discussion about the applicable research methodology and the researcher's motivation for the choice he made regarding this.

3.3 RESEARCH METHODOLOGY

A research methodology is typically the strategy or plan that enables the researcher to choose appropriate methods and design so that the desired outcomes are reached (Creswell, 2014). A researcher follows a particular methodology when collecting, processing and interpreting data about the phenomenon being studied with the aim of reaching conclusions about it (Kothari, 2005). It is a plan of action or an approach that connects methods to the outcomes related to the phenomenon under study (Creswell, 2014). Moreover, it refers to the specific and actual procedures followed by a researcher to identify, select, analyse, process and interpret data relevant to the study to answer the research questions, leading to an understanding of the phenomenon under investigation (Maree, 2016). A research methodology acquires its expression and tone from the research philosophy, which provides the framework for the execution of the study (McGregor & Murnane, 2010).

There are three research methodologies involving qualitative, quantitative and mixed methods research (MMR) designs (Creswell, 2014). The applicability of each is dependent on the research aim, statement, purpose and focus of the study (Kothari, 2005).

Thus, a researcher may use the quantitative research methodology (approach) under the positivists' philosophical orientation if the inquiry requires the measurement and counting of the traits representative of certain phenomena (Rajasekar, Philominathan & Chinnathambi, 2013). However, a qualitative research methodology is used if a researcher seeks to describe, observe, question, interview and study participants relative to the phenomenon under inquiry and interpret what is elicited by them (Leedy & Ormrod, 2013). These two research methodologies seem to approach the research inquiry in distinct but mutually exclusive ways. In order to use and apply elements of both quantitative and qualitative approaches, the researcher should apply a mixed methods research approach, which allows for the use of elements of each approach (Creswell, 2014).

A quantitative research approach is suitable for the objective testing of hypotheses as it involves examining the effects of independent variables on the dependent variable, for example (Maree, 2016: 56). In addition, this approach includes the manipulation of independent variables to determine their effects or impact on the dependent variable, so that the phenomenon could be better understood (McGregor & Murnane, 2010). Furthermore, it uses objective measurement instruments in ways that give the researcher an opportunity to analyse data using statistical operations or procedures (Creswell, 2014).

Conducting studies in this fashion does not necessarily allow for the researcher's personal attachment of epistemological meaning, as quantitative inferential studies are objective and deductive in nature (Bhattacherjee, 2012). However, quantitative studies can also be descriptive in their approach in that they use aggregates and percentages to describe the association between the constructs involved in the inquiry or to describe the nature of a phenomenon being studied (Bhattacherjee, 2012; Leedy & Ormrod, 2013). Clearly, subsequent research steps and procedures are reliant on the chosen research philosophy, as that sets the tone and ambiance of the research study. Everything that a researcher uses is dependent on the founding philosophy, and the results will be typical of it.

The quantitative research approach was not used in this study, as the researcher concentrated on qualitative data. The researcher was interested in the perspectives of learners (both boys and girls) towards studying technological concepts in the area of the study. The researcher neither used objective quantities nor considered deductive approaches to arrive at a conclusion about how girls, compared to boys, learn the technological concepts.

Therefore, in this study, the researcher used the qualitative research approach, as perceptions and attitudes were involved. Moreover, these perceptions and attributes were dependent on the interpretations of those who experienced the phenomenon at a given point in time (Creswell, 2014). To conduct the study, the researcher used an inductive approach, as it allowed the analysis of certain behavioural traits, attitudes and perspectives to arrive at decisions about the phenomenon being studied (Maree, 2016). Thus, the researcher worked inductively from common and general occurrences to conclusions about the phenomenon under investigation (Leedy & Ormrod, 2013). In simpler terms, the researcher focused on the specific behavioural cues displayed by both boys and girls while studying technological concepts to determine their perspectives in an attempt to answer the research questions. Moreover, their specific and inherent attitudes towards learning those concepts were thoroughly examined so that their actual perspectives could be determined.

This helped the researcher to interpret how these categories of learners related to (and learnt) those concepts. In other words, the researcher sought to interpret the way they approached and succeeded in learning technological concepts. A qualitative approach does not view reality in absolute and objective terms, as is the case with a positivist approach that studies reality in empirical terms, which excludes issues of feelings and attitudes (Aliyu, Bello, Kasim & Martin, 2014). A qualitative approach rather views reality as a subjective, relative and ever-changing set of related facets whose meaning depends on the feelings and views of those involved with it. Hence, it is combined with an interpretivist approach when the data are being analysed.

Interpretivists, as discussed above in the section on philosophical dispositions, promote the use, among other strategies, of semi-structured and/or open-ended interview questions as data collection mechanisms because they deal with a person's thoughts, feelings, views and inclinations towards a phenomenon, event, program or a project (McGregor & Murnane, 2010). Moreover, they make provision for follow-up questions to be posed for more clarity to be given on what respondents have to say (Creswell, 2014). Due to the nature of the data collected through semi-structured interview questions, the researcher was able to interpret what the respondents felt, viewed, experienced, and understand about the way they learnt technological concepts in the area of the study. By that token, the study subscribed to the interpretivists' philosophy because the interpretation of qualitative data led to the formation of particular meanings, observations and/or conclusions about the perspectives of boys and girls on learning technological concepts (Photongsunam, 2010). That positioned the researcher in asking main and follow up questions so that the learners' perspectives and attitudes could emerge. Specifically, the researcher was guided by the research questions in the formulation of the interview questions. The objectives and purpose of the study also presented vital hints about the specific aspects to be included in the interview questions and observation cues.

Based on the research sub-questions, it was evident that the main question was operationalised into different facets whose main aim was to explore the fundamental and specific essentials underpinning the research problem for informed decisions to be made. In simpler terms, the researcher used these questions to formulate the semi-structured interview questions and the observation cues that were used for the collection of data. That enabled the researcher to stick to the main thrust of the investigation without swaying away from the core of the research when dealing with the phenomenon in context. In addition, the usage of both the semi-structured interviews and observation cues enabled the researcher to tap into certain human traits, such as body language and emotions, which were important when contextualising the learners' views and feelings about the phenomenon. Thus, data about the interviewees' perceptions and attitudes towards the learning of technological concepts were revealed during the interviews and observations. Later in this chapter, the researcher will indicate how the validity and trustworthiness of the instruments and the collected data were ensured.

In Chapter Two of this research report, the concept "perspective" was unpacked and its influence on people's views, values, attitudes and interests was discerned. A perspective might be a new, unique approach or an angle through which existing problems, concepts or notions of topics are viewed so as to develop innovative ways of observing and approaching life and/or phenomena that make sense to the beholder, leading to changes in behaviour (Majumder, 2015). In other words, a perspective is like a glass-prism through which the phenomenon under inspection is viewed in the light of a person's earlier experiences that inform the new perception (Wallace & Priestley, 2011).

Thus, a perspective is an influential impetus that could drive a learner in his/her attempt to go through the learning task. In both Chapters One and Two, the concepts "perspectives" and "attitudes" were explained and contextualised. The idea was to demonstrate the role that each played in the learning of technological concepts on the part of both the boys and girls in the study. In other words, how the girls and boys learnt the concepts required their personal interpretation of technological concepts. In the study, the concepts "perspectives" and "attitudes" both referred to the learners' interpretation of technological concepts based on their experiences and socio-cultural influences. Both concepts have a qualitative value because they involve subjective feelings about a phenomenon. Therefore, they cannot be objectively measured, as is the case with quantitative variables (Creswell, 2014). Research studies that mainly aim to investigate peoples' perceptions and attitudes are qualitative and descriptive in nature because they deal with epistemological data as experienced by those involved (Bozalek, Garraway, & McKenna, 2011).

Epistemological data can be perceived in terms of peoples' interpretation of events, situations and phenomena, instead of objective and empirical reality (Leedy & Ormrod, 2013). This understanding of the concept of epistemological data resonates with the meaning and the definition of perspective as illustrated in Chapter Two. In other words, a qualitative research design seeks to unravel how those involved with a situation or phenomenon view, feel, understand and relate to it. Their points of view are important in understanding the impact of the phenomenon on their experiential world.

Below, we will discuss the research design that enabled the researcher to collect the necessary data in line with the interpretivist school of thought.

3.3.1 Research design

A research design is a specific plan, strategy or mechanism that informs the particular steps that the researcher will take in conducting the study. Moreover, it is mostly nested within the chosen research approach, methodology and paradigm (Maree, 2016). In Section 3.3 above, it was stated that the study assumed a qualitative research approach or trajectory. There are many interactive modes of inquiry in the qualitative research approach, namely case studies, ethnography, phenomenological studies, grounded theory studies and content analysis (Leedy & Ormrod, 2013:141) that all approach the inquiry in different ways for specific outcomes. It is important, therefore, that a researcher uses an appropriate research design because the success of the inquiry largely depends on the methods used in the study.

For the purposes of this study, a qualitative case study research design was followed. This type of design sets out to study a program or an event and the associated meaning that those involved attribute to it as they relate to, or engage with, it (Creswell, 2014). Moreover, it enables in-depth understanding of a phenomenon, as it takes place in its natural setting or context, and those involved with the phenomenon reveal their attitudes and perspectives about it (Leedy & Ormrod, 2013). It may involve asking questions that investigate, for example, how certain occurrences take place or how people feel about a certain situation (Maree, 2016). In the study, the researcher was interested in the perspectives of both boys and girls on learning technological concepts in the area of the study. To do that, the researcher needed to engage them so that they talked about their experiences of learning such concepts. Moreover, the researcher needed to observe the manner in which these learners learnt the concepts. That data would either confirm or refute the researcher’s understanding of the phenomenon or reveal a new angle to it. Moreover, the use of two research instruments (interviews and observation) ensured triangulation of the data.

In essence, the researcher asked questions about the nature of the perspectives of boys and girls towards learning technological concepts in the area of the study. In addition, it was imperative that the research subjects were observed so that certain attitudinal traits were revealed, which gave the researcher an opportunity to understand the learners’ attitudes towards the learning of technological concepts fully. In this way, the researcher engaged with the units of analysis in their natural working environment. A case study research design requires that subjects are studied in such an environment so that the outcomes of the study are dependable, trustworthy, transferrable and generalisable (Maree, 2016).

3.3.2 Research methods

In a qualitative case study research design, a researcher may use interviews, analyse documents relevant to the subject of the inquiry and observe subjects in their natural environment as a way of collecting the necessary data about the phenomenon under investigation (Yin, 2014). Baxter and Jack (2014:545) agree that a case study research design is suitable when a study seeks to answer questions such as ‘’what’’, “how” and “why” and when the researcher cannot manipulate the behaviours of the subjects. In addition, it is appropriate when the contextual conditions are imperative for the success of the study and when the boundaries between the subjects and context are not clear. For the researcher to come to grips with the phenomenon under study, the “what” “how” and the “why” questions were used in line with the main question and sub-questions elaborated upon in Chapter One. Moreover, the researcher conducted the study in the subjects’ normal operational contexts, and there was no manipulation of any variable towards the attainment of the aim and objectives of the study.

In using the “what” “how” and “why” questions, the researcher developed interview questions that were crafted in line with the content of the topic of the study, the aims and objectives of the study as well as the main and sub-questions. Moreover, observation cues based on the same criteria as the interview questions were developed to direct the focus of the researcher during observation. This enabled the researcher to derive data about a wide spectrum of important aspects, such as interests, perspectives, attitudes and behavioural traits. Data not easily collected through the semi-structured interviews were collected through the observation cues. These two methods, therefore, complemented each other in that they treated similar and different parts of the data. Thus, this strategy allowed for the triangulation of data from which inferences were made about the phenomenon under study.

Semi-structured interview questions and observation techniques were used to collect the necessary data for the study for various reasons. Semi-structured interviews were chosen for their adaptability and applicability to challenging field conditions as well as their relevance in generating understanding about the phenomenon (Yin, 2014). Observations were relevant because they enabled the researcher to jot down notes on the observed behaviour. The researcher was also able to record what was being observed without restricting the outpouring of data, even though some of the data was repeated. Lastly, the observation technique allowed the researcher to observe the respondents in their daily operational context, which helped with the generation of genuine and complimentary data that the researcher was able to analyse with a view to reaching conclusions about the phenomenon under study (Jamshed, 2014).

Interviews, observations, the inspection of key documents, the interpretation of tabular materials, narratives, photographs and audio files could be used as multiple data sources for the collection of the necessary data for a study (Baxter & Jack, 2014). According to Baxter and Jack (2014:554), a researcher may use two or more of these data collection mechanisms depending on the nature and purpose of the study. It is against this background that both semi-interviews and observation techniques were used in this study for data collection. These techniques are discussed in more details below.

3.3.2.1 Semi-Structured Interviews

Semi-structured interviews were used to come into proximity of the phenomenon under investigation. The researcher had to be in close contact with the interviewees, and deep and probing questions were used for data collection. These interviews were conducted in the selected schools where the sampled learners attend classes. An interview schedule was developed and the interviews did not disturb the normal teaching and learning, as they were mostly conducted in the afternoon. The semi-structured interview is an important procedure in case study research design as it is meant to elicit a clear and up-close picture of the participants' views, attitudes, orientations, thoughts and perspectives concerning the issue being investigated (Showkat & Parveen, 2017). It is usually a preferred method when few participants are involved, and they are knowledgeable or experienced with regard to the phenomenon under investigation (Morris, 2015). In the study described in this research report, only ten participants were involved, which was a manageable number. Moreover, the interviews did not last longer than the planned and expected time. A smaller number of people are better managed, compared to a large group of participants. Interviewing knowledgeable and experienced interviewees requires time and an in-depth approach because some data may not be revealed during a short interview session, as they lie dormant and can only be unearthed during a close encounter with the interviewees (Showkat & Parveen, 2017). Semi-structured interviews accorded the researcher the opportunity to come into close contact with the participants in ways that revealed deeper perspectives about the topic of the study.

In essence, semi-structured interviews involve face-to-face encounters with participants as well as deep and elaborate questions to extract relevant and helpful data about their views, perceptions, perspectives, knowledge and orientation regarding the phenomenon under investigation (Showkat & Parveen, 2017; Morris, 2015). Showkat & Parveen (2017:3) posit that semi-structured interviews are mostly relevant and helpful when few participants are involved in a study. In this study, only ten participants were interviewed.

Effectively, ten learners selected from the promotional schedules of the past few years were interviewed. This sample comprised five females and five male respondents in line with the purpose of the study. The researcher used the purposive sampling procedure to come up with the list of 10 participants. Purposive sampling is an intentional identification of participants based on their potential to elicit the required and specific themes, concepts, traits, information and data about the phenomenon being investigated (Edwards & Holland, 2013).

Each interviewee was interviewed for a period of an hour. Interviews stretching for an hour are acceptable and perfect for the attainment of the desired quality of outcome (Jamshed, 2014). Longer interviews have the potential to strain the participants, which could jeopardise the quality of the findings and lead to the drawing of inaccurate conclusions (Laforest, 2009)

Interviews in qualitative research come in different forms and a researcher must be able to choose the most appropriate one if the dependability of the study is to be enhanced. However, depending on the nature of the study, different types of interviews may be used in each study (Edwards & Holland, 2013). Edwards and Holland (2013: 40) identify focus groups as well as face-to-face, telephonic and/or email interviews as some of the mechanisms that a researcher could consider in case study research designs. Of course, these mechanisms are informed by the size of the sample and the location of the participants. For instance, it would be extremely expensive for a researcher to conduct face-to-face interviews with respondents who, for example, work in a multinational company, as that company would have offices across the globe. In this instance, email or telephonic interviews could be conducted.

In other words, face-to-face interviews work well when the researcher is able to interact physically with the participants in a given space in time (Jamshed, 2014). In addition to the mode of the interviews, a researcher has the obligation to choose the form and structure of the interview questions. Interview questions could be structured in a number of ways. For example, the researcher may choose either structured or semi-structured interview questions, depending on the aims and objectives of the research. Semi-structured interviews questions are structured in such a way that the planned questions are approached with flexibility, which allows for the researcher an opportunity to make follow-up questions in the event that an idea is not well expressed (Jamshed, 2014; Leedy & Ormrod, 2013). In this way, a researcher is able to assume control of the process by managing its direction and course, which indicates an epistemological approach. In simpler terms, if respondents do not understand the question, another form of the question is devised so that it elicits the desired response in line with the intention of the research.

In the study, the researcher used semi-structured interview questions that are reliable and consistent in yielding the desired results if they are pre-planned (Edwards & Holland, 2013). The researcher used them in such a way that they were not prescriptive but allowed for rephrasing and follow-ups to be made (Jamshed, 2014). Leedy and Ormrod (2013:190) agree that semi-structured interviews are effective instruments for the collection of data related to feelings, views, perspectives and attitudes, as the researcher is accorded the space to develop prior questions to spark the process of the interviews. Moreover, individually developed questions could be posed during the interviews to gather more information relative to the phenomenon under study.

The researcher did not use structured interview questions, as they have the potential to limit the process to a pre-planned set of questions that may not be well understood by the respondents; and, there is no room for interpretation of any questions (Leedy & Ormrod, 2013). In studying the perspectives of respondents on a phenomenon, a researcher would be required to clarify and or even restate a question so that the respondents could fully understand it (Edwards & Holland, 2013). Clearly, all data collection mechanisms have certain merits and demerits. Below is a discussion of the merits and demerits of semi-structured interviews as a preferred mechanism in this study.

Cohen and Crabtree (2006:32) identify the following as the benefits of using semi structured interviews:

- The interviewer and respondents engage in a formal interview.
- The interviewer develops and uses an interview guide. This is a list of questions and topics that need to be covered during the conversation, usually in an order.
- The interviewer follows the guide but can follow topical trajectories in the conversation that may stray from the guide when he or she feels this is appropriate.
- They are used when the interviewer does not have more than one chance to interview someone.
- Interviews are prepared ahead of time, which allows the interviewer to be prepared and appear competent during the interview.
- The interviewer may use a tape-recorder or script notes, which allows for an opportunity to capture the proceedings accurately.

Van Teijlingen (2014:63) identifies the following demerits:

- Equivalence of meaning' difficulties may arise, as the respondents may answer the questions in a way that may present challenges during data analysis.

- Preferred social responses may be given, as the interviewee is in close contact with the interviewer.

- There could be non-responsiveness from certain groups of individuals, which may hamper the interviews.

- They largely depend on the skills of the interviewer (the ability to think of questions during the interview, for example) and the articulacy of respondents.

- They seem time consuming and relatively expensive to conduct.

- Because of their personal nature, valid data may be difficult to generate, which may affect the reliability of the study.

- More time is consumed as respondents can express their viewpoints in their own way. Moreover, the follow-up questions that assist the research in getting to grips with the participants' thought processes may be time-consuming.

To deal with the shortcomings of semi-structured interviews, the researcher developed them with care, foresight and attention to the practicality of the questions, which assisted in the enhancement of the validity and trustworthiness of the study that will be discussed later in this chapter.

As stated above, the researcher used the research aims and objectives, main question and sub-questions to develop the interview questions for this study. The main question of this study was, "What are the perspectives of boys and girls on learning technological concepts at the Senior Phase of selected schools in the Gert Sibande Education District? This question enabled the researcher to focus on specific aspects of the curriculum and on what learners thought about them. This was done with the aid of the sub-questions as follows:

- What are grade seven learners' perspectives on strategies for the effective learning of Technology?

- How do boys and girls perceive the development of certain perspectives on learning technological concepts?

- How do the grade 7 learners experience societal biases towards the effective learning of technological concepts?

- How do certain perspectives influence boys and girls in the effective learning of technological concepts?

- What strategies could be suggested to help learners develop effective perspectives for the successful learning of technological concepts?

Ten interview questions were developed as per Appendix G. Some sub-questions were further explored and directed to elicit more specific data in line with the main question.

In the actual conduction of the interviews, the following procedure, as recommended by Cohen and Crabtree (2006:31), was followed.

- Each interviewee was given time for the interview and no follow-up interviews were conducted.

- The semi-structured interview guide was used in the development of the interview questions, which assisted in the relatively accurate depiction of feelings, perceptions and perspectives.

- As will be shown below, the semi-structured interviews were preceded by observations that gave the researcher the time and opportunity to develop a keen understanding of the topic of interest that was necessary for developing relevant and meaningful semi-structured questions.

- The previously prepared semi-structured questions helped the researcher to focus on the planned course of the interview and to avoid unnecessary discussion of unrelated data.

In line with the protocol for semi-structured interview questions, the researcher used an audiotape to capture the proceedings accurately. In other words, the researcher recorded the interview so that themes could be identified. In addition to audiotaping, the researcher used notes to record the salient aspects of the interviews, which allowed him to coalesce the data for informed processing. In this way, no significant aspect of the interviews was left unattended to, which enhanced the internal validity of the interview questions. To ensure that valid, fair, credible and trustworthy data was extricated, consent from the participants was sought, and the process was free from subjugation. If the researcher did not assure them of the secrecy of the process, the respondents would have resisted answering certain questions, which may have affected the outcomes to be discussed in Chapter Four.

3.3.2.2 Observation

In addition to interviews, the researcher observed the way respondents usually studied and interacted with technological concepts. For purposes of observations, the respondents were observed during class time, when the learners were taught, which gave the researcher an opportunity to do on-site observation of the way they learnt those concepts. It is in the teaching and learning environment that learners interact with content. Thus, data about traits, such as attitudes, resilience, approaches and technological skills, could be revealed for the researcher to determine what lay beneath the perspectives that they harbour (Jamshed, 2014). To do that effectively, the researcher used the aim and objectives of the study to develop observation cues, which ensured that the exercise was guided, and thus reliable and trustworthy. In other words, the main question and sub-questions of the research, as stated in Chapter One, were used as a base for the observation cues. Moreover, the content of the questions was vital in driving the process from an informed point of view.

As there are elements that an interviewer cannot gather through interview questions in a research situation, it was important to add observation to the research proceedings. However, although observation is a valuable data collection mechanism, it cannot collect all the information needed in qualitative research. Appendix H bears the observation cues used in this research. Notably, these cues, like the interview questions, were developed based on the main question and sub-questions as well as the aim and objectives of the study. The researcher changed the interview questions so that they could guide observations of how the learners were doing what they claimed to be doing during the interview session. A distinction was then drawn between the “what”, “why” and “how” that they claimed to do when learning technological concepts and the “what”, “why” and “how” they actually did. This elicited more information when the data were compared during processing, as commonalities and discrepancies were identified for inferences to be made. The observations were properly planned in line with the conditions espoused by Cohen and Crabtree (2006: 12) shown below. According to Cohen and Crabtree (2006), the following necessitates the use of observation in a study:

- When the nature of the research question to be answered is focused on answering a how or what type of question
- When the topic is relatively unexplored, and little is known to explain the behaviour of people in a setting
- When understanding the meaning of a setting in a detailed way is valuable
- When it is important to study a phenomenon in its natural setting
- When self-report data (asking people what they do) are likely to be different from actual behaviour (what people do)

Therefore, the observation cues of this study took all the above factors into account, which meant that required data was elicited through both interviews and observation. However, as stated above, observation cannot ensure a hundred percent clarity in the data collection process. There are advantages and disadvantages that need to be considered:

a) The advantages

- Ensures that the data are collected according to a direct method – best for the study of human behaviour
- Collects data that is accurate in nature and very reliable

- Improves the precision of the research results
- Decreases the problem of depending on respondents' words
- Helps in understanding the verbal response more efficiently
- Can be used continuously and for a relatively long time by using effective modern gadgets
- Demands less from the researcher's input than interviews, which makes the data less biased
- Allows for the identifying of a problem by means of an in-depth analysis of the problems.

b) The disadvantages

- Problems of the past cannot be studied by means of observation.
- Having no other option, the researcher has to depend on the documents available.
- Controlled observation requires special instruments/tools for effective working, which are costly.
- One cannot study opinions by this means.
- Attitudes cannot be studied through observations.
- Sampling cannot be brought into use.
- Observation involves a lot of time, as the researcher has to wait for an event to happen to study it.
- The actual presence of the observer himself during the event under study is almost unknown.

- Complete answers to any problem or any issue cannot be obtained by observation alone.

To ensure that the disadvantages of observation did not tarnish the value of the outcome of this study, the researcher needed to plan according to the research questions, the aim and the objectives of the study (Cohen & Crabtree, 2006). For effective observations to be made in the study, the researcher developed cues, and thus had a record of prompts that guided the observations. Leedy and Ormrod (2013:152) posit that observations are supposed to be unstructured and free-flowing so that the basic traits can be activated. In other words, the process should enable a natural flow of events for proper conclusions to be reached. If observations are conducted in this way, they allow a researcher an opportunity to view phenomena as they appear because one object may overlap with another. However, there is a need for a researcher to have planned the research proceedings in light of the observation cues. Otherwise, he/she may observe unintentionally, which may hamper the objectives of the study.

For the purposes of the study, the researcher planned certain key criteria that were worked out to assist the observation process. The following questions assisted the researcher in developing cues and considerations for the observations:

- What is the nature of the perspectives that boys and girls display towards the effective learning of technological concepts?

- What experiences lead to the development of certain perspectives between boys and girls?

- How do boys and girls deal with societal expectations of advancement in technology?

- How are boys and girls affected by societal expectations of learning technological concepts?

- To what extent do boys and girls show determination by using different methods to succeed in learning technological concepts?

- What is the level at which boys and girls exert effort to overcome certain difficulties that emanate from the long list of concepts and practical assignments that they are expected to complete per study unit?

The interview questions were changed into observation cues. In other words, traits, such as attitudes, body language, behaviour and perspectives were easy to determine through the cues that indicated the information required. Where the interviews required information about the participants' perspectives, the observation cues elicited data about the attitudes that underpinned them. Hence, data triangulation took place because more than one method of data collection was used.

3.4 POPULATION AND SAMPLING

3.4.1 Population

The population of the study was grade 7 Senior Phase learners of five primary schools in the Ermelo Sub-District of Gert Sibande District that also comprises the Sub-Districts of Eerstehoek and Evander. The Gert Sibande District office is housed in the Ermelo Sub-District, which comprises diverse schools, ranging from quintiles 1-5. The quintile system places schools in a ranking order that the DBE uses to classify them in terms of the socio-economic status of both the area and the learners' parents (DBE, 1996). In terms of this classification, schools at quintile 1 need 100% funding, and the criteria continues until it reaches quintile 5 that does not need any funding from the DBE. The quintiles guided the constitution of the population. Moreover, it was the basis for the selection of the sample, as the diverse socio-economic issues that characterise the area of the study were considered.

A population of a study is the entire body of the research focus from which samples or a sample could be drawn, depending on the nature of the study (Maree, 2016). In other words, a population consists of all the relevant elements of the study (Fowler, 2014: 4) as well as all the individuals or units of analysis that relate to the aim and purpose of the research inquiry (Maree, 2016). A target population is the whole body of the research that encompasses all the potential units of analysis from which the population and then the samples could be drawn (Bhattacherjee, 2012).

Hanlon and Larget (2011:5) view a population as the object of a study that consists, for example, of individuals, groups of people, an organisation or a programme relating to the topic of the study. Moreover, a population could be a group of elements, cases, events and programs that conform to specific criteria, and enable the researcher to generalise the research results (Heffner, 2017). Essentially, a population is made up of all the characteristics and factors that are relevant to the aim and objectives of a study.

3.4.2 Sampling and sampling procedures

The sample of this study comprised ten participants who were interviewed and observed to ascertain how they viewed and learnt technological concepts. To draw this sample effectively, an equal number of learners were drawn from schools in the five quintiles of Gert Sibande Education District as described in 3.4.1 above. In other words, two learners were sampled from each quintile, i.e. 2x5=10 participants. Essentially, an equal number of boys and girls were sampled across the five quintiles so as to neutralise possible biases. Moreover, in the literature review, it emerged that boys and girls are biologically different, but socialisation and cultural expectations have a major role in what becomes of their cognitive abilities in the academic world (Chan & Cheung, 2018). Thus, it was important to sample both boys and girls so that a clear and vivid picture could emerge. The schools' records (promotional schedules) of previous performances were utilised, as they bear information of learners' academic performance for current and past years.

The above selection was informed by the aim of the study, which was to understand the perspective of boys and girls on studying technological concepts. In this way, the purposive sampling procedure assisted, as participants were chosen for an objective in line with the general aim and purpose of the study (Leedy & Ormrod, 2013). As stated in 3.3.2.1 above, the previous performance of learners in Technology was considered. To that effect, learners who achieved 70% and above, those who achieved between 40% and 69% and those who achieved below 40% were selected. To be precise, two boys and two girls who achieved above 70%, two boys and two girls who achieved between 40% and 69% and one boy and one girl who achieved below 40% were selected as respondents.

The sample described above was selected by means of purposive sampling, which is an intentional identification of participants based on their potential to elicit the required and specific themes, concepts, traits, information and data about the phenomenon being investigated (Edwards & Holland, 2013). Welman, Kruger and Mitchell (2007:69) posit that purposive sampling is relevant when a researcher uses his/her experience of the unit of analysis to study the phenomenon. As the focus of this study was the perspectives of boys and girls in learning technological concepts, the researcher used his experience of learners' performance based on previous records to come up with the sample for this study.

Among other important factors for the successful completion of a research inquiry, the research approach and methodology, the aims/purpose of the study and the size of the population are important ingredients that inform the choice that the researcher needs to make about the size of the sample to be involved in the study (Maree, 2016). Accordingly, a sample of a study is defined as a subset of a population that gives a researcher an opportunity to study a limited portion of it so that an understanding about the entire population can be gained (Alvi, 2016). Usually, it is difficult and practically impossible to study the entire population, but a subset of it could be studied so that generalisations can be made, thus enhancing understanding of the phenomenon relative to the entire population (Alvi, 2016).

Sampling, therefore, does not happen aimlessly, as there are procedures that need to be followed for the correct sample to be chosen. To that effect, there are different procedures and types of sampling involved in a study, which should help the researcher reach an informed conclusion about the phenomenon under scrutiny (Alvi, 2016). A researcher needs to choose either probability or non-probability sampling procedures, depending on the nature of the study and the unit of analysis involved. In probability sampling, the subjects of the inquiry have an equal chance of being part of the sample, whereas in non-probability sampling, there is no chance that the whole population could be part of the unit of analysis (Surbhi, 2016). These two types of sampling procedures are discussed below.

3.4.2.1 Probability Sampling

If a researcher uses a sample based on the whole population having an equal chance of being selected, he/she would follow a probability sampling procedure (Maree, 2016). In other words, this sampling procedure would apply if the sample were representative of the population in all respects (Leedy & Ormrod, 2013). Thus, the probability sampling procedure would not jeopardise the outcome of the study, even if it meant that any number of participants were to be chosen. In fact, these participants would all represent the characteristics in which the researcher is interested. Moreover, all the samples would stand a chance of being selected and, if that happened, the study would not lose its validity and reliability, as the characteristics of interests are shared by all of them. Therefore, if the samples were randomly selected, the purpose and the aim of the research would not be thwarted.

Probability sampling is essentially based on the concept of the random selection of respondents, which requires some control so that all elements are given a zero chance of being selected (Maree, 2016). In this way, there is no single element of the population that is better off than the rest, as all of them have a zero chance of being selected.

In the study, however, the researcher did not make a random selection of participants because the nature of the study did not allow for that. For example, an equal number of boys and girls had to be selected. Moreover, the researcher had to consider the five quintiles of the South African school system. Clearly, choosing respondents in line with this requirement made it impossible for the researcher to consider the randomisation of participants for selection purposes.

Since this study did not use probability-sampling procedures, the researcher will not discuss them in this chapter. Nevertheless, there are different types of probability sampling procedures available. According to Showkat and Parveen (2017), the following are examples of probability sampling procedures:

- Simple random sample
- Stratified random sample

- Systematic sample
- Cluster sampling

In the study, the probability sampling procedure was not used because not all learners in the district had an equal chance of being selected. Hence, the researcher adopted a non-probability sampling approach. The different types of non-probability sampling procedures are discussed below.

3.4.2.2 Non–Probability Sampling

Unlike probability sampling, non-probability sampling (hence, its name), means that not all the elements of the population have a chance of being part of the sample (Showkat & Parveen, 2017). In other words, certain elements may be selected for choosing the participants based on particular criteria. Thus, a researcher is guided by a set of criteria to determine the suitable sample. Only the elements of the population that are required determine the selection, in which a researcher plays a pivotal role. There is no provision for an element of chance in the selection of the samples, which means that a researcher does not use what the numbers have indicated as a relevant sample. Numbers are not allowed to determine the course of events in so far as sampling is concerned (Leedy & Ormord, 2013). Rather, a researcher determines the sampling procedure in the interests of the aim of the study and focuses his/her attention on the elements of the population that are relevant to the study being undertaken. As a result, not all the elements of the population have an equal chance of being selected as a sample. The following are techniques that are applicable in non-random sampling procedures:

- **Accidental sampling**

Accidental sampling is regarded as the most convenient procedure for efficient and fast sampling, depending on the nature of the population and the aim of the study (Showkat & Parveen, 2017). In this sampling procedure, the researcher chooses samples according to their convenience. In other words, the researcher chooses participants who are readily available for purposes of the research. Practically, the researcher would not choose a participant who stays far from the area being researched, which would be the case if the researcher used convenience sampling.

Rather, participants who live near the area of the research would be chosen, provided they meet the criteria (Etican, Musa & Alkassim, 2016). Etikan et al. (2016:2) often refer to accidental sampling as convenience sampling because of the convenience of selecting the samples. This sampling procedure could not have worked for purposes of the study, as the researcher had to come up with a sample that was difficult to select with the aid of accidental sampling. The researcher did not rely on luck or convenience in choosing the elements of analysis. Rather, a more direct approach was used, as boys and girls in schools belonging to different quintiles were to be selected.

- **Convenience sampling**

In convenience sampling, the researcher does not use a scientific approach in selecting the sample, and it was relatively easy to do this (Showkat & Parveen, 2017). Etikan et al. (2016: 2) posit that this sampling procedure does not involve the haphazard selection of cases. Only the cases that a researcher is interested in are selected for the purposes of the study. In this sampling procedure, the elements of interests are easiest to select (Leard, 2012). This sampling procedure is convenient to conduct, and the samples are convenient to gather or select. In other words, a researcher does not have to battle or struggle because only the convenient samples will be selected for the study.

In the study, the researcher was interested in the perspectives of boys and girls in studying or learning technological concepts. The researcher, therefore, had to use a different approach, as convenience sampling would have led to biased samples, which may have affected the outcome of the study. An equal number of boys and girls according to the quintiles had to be selected. Therefore, the criteria that had to be considered made it impossible for a convenience sampling procedure to be used.

- **Snowball sampling**

Waters (2014: 367) views snowball sampling as a procedure that researchers use to access difficult populations. Moreover, this type of sampling enables a researcher to study a very sensitive matter that requires an intermediary to access the samples (Waters, 2014). Welman et al. (2007: 69) maintain that snowball sampling takes place in instances where a few individuals from the relevant population are approached to act as informants and to identify people from the same population for inclusion in the sample. In the study, the researcher selected the samples because they met the requirements of certain criteria, i.e. an equal number of boys and girls representing quintiles 1-5.

The researcher did not send a representative to select the samples. As a result, the snowball sampling procedure was not used in the study. The researcher interacted directly with the respondents, and the samples were selected in line with the purpose and the aim of the study.

- **Self-selecting sampling**

Self-selecting sampling procedures allow participants to choose voluntarily to be part of the study as elements of analysis (Leard, 2012). In other words, participants are at liberty to elect to participate, if they are affected by the phenomenon under investigation. In the study, participants did not choose to participate; instead, the researcher played a pivotal role in selecting them. The criteria were the only considerations in coming up with the sample.

- **Quota sampling**

In quota sampling, participants are selected according to the categories in which they find themselves (Leedy & Ormrod, 2013). In addition, a researcher can conveniently, choose any participant as long as he/she fits into the categories in which he/she is interested (Maree, 2016). In other words, a researcher uses his/her knowledge of the participants to select the desired ones. If all the categories are represented, he/she will select any participant in ways that suit him. In this sampling procedure, there is no randomisation of participants for selection purposes. A researcher goes into the research space with certain information that he/she will use to identify potential participants.

In the study, the researcher could not use quota sampling as boys and girls in different quintiles were involved. Moreover, not all learners, regardless of their subjects, were potential participants. Only those who did Technology were the subject of inquiry.

- **Purposive sampling**

In purposive sampling, a researcher uses his/her previous knowledge of the participants to select suitable ones for purposes of the inquiry, provided they fall within the criteria that guides the selection process (Maree, 2016). In simpler terms, a researcher selects participants with a particular purpose in mind. Only those that meet the criteria are selected. In the study, the selection was based on the criteria of boys and girls from quintiles 1-5 who were studying Technology as one of the subjects offered at the Senior Phase of the South African school system.

Essentially, the sample of this study consisted of ten participants comprising five males and five females. Therefore, an equal number of learners were drawn from schools in the five quintiles of the Gert Sibande Education District. In simpler terms, two learners were selected from each quintile. Therefore, the purposive sampling procedure was used as it met the requirements of the study.

3.5 TRUSTWORTHINESS OF THE STUDY

In quantitative research, validity and reliability are the mostly used measures of determining the trustworthiness of a research study (Maree, 2016). One of the aims is to determine the reliability of the items that would be used in the study and to determine the validity of the outcomes of the research. In qualitative research, the researcher is required to determine the trustworthiness of the research processes. Trustworthiness is a measure that researchers use to determine the credibility, transferability, dependability and confirmability of the entire research process (Maree, 2016). Korstjens and Moser (2018:121) agree with that definition but add reflexivity as a criterion against which the trustworthiness of a study could be assured. In simpler terms, trustworthiness deals with the extent to which the whole process could be trusted. In other words, trustworthiness answers questions about the procedure, including the research design; data collection and analysis approaches; the nature of the findings; conclusions and recommendations. If the research process followed the applicable procedures of conducting a qualitative research, the outcomes may be regarded as trustworthy or possessing a certain degree of trustworthiness.

In the context of the study, the researcher sought to determine the perspective of boys and girls on studying technological concepts. If the process and procedures were flawed, the outcome of the study might be questioned and rejected. It is important, therefore, that checks and balances are made so that a study yields trustworthy outcomes and ensures transferability. If the trustworthiness of a study has not been determined, the findings may pose challenges in implementation, as they may not be credible; therefore, they would be worthless.

To ensure the trustworthiness of this study, the researcher used the criteria discussed below:

3.5.1 Different types of trustworthiness

- **Credibility**

Credibility seeks to understand the extent to which the results represent reality (Maree, 2016). In other words, this type of trustworthiness addresses the uncertainty surrounding the results of any qualitative study. There has to be relevance and truthfulness in the manner in which the study is carried out and in the outcome following the inquiry. In agreement with the above, Korstjens and Moser (2018:121) view credibility as the degree of confidence that could be placed in the truth of the research findings. Credibility, therefore, establishes whether the research findings represent believable data derived from the participants and whether whatever is processed represents the original perspectives of the participants' interpretation of the phenomenon under investigation.

To ensure the credibility of the study, the researcher was engaged with the participants for a considerable time. The semi-structured interviews and observations needed the researcher to spend time with the participants. This included the initial visit when the researcher introduced himself and indicated the purpose of the research study. The permission from the Mpumalanga Department of Education was used to make sure that the learners felt unrestricted and that they cooperated during the study. Moreover, the researcher involved them in the development of a suitable schedule for the study. The ethical issues were also addressed to ensure that they felt safe and that they participated of their own freewill. The fact that the planned outcome of the research was to derive data in order to assist South African learners with the learning of technological concepts was explained to the study participants. Additionally, the researcher indicated to them that they were allowed to withdraw from the study if they felt uncomfortable with the process.

The researcher also familiarised himself with the schools' surroundings (climate and atmosphere) to test for misinformation in order to build trust and be able to generate rich data about the phenomenon. The researcher further observed the environment to determine characteristics or factors that were relevant to the statement of the problem to limit the study focus to issues that mattered the most. The use of both interviews and observation cues enabled the researcher to derive rich data from different perspectives and angles. Data derived in this fashion assisted the researcher in classifying common aspects and in discarding differences so that the perspectives of learners on technological concepts could be better understood.

Moreover, the use of interviews and observations ensured data triangulation, which made them more trustworthy. According to Korstjens and Moser (2018:121), triangulation refers to the usage of multiple data sources that could spread over a period in different settings or contexts involving different people. In the study, the researcher used observation cues at different times with the aid of a timetable (schedule). The observation cues were derived from the main question and sub-questions, and the outcome of the observation was recorded. The researcher recorded the outcome of the observation exercise so that nothing was left to chance. In addition, the researcher conducted semi-structured interviews with the same respondents so that their perspectives could be heard. An audiotape was used to record the proceedings, and a comparison was made between the data collected through the two data collection mechanisms. The data were characterised through the usage of codes by means of which similar pieces of information (from the observation and interview results) were grouped together so that patterns could be identified for conclusions to be reached.

- **Transferability**

The researcher also ensured the transferability of the study by making all that took place available for use by anyone who interested in the study. In this way, the researcher was transparent and laid bare everything that went on in the study.

Transferability depends on inviting other researchers in the field to determine points of convergence or divergence in understanding the elements of the study (Maree, 2016). In qualitative studies, a researcher depicts the phenomenon in ways that will prompt the reader of the research document or other researchers to draw their own conclusions about the phenomenon under investigation based on the conditions that have been clearly explained (Maree, 2016). This means that the reader or researcher can make his/her own inferences about what the researcher has found through the inquiry. Research is not necessarily only about the expressions made by the respondents, nor is it only about their behaviour; it is also about the context in which they occur. However, they are vital because they provide valuable information that other researchers or scholars may utilise when they replicate the study (Korstjens & Moser, 2018).

As explained in sections 3.4.1 and 3.4.2, the population of the study comprised grade 7 learners of five primary schools representing quintiles 1-5, in the Ermelo Sub-district of the Gert Sibande Education District. The schools selected for the study included 2 former model C schools and 3 township schools. These were Ellis Combined School (former model C, quintile 4); Elmira Primary School (Former model C, quintile 5), Bayethe Primary School (township school, quintile 3), Calokuhle Primary School (township primary school, quintile 1) and Wellington Primary School (township primary school, quintile 2).

The promotional schedule of the previous year was used for the selection of the participants. The focus was their performance in Technology. The study did not concentrate on the overall performance of the learners. Concentrating on the overall performance may have presented challenges, as the researcher would have been required to extend the focus and scope of the research. Those that failed are usually found in previous grades, and the management of that was going to be difficult, thus compromising the trustworthiness of the research. The DBE (2011b: 23) uses the NPPPR for grades 7–9 as follows:

Table 3.1: Promotion requirements for grades 7–9

PROMOTION REQUIREMENTS FOR GRADES 7–9
• Adequate Achievement (Level 4) in one language at Home Language level. • Moderate Achievement (Level 3) in the second required official language at First

Additional Language level.

- Moderate Achievement (Level 3) in Mathematics.
- Moderate achievement (Level 3) in Life Orientation.
- Moderate Achievement (Level 3) in any three (3) of the following subjects:
  - Natural Science
  -Technology
  - Social Sciences
  - Creative Arts
- A learner may only be retained once in the Senior Phase in order to prevent the learner being retained in this phase for longer than four years.
- A learner who is not ready to function at the expected level and who has been retained in the previous phases for four (4) years or more and who is likely to be retained again in the third phase for four (4) years or more, should receive the necessary support in order to achieve an appropriate level of competence in order to progress to the next grade.

Based on Table 3.1 above, a learner may be promoted if he/she fails at least two subjects from the category of the “other subjects” of the Curriculum and Assessment Policy Statement (CAPS), National Curriculum Statement (NCS), in the South African schooling system (DBE, 2011b). Moreover, a learner may not be retained in the phase for a period longer than four years. A learner who fails for the second time is progressed to the next grade. It means a learner is allowed to fail only once in that phase. Progressed learners are those that have actually failed, but because they have failed a second time, they are progressed to the next grade or phase and that happens once in a phase (DBE, 2011b). Promoted learners are those who have actually met the pass requirements to be in the next grade or phase (DBE, 2011b)

If a learner fails Technology, for example, that learner may be promoted to the next grade provided the minimum requirements for the other subjects have been met. The promotional schedule of the previous year has the information about learners’ performance in the previous grades. Therefore, the researcher was able to select learners who had failed Technology and those who had passed it. These learners were sampled as explained in section 3.4.2 in this chapter.

Table 3.2 below was used for selection of learners according to the achievement levels. The research selected from the learners who had achieved above 70%, between 40% and 69% and 0% to 39%. This was done so that the learners’ performance was evenly spread across the 7 levels. Some levels were joined as they were related and could be classified in terms of poor, mediocre and high achievers.

Table 3.2: Scale of achievement for the national curriculum statement grades 7 – 9

ACHIEVEMENT LEVEL	ACHIEVEMENT DESCRIPTION	%
7	Outstanding Achievement	80 – 100
6	Meritorious Achievement	70 – 79
5	Substantial Achievement	60 – 69
4	Adequate Achievement	50 – 59
3	Moderate Achievement	40 – 49
2	Elementary Achievement	30 – 39
1	Not Achieved	0 – 29

As stated above, the researcher worked with two groups, i.e. groups 1 and 2. Table 3.3 below represents the two groups.

Table 3.3: Classification of learners for purposes of selection

Group 1	Group 2
• 2 learners who achieved above 70% (1 boy and 1 girl) • 2 learners who achieved between 40% and 69% (1 boy and 1 girl) • 1 learner who achieved below 40% (1 girl)	• 2 learners who achieved above 70% (1 boy and 1 girl) • 2 learners who achieved between 40% and 69% (1 boy and 1 girl) • 1 learner who achieved below 40% (1 boy)

This selection was done because the researcher wanted to cover all possible performance ranges, i.e. poor, mediocre and good. Selecting participants in this fashion allowed for the consideration of different perspectives and attitudes. Learners who performed poorly in the previous grade would have a different attitude and perspective on learning technological concept than those of a learner who excelled in the subject. They would also have used different approaches in learning technological concepts. Moreover, the experiences, self-efficacy, cognition and metacognition underpinning their different approaches to learning technological concepts would not have been the same.

As stated above, an interview session lasted for an hour; moreover, interviews were conducted over the period of a week, and another week was used for the observation exercise. The same learners were used for both interviews and observations. The use of both methods ensured data triangulation as discussed above.

As the researcher had used the purposive sampling approach, he was able to identify participants that suited the criteria directly, as explained above. To that effect, the promotional schedule was used to select participants according to the performance in line with the requirements stipulated in the DBE's NPPPR document. According to Edwards and Hollards (2013:40), purposive sampling is the intentional identification of participants based on their potential to elicit required/specific themes, concepts, traits, information and data about the phenomenon being investigated. This sampling procedure was discussed in Section 3.4.2.

- **Dependability**

Dependability refers to the extent to which the research approach and outcomes have helped the researcher to arrive at an appropriate correct or dependable outcome of the inquiry (Maree, 2016). A researcher could ask the following questions to evaluate the dependability of the research:

- Is the outcome credible or are the results and methods used credible for the outcome attained?
- Is the study really undertaken and is it something of value to the development of the knowledge economy?
- Could the study be used to deal with the issues it raises?
- Could the study be regarded credible in terms of its methods, population and samples, philosophy and methodology adopted?
- Could the outcome be dependable for the outcome it has arrived and the realities it depicts?
- Could other researchers arrive at the same conclusion if they were to carry out the research?

Based on the above questions, dependability refers to the trustworthiness of the study and its findings (Maree, 2016). If the above questions could be answered with certainty, the study could be considered dependable. If the answers lead to doubt about the dependability of the study, then it cannot be considered trustworthy.

Dependability also refers to the stability of findings over a period if a study were to be undertaken under similar conditions (Korstjens & Moser, 2018). The evaluation of the veracity of the study could be done by other researchers in the field or any scientist who has an interest in the research. Thus, dependability also relies on participants' evaluation of the findings, interpretation and recommendations that should be supported by the data derived from the participants (Korstjens & Moser, 2018; Maree, 2016).

Korstjens and Moser (2018: 123) posit that a researcher should keep a record of everything he/she has done throughout the process to ensure the dependability of a study (Maree, 2016). For example, the record could indicate how data was collected, interpreted and processed to arrive at the conclusion formulated by a researcher. In essence, this involves keeping records of every step that a researcher has undertaken throughout the process (Maree, 2016). This would ensure transparency, and any person who might aspire to replicate the study would know how it was actually executed (Maree, 2016).

To ensure dependability, the researcher recorded every step undertaken in the execution of the study. He made notes of every step, including the proposal, its approval, letters of consents, the schools involved, the interview and observation schedules, the formulation of codes and categories for data analysis, the literature studied, the usage of data collection instruments, the actual data collected, the analysis and the presentation of findings. A paper trail is available on how the entire study was carried out. Therefore, any person who reads the notes would be able to know how the study was conducted, which obstacles were encountered and how the researcher overcame them.

- **Confirmability and Transparency**

The detailed record of everything that the researcher did can be accessed by anyone who has an interest in the study. There were no hidden processes and the participants were involved with the study of their own volition. Notes giving a detailed account of all the steps of the processes and the hurdles the researcher went through were kept. Furthermore, these provided hints about certain key aspects of the study. In fact, this research report elucidates everything in a transparent and verifiable manner. Any person who wishes to verify or replicate the study will not struggle as everything is explained in a detailed but succinct manner. There was a high degree of transparency in the manner the study was carried out.

Confirmability is the degree to which the findings of the research study could be confirmed by other researchers or anyone who has an interest in it (Korstjens &

Moser, 2018). It, therefore, concerns itself with the veracity of data collection, analysis and interpretation leading to conclusions (Korstjens & Moser, 2018). The researcher's record of everything that was done in the study serves to confirm that the study was indeed carried out, and it is not a figment of the researcher's imagination. Any person or other researchers could use the record to verify the authenticity of the whole process.

3.6 DATA ANALYSIS PROCEDURE

3.6.1 Understanding data analysis

Data analysis involves the mechanisms and approaches that a researcher could use to operationalise the collected data in ways that reveal certain patterns for the necessary conclusion to be reached about the phenomenon under investigation (Peersman, 2014). It refers to the way the collected data is be analysed to answer the research main question and sub-questions and to meet the objectives of the study (Maree, 2016). In the study, the interview questions were administered to ten respondents as explained in section 3.4.2 above. Moreover, these participants were observed while studying the technological concepts in their normal classrooms. The ideas behind the two data collection mechanisms, i.e. observation and semi-structured interviews were explained in Section 3.3.3.1, 3.3.3.2 above. For recording the proceedings of the interviews, the researcher used an audiotape. Consent for its use was sought and no participants were forced to accept its use. The observation procedure was recorded in line with the observation cues that sought to direct the researcher towards specific issues as derived from the research questions and the objectives of the study.

Earlier, we indicated that the study was based on qualitative research approaches, particularly as it followed a case study research design. Therefore, the researcher used inductive reasoning in order to process and operationalise the collected data. An inductive approach starts with an observation of the current occurrence to arrive at a conclusion about the phenomenon that is being researched (Leedy & Ormrod, 2013). In contrast, a deductive approach starts with assumptions or pre-established beliefs about the phenomenon under study, leading to conclusions or generalisations about it (Maree, 2016). Thus, wrong conclusions about the phenomenon being investigated might be reached, which negatively affect the phenomenon being studied. Moreover, false impressions may be given, which minimises the veracity of the study and jeopardises its trustworthiness.

Therefore, the researcher used inductive content analysis that works well with data related to communication and observations (Elo, Kääriäinen, Kanste, Pölkki, Utriainen, & Kyngäs, 2014). Inductive content analysis requires a researcher to focus on the pieces of content underlying the phenomenon that is being investigated (Leedy & Ormorod, 2013). In other words, key words related to the phenomenon being studied are determined. For example, if a researcher wants to extract data about the perceptions of boys and girls on studying technological concepts, the content of the respondents' answers to questions would contain pieces of information based on the views of the different genders on learning technological concepts. This information would be divided into categories so that the learners' overall perceptions on the concepts are revealed. Moreover, the number of concepts, for and against, would then be counted so that the perspectives are clear.

In the study, the researcher essentially reduced the collected data into concepts that underpinned the perspectives that were displayed in relation to the interview questions and the observation cues. Thereafter, these concepts were categorised to formulate a conceptual map or pictorial pattern of the data (Elo et al., 2014). Therefore, inductive content analysis involves the preparation or description of data; the identification of characteristics; the organisation and coding of the depicted data traits; the classification and categorisation of these traits; and the reporting of results or the description of the patterns that the data reflects (Leedy & Ormrod, 2013).

In the study, the researcher coded the participants so that each trait could be associated to its rightful respondent, thus avoiding duplications. The answers to the interview questions were further explored for themes that were used to classify the responses according to their content. The same procedure was followed when analysing the data from both the interviews and observation. The aim was to identify, classify, characterise and reveal common concepts for conclusions to be reached about the perspectives of boys and girls on learning technological concepts. This will be further discussed in Chapter Four.

In essence, data collected through both the interviews and observation techniques were classified, characterised, coded and processed to depict patterns from which conclusions were reached (Peersman, 2014). To do this, careful planning was done as the categories had to be properly arranged to avoid any potential for confusion. Therefore, the data was diligently and scrupulously handled and treated. Finally, a conceptual map of the categories was produced, through which reporting was done. The value of a conceptual map is to depict the evolving nature of the phenomenon and describe how certain conditions lead to certain actions or interactions, how those actions or interactions lead to other actions, and so on, with the typical sequence of events being laid out (Leedy & Ormrod, 2013).

3.7 LIMITATION OF THE STUDY

The study could not reveal all the perceptual challenges experienced by both boys and girls when learning technological concepts in the area of the study. For a perfect and accurate depiction of that, the whole population of boys and girls in the Gert Sibande Education District would have been studied. A study in that direction could take years to complete, as all the units of analysis would have to be extensively studied. Studying the whole population is practically and economically impossible if consideration is made of the number of schools in Gert Sibande Education District. The units of analysis are at school to be taught and not for scientific inquiry. Even if consent was sought from the parents of these learners, they could not be subjected to an extensive scientific inquiry. Moreover, the Gert Sibande Education District may not allow learners to spend extensive time in such a study. The principals of the sampled schools may not allow disturbance of teaching and learning time, as their prime aim is to teach these learners. Eventually, they become accountable for the performance of all learners in their schools. Failure because of a scientific inquiry may not be taken as a valid reason.

In addition to the above, in the afternoon, learners have extramural activities and their trainers would want them to be at the playing fields. Therefore, for a larger population, it could be practically impossible to do a scientific enquiry, as it could be extremely expensive to complete. It may also pose serious challenges to the sampled learners, as they could be disturbed in their normal learning routine.

Such a disturbance might not only affect the learners concerned but their teachers could also be affected, as some teaching time may be spent on this inquiry. Educators may also complain about the long periods of absence by the sampled learners. The researcher, thus, relied on the samples' focusing on all the five quintiles. For a picture to be derived of the perceptions of boys and girls on learning technological concepts in the study, the researcher sampled schools according to quintiles, i.e. quintiles 1-5 as explained in the section on sampling. These quintiles carry essential data about learners' socio-economic dimensions. Socio-economic data was important in yielding a balanced picture about the phenomenon under study. Without the inclusion of learners from different socio-economic strata, the outcome could have been biased, which might have prejudiced the outcome of a study.

3.8 ETHICAL CONSIDERATIONS

To ensure that ethical issues were at the forefront when conducting this study, the researcher did the following:

- Sought consent from the Director of the Gert Sibande Education District. This consent was used when the selected schools were approached

- Sought consent from the parents of the learners who were selected for the study

- Ensured that the participants were assured of the confidentiality of the whole process — assurance was given that no respondent would be prosecuted because of his/her participation in the study and that the outcomes were only meant for research purposes, nothing else

- Conducted the research process in environments (real-life settings) where the respondents felt free to participate — their usual working environment was used

- Lastly, consent was also sought from the University of South Africa, which ensured that the university's standard ethical considerations

3.9 CONCLUSION

In this chapter, the researcher discussed the following aspects of the research methodology of the study: the research philosophy; approaches; the research design; instruments for data collection; aspects of validity and reliability; and the sampling procedures. Having made sure that all the aspects of the study were covered meticulously, the researcher, however, could not claim 100% accuracy for the sampling procedures, data collection and analysis. However, a high degree of certainty was the aim. To that effect, all the elements of inquiry and data analysis were subjected to a process of ascertaining validity and reliability to enhance their trustworthiness, dependability, credibility and replicability.

Chapter Four will deal with the data analysis, discussion of findings and interpretation of the results.

CHAPTER FOUR

DATA COLLECTION, ANALYSIS AND FINDINGS

4.1 INTRODUCTION

As stated in line with Chapter Three, the researcher used both semi-structured interviews and observation techniques to collect the required data. The use of both mechanisms ensured data triangulation that leads to a balanced explanation of the phenomenon under study. In addition, it enabled the collected data to coalesce for the depiction of certain patterns from which inferences were made about the phenomenon under investigation (Edwards & Holland, 2013). The interview questions and observation cues were based on the same questions, but from different angles. On the one hand, the interviews mainly dealt with how the learners thought and reacted to technological concepts. The observation technique, on the other hand, focused on how they related to and felt about learning the concepts.

Thus, more than one source provided data about the same phenomenon, which enhanced the trustworthiness of the study (Baxter & Jack, 2014). One data source could not in all certainty have claimed to have exposed the dynamic nature of the phenomenon being studied, and the outcome of a study may not have assisted in a better understanding of the phenomenon in which the researcher was interested (Yin, 2014). Therefore, the use of interviews and observation techniques sought to collect data from different angles in relation to the topic of the study, which led to a clear and comprehensive understanding of the phenomenon. Consequently, the data sets from the two different sources complemented each other, and divergent meanings attributed to each contributed to a balanced view.

Therefore, each instrument had its unique way of eliciting the required data about the case being studied. Where one instrument did not reveal certain important aspects about the phenomenon, the other instrument disclosed them. For example, data collected through interviews could not on their own reveal reliable and salient data about the emotions expressed during the learners’ interaction with technological concepts (Jamshed, 2014). However, the observation technique helped the researcher to tap into these emotions (Jamshed, 2014), although it did not necessarily reveal data about learners’ views, thoughts, knowledge and perceptions concerning learning the concepts that could reliably be extracted through interviews (Cohen & Crabtree, 2006).

Data on the learners' emotions provided by the use of observation were needed to arrive at a complete picture of their perspectives on learning the concepts (Jamshed, 2014). Moreover, the researcher could not have been able to unearth valuable data about the respondents' attitudes and perspectives if they had not been asked questions (Van Teijlingen, 2014). Therefore, both data collection mechanisms assisted the researcher in discovering the true nature of the phenomenon under study.

To use both mechanisms effectively, the researcher drew up a timetable for the interviews with which the principals agreed. Moreover, as the study was not supposed to interfere with normal school proceedings, it was necessary for both the respondents and the principals of the schools to agree on the timetable. For the observations, the researcher developed an itinerary to which the respondents and the principals of the sampled schools consented. In this regard, the timetable table for the teaching of Technology was used. The researcher used normal teaching hours to observe the teaching and learning process. Necessary arrangements were made with all the key role players to ensure that the observations did not create discomfort or agitation on the part of both learners and the teachers affected.

4.2 DATA COLLECTION FROM SAMPLES

4.2.1 Data collected through interviews

As stated in Section 3.3 of Chapter Three above, data were collected through semi-structured interviews and observation techniques. The collection of data through these methods needed a structured approach. The researcher needed to drive to the sampled schools for both the interview and observations. The selected schools in the Ermelo Sub-district are close to each, which made it possible for the researcher to reach two of them per day. Each day was specifically reserved for the interviews of each boy and girl selected from the particular school that the researcher was visiting.

As stated above, an interview grid and observation cues were developed. Furthermore, an implementation schedule was negotiated with the affected schools and their learners. Table 4.1 below reflects how the data was collected from the participants when the timetable was finalised.

The researcher created codes for boy respondents as follows: BY1 (boy 1), BY2 (boy 2), BY3 (boy 3), BY4 (boy 4), and BY5 (boy 5). The codes for the girl respondents were as follows: GL1 (girl 1), GL2 (girl 2), GL3 (girl 3), GL4 (girl 4), and GL5 (girl 5).

In addition to the codes of the participants, the researcher classified the schools as S1 (school 1), E2 (school 2), QP3 (school 3) EP 4 (school 4) and TG 5 (school 5). It should be noted that, in terms of the learners' and the schools' codes, the following signified the learners together with their schools: Learners GL1 and BY1 were from S1; GL2 and BY2 from E2; GL3 and BY3 from QP3; GL4 and BY4 from EP4; and GL5 and BY5 from TG 5.

For the interviews, the schedule in Table 4.1 below was followed.

Table 4.1: Participants interview schedules

Participants	Grade	School	Date of Interview	Time
BY1	7	S1	06/05/2019	14h00 to 15h00
BY2	7	E2	07/05/2019	16h00 to 17h00
BY3	7	QP3	08/05/2019	14h00 to 15h00
BY4	7	EP4	09/05/2019	15h00 to 16h00
BY5	7	TG5	10/05/2019	14h00 to 15h00
GL1	7	S1	06/05/2019	15h00 to 16h00
GL2	7	E2	07/05/2019	15h00 to 16h00
GL3	7	QP3	08/05/2019	15h00 to 16h00
GL4	7	EP4	09/05/2019	14h00 to15h00
GL5	7	TG5	10/05/2019	15h00 to 16h00

The interviews questions were structured as shown in Textbox 4.1 below.

Textbox 4.1: The semi-structured interview questions

1. Explain your views and feelings of studying and learning technological concepts.
2. How do you deal with difficult concepts in Technology?
3. Has it ever happened that during learning, you decided to give up and how did you deal with that?
4. If you come across difficulties during learning technological concepts, how do you deal with them?
5. In which ways do your teachers assist you in dealing with the difficulties that Technology may pose?
6. Which strategies do you utilise in dealing with difficult parts of Technology?
7. How do you apply different learning approaches in effectively studying and learning technological concepts?
8. Explain the way your teachers influence your learning of Technology.
9. In your opinion, how do your parents motivate you in pursuing technological related careers?
10. Your community has different needs; do you think Technology could play a role in your community? Explain your views/feelings.

In addition to the codes given to the participants and the schools above, the researcher classified the schools in terms of their quintiles as follows: S1 is quintile 3, E2 is quintile 4, QP3 is quintile 2, and EP4 quintile 5 and TG 5 is quintile 1. The quintile system in the South African context refers to the ranking order of schools used by the DBE to classify them in terms of the socio-economic status of both the area that the school finds itself in and that of the parents of learners in attendance of the school (DBE, 1996: B-52). In terms of this classification, quintile 1 schools need 100% funding, and the criteria continues until it reaches quintile 5 schools that do not need any funding from the DBE. Table 4.2 below outlines the schools' classification according to quintiles.

Table 4.2: Schools classification according to quintiles

(Codes and classification) **Proposed codes after the schools' classification**
S1 [QNT 3]
E2 [QNT 4]
QP3 [QNT 2]
EP4 [QNT 5]
TG5 [QNT 1]

Appendix 1 contains the interview schedule followed by the researcher when engaging with the participants. During the data analysis, conceptual themes were used to categorise similar themes emanating from the responses of the interviews. The researcher counted the number of responses on each conceptual theme. The counting indicated the frequency of each concept (the number of times each concept was repeated). This data analysis approach helped the researcher to identify the patterns that the data revealed during processing. The data from the semi-structured interviews was then compared with the data derived through observation techniques.

4.2.2 Data collected through observations

Classroom observation had to take place during the Technology periods so that the learning process could be monitored. A schedule was then developed to conduct the observations. Table 4.3 below reflects the school's observation schedules followed by the researcher.

Table 4.3: Schools observation schedules

School	Grade	Period Number	Date of Observation	Time
S1 [QNT 3]	7	3	06/05/2019	10h00
E2 [QNT 4]	7	4	07/05/2019	11h00
QP3 [QNT 2]	7	5	08/05/2019	12h00
EP4 [QNT 5]	7	4	09/05/2019	11h00
TG5 [QNT 1]	7	2	10/05/2019	9h00

The observation cues were structured as shown in Textbox 4.2 below.

Textbox 4.2: Observation cues

1. How do the learners expend effort in dealing with technological concepts?
2. When they encounter difficulties, how do they deal with them?
3. How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?
4. Do they cooperate and work in groups, and how is the spirit of the groups?
5. Explain the state of learners' adeptness in applying various strategies in dealing with the learning of technological concepts?
6. Do they show resilience and persistence in the face of difficulties? Explain your answer.
7. What are the differences between boys and girls when they militate against difficulties arising from learning the technological concepts?
8. How do learners differ based on the quintiles?
9. How do socio-economic differences in learning technological concepts influence quintiles?
10. How does the family background influence the rate at which learners succeed in Technology?

Data collected through observations

The findings of the data collected through observation technique are contained in Appendix J. For the observation, the researcher used the conceptual themes related to the ones used for the semi-structured interviews to process the data. The conceptual themes were broken down to specific concepts that were used as cues for purposes of capturing and processing. Thus, the conceptual themes assisted the researcher in identifying areas of commonality and in isolating divergent perspectives for classification and characterisation. This assisted with the triangulation of data to be explained in section 4.3 of this chapter.

4.3 DATA ANALYSIS AND INTERPRETATION

4.3.1 Content analysis of data

Content analysis involves a process in which content or information about the phenomenon under investigation is organised in themes to enable a researcher to classify, categorise and code it for further processing (Brough, 2019). It is a process of representing information/messages/content emitted or elicited through different data collection mechanisms to gather common elements from the respondents views, opinions, perspectives, attitudes, and so on (Leedy & Ormrod, 2013). In Sections 4.2.1 and 4.2.2 above, the researcher presented the data elicited through semi-structured interviews and observation procedures based on the aims and objectives of the study. The main and the sub-problems also influenced the data collection process.

The data derived through interviews was recorded and written verbatim, whilst the information based on the observation cues was written in a summary form. The observation cues consisted of critical information derived from the observation exercise that was in line with the study focus. The observation cues enabled the researcher to jot down the observable conceptual technological themes during the teaching and learning of technological concepts. All these points formed the basis from which further analysis of data was made. This data was then operationalised with the aid of triangulation procedures so that common themes could be clearly visible for inferences to be made. Data that contained similar conceptual technological themes was put together, while those that differed were singled out so that comparisons could be made. This helped as it showed how most of the learners' view, feel, perceive and learn technological concepts. All this data had to be processed for meaningful patterns to be revealed.

In the analysis of data derived from the semi-structured interviews, the researcher used a table that consisted of columns containing information about the gender of participants, the conceptual technological themes that were exhibited and the quintiles of the schools from which the participants came. Codes were used to represent each participant. To that effect, each gender was given a unique code. For example, the letters BY and GL were used to represent boys and girls respectively. These codes were unique so that there would not be any confusion or duplication.

For the conceptual themes, the researcher used the key words of the main question and sub-questions to classify the responses. These key words also informed the development of the interview questions and observation cues. The conceptual technological themes that were used for the semi-structured interviews were as follows:

- Views and feelings of studying technological concepts
- The way difficult aspects of Technology are dealt with
- The extent to which participants persevere in learning technological concepts
- The way participants deal with difficult technological concepts
- The way teachers help learners learn the concepts
- The strategies that learners utilise in dealing with difficult concepts in Technology
- The use of different learning approaches in effectively studying and learning technological concepts
- Teachers' influence in learning Technology
- Motivation by parents to pursue technology-related careers
- The role of technology in the community

For each interview question, the researcher concentrated on the above conceptual themes in the participants' responses. The exhibited themes were then written in a column for purposes of tallies for triangulation. In this regard, common themes were made to coalesce for easy identification and calculation. This exercise was done for all the interview questions. At the end of the interviews, the researcher analysed and interpreted the responses. In the analysis section of this chapter, the conceptual themes constituting learners` perspectives on learning technological concepts are presented in tables and figures. To work out the qualitative total of each questionnaire, the researcher used the Excel computer program. The program was able to give a picture of the concentration of views, values, perspectives and perceptions in each questionnaire. The spread of the tallies based on the responses enabled the researcher to infer the meaning of the formed patterns. Consequently, the perspectives of boys and girls on learning technological concepts were determined.

The researcher did not only rely on the data collected through the semi-structured interviews. In Chapter 3, the researcher explained the rationale behind the use of two data collection mechanisms. Primarily, the data collected through semi-structured interviews needed to be checked against data collected through different mechanisms. To support or refute the findings made through semi-structured interviews, the researcher also used the observation techniques. This technique is explained below.

In addition to semi-structured interviews, the researcher used observation data collection mechanisms to collect the needed data. To that effect, observation cues were used, and they were based on the aims, objectives, main questions and sub-questions of the study. The main aim of the observation cues was to direct the attention of the research so that the study focussed on what mattered the most. Without observation cues, the researcher may have swerved away from the main conceptual technological themes of the study. To an extent, the observation cues used almost the same contextual themes as the ones used for the interview questions. In other words, what respondents said about their perspectives on learning technological concepts was either confirmed or refuted by the evidence of the observation exercise. The conceptual technological themes that were worked out of the observation cues are given below.

- The manner in which learners persist and expend effort in studying the concepts
- The manner they deal with learning difficulties
- Demonstration of enthusiasm when they face difficulties
- The use of group work or collaborative learning strategies
- The use of different strategies in learning the concepts
- Their resilience and persistence
- The differences between boys and girls in learning the concepts
- The role of quintiles

- The role of the learners' socio-economic conditions in learning the concepts
- The role of the family in learning Technology

To actually derive and package the evidence of the observation cues, the researcher used a pen and paper to jot down what was exhibited during the learning of the technological concepts. The observation schedule in 4.3 was followed and all the identified quintiles were accommodated. In the actual observations, the researcher was guided by the conceptual themes elucidated above. Practically, the researcher allowed the free flow of the learning process and observed the whole process of learning while the important aspects are jotted down. In this regard, the researcher tallied common conceptual technological themes and isolated divergent conceptual technological themes for patterns to be revealed. Once the patterns were revealed, the researcher drew inferences about how the learners learn technological concepts based on the technological conceptual themes.

The way the researcher processed the data is shown below.

4.3.1.1 Findings from structured interviews

The findings from semi-structured interviews are presented below. Notably, the interview question is stated first, followed by a table that details the gender of the participants, the conceptual themes, and quintiles of the participating school. A summary of the findings and the figure that represents them are below the table.

Q1: Explain your views and feelings in studying and learning technological concepts.

Table 4.4 below reflects the conceptual technological themes formulated from the participants responses to Interview Question 1.

Table 4.4: Explain your views and feelings in studying and learning technological concepts.

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Enjoy for information it gives
BY1		Enjoy for careers
	GL2	Nice to know stuff
BY2		It helps in careers
	GL3	Interesting because the teacher is nice
BY3		Interesting as it makes life easier as career opportunities are availed.
	GL4	Like it as it helps with careers
BY4		Like it as it gives more information about available careers
	GL5	Like it as it provides information about different jobs
BL5		I like if for the careers it provides

In Question 1, the respondents were asked to explain their views and feelings in studying and learning technological concepts. Based on Table 4.4 above, 1 out of 5 girls indicated that she liked Technology because the Technology teacher was nice. Probably, the niceness of the teacher also helped her with information regarding the various career that Technology could provide. This could be associated with the fact that the teacher's behaviour was liked by the learners, and they would want to act out or replicate the behavioural traits that the teacher displays. Based on that, the learners might have emulated how the teacher displays the learning content. For example, learners may have been able to understand what was involved in certain experiments. This could be the case because the steps could be lucidly seen while the teacher was presenting or demonstrating. Those steps could be iterated leading to their mastery, and that could be called effective learning. According to behaviourism, a learner follows a stimuli and reinforcements. (Mechlova & Malcik, 2012: 47).

Four out of 5 girls indicated that they love Technology because of the technology-related careers to which they may be exposed. Clearly, even here, learners seemed to be encouraged by external stimuli that may have had potential benefits to them later on in life. The eventual benefits may have urged them to exert effort and grasp the content contained in the ATP. In other words, learners may have then used deeper learning approaches to understand the technological concepts. That may have included the utilisation of previous knowledge to process incoming content as espoused by the cognitive theory of learning (Mechlova & Malcik, 2012). According to Mechlova and Malcik (2012: 41), information processing requires, inter alia, that the learner use his/her cognitive learning skills that include the formation of schemata with which the new content could be matched for better understanding. The advantage of this learning approach is that learners eventually develop some form of understanding of the concepts in the subject. They will do this, because they are interested in the careers that they may pursue if the content is well processed. Therefore, in the study a combination of behaviourism and information-processing learning epistemological approaches seemed to be utilised for the learning of some technological concepts.

In an almost similar way, 5 out of 5 boys indicated that they loved Technology because of the number of technology-related careers it provides. Thus, the learning of technological concepts was enhanced by the value the subject held for them. In other words, relatively more boys may have resisted and contended with the pressure that came with the learning of the concepts in Technology, precisely, because they saw value in the subject. As a result, various modes, strategies, and approaches might have been utilised to contend with the subject, even if difficult aspects were dealt with. This would have included the usage of different learning techniques as discussed in Chapter Two. Despite the marginal difference between them, both boys and girls in the study viewed Technology as a gateway subject towards numerous technology-related careers. The gender difference was minimal, and it could be concluded that both genders learnt the subject because of the perceived career value it possesses.

Figure 4.1 below is a graphical representation of the findings of Interview Question 1.

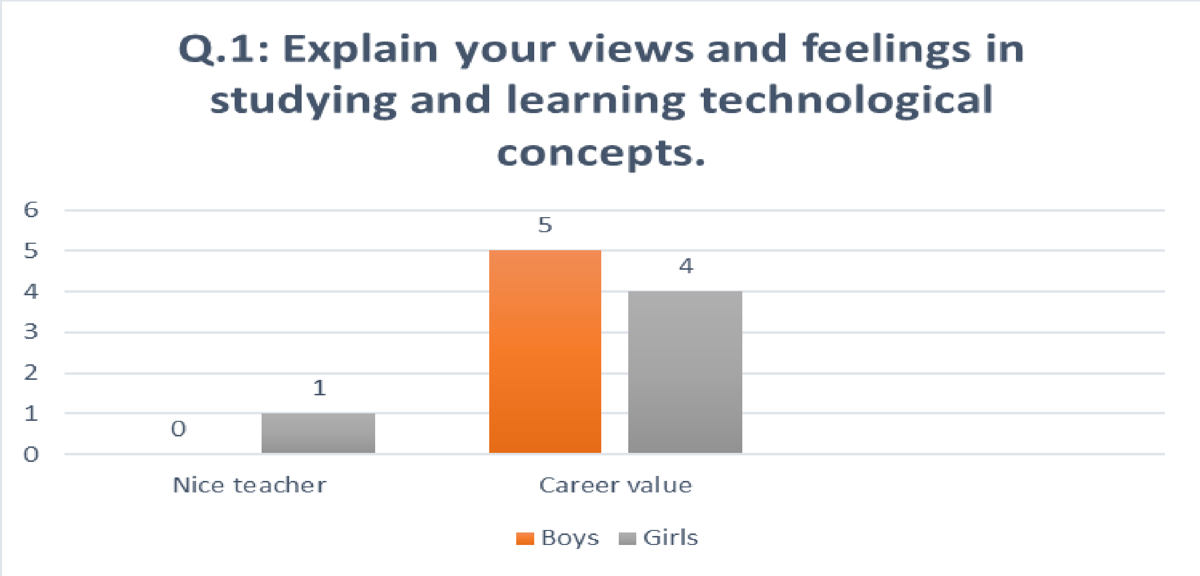


Figure 4.1: Views and feelings in studying learning technological concepts

Based on Figure 1, more boys than girls seemed to study the technological concepts because of the career-related value that the subject could provide. In other words, boys seemed to learn the concepts because of the value the subject possesses. However, the difference between boys and girls on this question was not huge and that means they did not markedly differ in their volition and attitudes in studying the concepts. They generally studied the concepts because of the value the subject holds in the world of work, which would have influenced the attitudes and perspectives they had developed overtime towards learning the concepts in the subject. However, this finding seems to confirm the view that males are groomed to follow technology-related subjects due to patriarchy or the expectations of society that seem to favour boys over girls (Muller et al., 2014; Ardies et al., 2015a; Leahy & Phelan, 2014; Udousoro, 2012; Gasant, 2011; Jensen-III, 2015; Cook & Cook, 2014). There could be girls that view Technology as a subject that opens doors for technology-related subjects, but the interest with which they view it is not like the one that boys demonstrated in the study. It should be noted, however, that the difference between boys and girls in this finding was minimal and this confirms the opinion of Ardies et al. (2015: 34a) who posit that there is no direct correlation between learners' attitudes towards technology-related subjects and gender attributes.

According to Figure 4.1 above, all boys viewed their subject “Technology” as being valuable for technology-related careers, and this cut across all the quintiles. In fact, the majority of these learners, i.e. boys and girls, seemed to like and enjoy Technology because of the prospective careers that the subject could open for them. Moreover, there was no marked difference between boys and girls from the different quintiles. Out of the ten respondents, only one provided a reason that seemed to be related to the character of the Technology teacher. This finding indicates the value of modelling and identification with a model as espoused by behaviourism, which was explained in Chapter Two. It could then be concluded that no significant gender differences existed between the boys and girls in the way that they felt about Technology and the career value it has (Ardies et al., 2013b).

Q2: How do you deal with difficult concepts in Technology?

Table 4.5 below reflects the themes formulated from the participants responses to Interview Question Two.

Table 4.5: How do you deal with difficult concepts in Technology?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Seek help from teachers
BY1		Study at the library until it makes sense
	GL2	Break it down for understanding
BY2		Ask teachers for help
	GL3	Teacher explains
BY3		Ask questions
	GL4	Ask the teacher
BY4		Study on my own
	GL5	Use the dictionary
BL5		Study more

The respondents were asked to explain how they dealt with difficult concepts in Technology. Based on Table 4.5 above, 3 out of 5 girls indicated that they usually sought help from their teachers. Two indicated that they studied on their own until the concepts were clear. In contrast, only 2 out of the 5 boys indicated that they sought help from their teachers. However, 3 indicated that they study on their own.

Figure 4.2 below is a graphical representation of the findings of Interview Question 2.

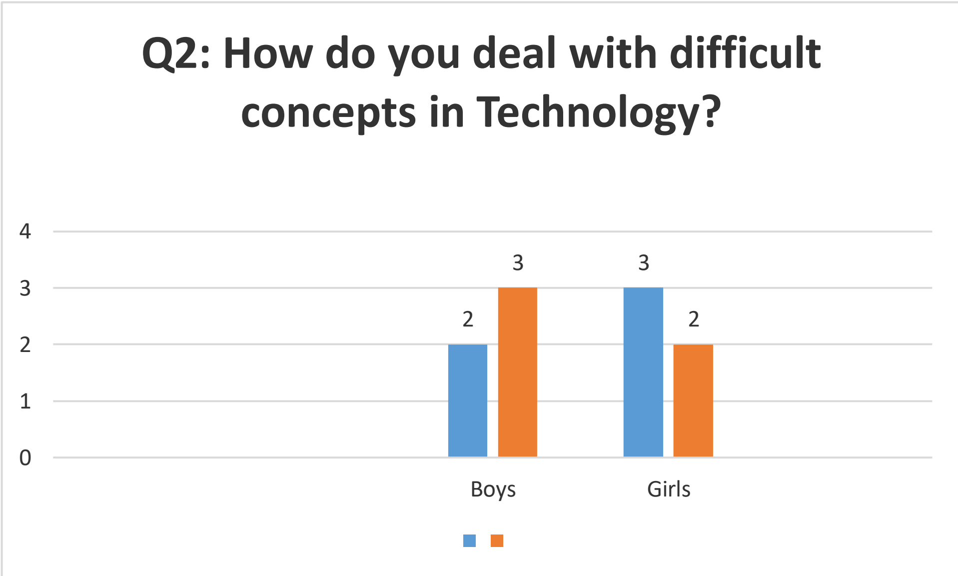


Figure 4.2: How do you deal with difficult concepts in Technology?

Based on Figure 2 above, it appears that boys were more independent in studying the concepts on their own than girls. There was a difference of one between the self-efficacy and independence levels of boys and those of girls in learning technological concepts. More boys than girls seemed able to push themselves to work alone, even if the content presented some challenges, and they only consulted with the teacher when it became extremely important. Girls seemed to have lower levels of an inner locus of control than boys did when they studied technological concepts. The majority seemed to have a tendency of seeking help in the face of minor or major difficulties when the concepts were dealt with. This could perhaps have arisen because of societal beliefs that technology subjects are a preserve for males who are expected to do everything in their power to pursue careers in this direction (Leahy & Phelan, 2014). Put plainly, boys might want to work on their own probably because consistent cries for help could be a demonstration of failure and ineptitude, which may frustrate their career aspirations and be unconscionable to society that expects them to perform in technology subjects. Boys then resort to working on the demonstration of their abilities and skills in dealing with technology content in order to subscribe to societal expectations.

Generally, it seems that girls are adept at asking for help from teachers when they face difficulties. Therefore, unlike boys, they need constant stimulus and a shoulder to lean on so that they effectively study the concepts. Asking help from teachers could be helpful, as the important aspects can be explained, and the learner may continue with confidence in learning. Working alone has the potential to frustrate the acquisition of important aspects of the content because they are not explained (Mechlova & Malcik, 2012). A learner may rely on his/her own understanding of the concepts only to learn that he/she misses the most important aspects that would have been explained had help been sought. Collaboration and interaction are important aspects for the effective learning of various content areas in different subject disciplines (Koparan & Güven, 2014). This allows for interactive exploration of the underlying concepts of the content by approaching them from different angles (Schunk, 2012). Nevertheless, a learner may work alone because he/she does not necessarily encounter debilitating content for which help needs to be sought. Even then, the likelihood is that such learning may result in surface reading, which does not necessarily allow learners to fathom subject-related concepts (Schunk, 2012).

Evidently, boys and girls seem different with respect to how they persist for better understanding of subject concepts. If learners are able to study continuously until understanding of these concepts develops, it perhaps means that different approaches may have been used. In the study, the majority of the boys seemed to use more diverse learning approaches than the girls did. Moreover, the boys seemed to demonstrate more self-regulated approaches to learning, as only few indicated that they sought help from teachers. That shows the degree to which boys may be self-reliant and self-regulated, using an inner locus of control when interacting with subject content.

Q3: Has it ever happened that during learning, you decided to give up and how did you deal with that?

Table 4.6 below reflects the themes formulated from the participants responses to Interview Question 3.

Table 4.6: Has it ever happened that during learning, you decided to give up and how did you deal with that?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	It happened, and help was sought
BY1		It never happened as I work with parents
	GL2	It happened, and I memorized
BY2		It happened, but I insisted
	GL3	It happened, but the teacher motivated us
BY3		It happened, but the reasons for studying Technology pushed me to do more.
	GL4	It never happened because of my love for the subject
BY4		It happened, and I am helped at home
	GL5	It happened, but I am helped by friends at school
BL5		It happened, but the value of the subject pushes me.

The respondents were asked whether it ever happened that during learning, they decided to give up and how they deal with that. The collected data showed that 4 out of 5 girls indicated that it had happened to them that they wanted to give up, but they either had sought help or persevered. Moreover, 1 out of the 4 girls indicated that she memorised the content without attaching meaning to it, as it was difficult for her to comprehend. Only 1 out of the 5 girls indicated that it had not happened to her because she loved the subject, which propelled her to do even more to understand.

However, only 2 boys indicated that it had happened, but they had sought for help. One boy indicated that it had never happened because of his love for the subject. Two boys indicated that it had happened, but they had persevered. Out of the 5 boys interviewed, 4 agreed that it had happened, but they either had sought help from teachers, friends and family or persevered because of their love for the subject.

Figure 4.3 below is a graphical representation of the findings of Interview Question 3.

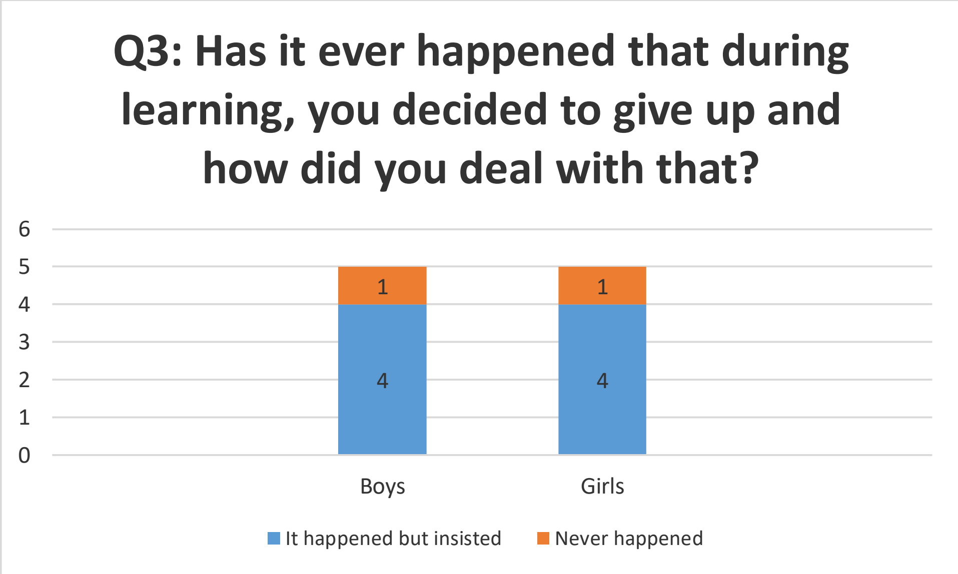


Figure 4.3: Has it ever happened that during learning, you decided to give up and how did you deal with that?

Based on Figure 4.3 above, an equal number of boys and girls agreed that it had happened that they wanted to give up due to the difficulties they experienced learning the concepts, but they had either sought help from teachers, parents, and friends or persevered by using other mechanisms to master the content. Interestingly, one girl confessed to have resorted to memorisation of the content without understanding what it meant. This was an attempt to simply acquire certain concepts without their broader meaning being developed. It was a desperate attempt by the learner to learn at all costs. There could be many reasons that are attached to this attempt. For example, it could be because she felt compelled to master the content, or she felt left behind by her peers. Ostensibly, that may account for an eagerness to learn in order to satisfy others, which would prevent the effective learning of technological concepts. Only 1 boy and 1 girl indicated that it had never happened to them because they loved and understood the subject. Seemingly, both boys and girls demonstrated the same perspectives on learning the difficult parts of the Technology (Ardies, et al., 2015a).

The above finding demonstrates that both boys and girls seem to have the same perceptions and attitudes towards the general learning of technological concepts. It is also evident that there is little gender difference when learners approach these concepts. However, one girl crammed the content as a desperate measure to learn it. Memorisation may help in the classification and arrangement of certain content for later attachment of meaning, as may be the case in mnemonics, sequences and so on. Even though, rote learning does not necessarily lead to effective learning, it may help in the remembering of certain aspects of the content that could be later explored for more meaning to be attached (Schunk, 2012. Some content may be learnt through cramming, which may include number/word sequences for easy recall to process the underlying factors in a meaningful and sensible manner (Mechlova & Malcik, 2012). Effective learning involves, inter alia, the attachment of meaning to learning content, the formation of associations between the hallmarks of the content and the deep processing of content in packages of meaning (Mechlova & Malcik, 2012).

Not a single boy used the cram method, although some boys sought help from friends, family and teachers. This showed the boys viewed and felt about learning technological concepts. Instead of cramming the content, they pushed on by seeking alternative ways of learning the content in meaningful ways. That differentiated between the boys and the girls. It could have been because of pressure and expectations from society, and they did not want to be failures (Kok & Van Schoor, 2014). That may have pushed them to endure the struggle even in the face of difficulties. Girls seemed to have succumbed to the very same societal expectations in that they did not persist on their own, as was the case with boys.

Comparatively speaking, boys seemed able to militate against the adversities that Technology may have presented, which may have been attributable to societal expectations more than to biological or physiological differences (Cook & Cook, 2014). Therefore, the findings of the literature review were confirmed by this finding (Kok & Van Schoor, 2014; Cook & Cook, 2014).

Q4: If you come across difficulties during learning technological concepts, how do you deal with them?

Table 4.7 below reflects themes formulated from the participants responses to Interview Question 4.

Table 4.7: If you come across difficulties during learning technological concepts, how do you deal with them?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Seek help from my siblings
BY1		Ask my teacher
	GL2	Get more information from parents
BY 2		Research on internet
	GL3	Read hard and ask teachers
BY3		Research on internet
	GL4	Seek help from home
BY4		Work together with friends
	GL5	Skip the difficult aspects
BY5		Study hard

The respondents were asked how they dealt with the difficult concepts in Technology during learning and studying. Based on Table 4.7 above, 3 out of 5 girls indicated that they sought help when they encountered a hurdle in their learning. Only one girl learner indicated that she studied hard and asked questions about unclear content. One girl indicated that she skipped the difficult aspects or concepts and continued with what she understood.

In contrast, 1 out of 5 boys indicated that he sought help from home. One read hard and asked teachers for clarity. Two sought information on the Internet and one opted for cooperative learning until the issues were.

Figure 4.4 below is a graphical representation of the findings of Interview Question 4.

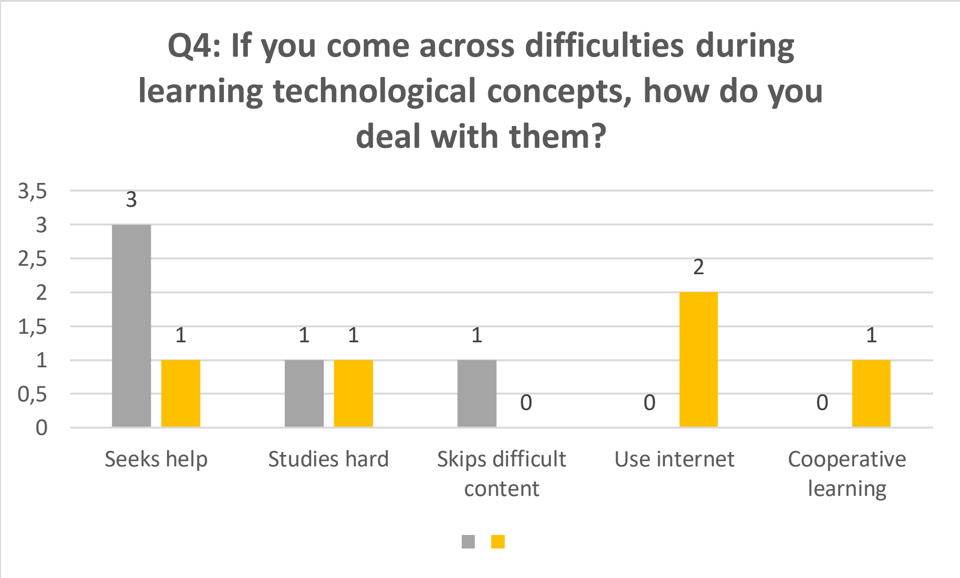


Figure 4.4: If you come across difficulties during learning technological concepts, how do you deal with them?

Based on Figure 4.4 above, more girls than boys appeared adept at seeking help from home as against one boy who did that. Only 1 out of 5 girls indicated that she skipped the difficult concepts, whereas no boys did that. Moreover, boys indicated that they took the initiative to seek answers on the Internet, whilst no girls did that. In addition, one boy engaged with his classroom peers in grappling with the content. In other words, this learner used a cooperative learning approach, an underpinning of the constructivist learning theory, for the difficult parts of the content, which may have enhanced understanding of the content (Schunk, 2012). Girls did not consider cooperative learning approaches. Instead, they preferred help from teachers and parents. Thus, it seems that the girls submitted to being helped rather than engage with the content through the usage of different learning approaches.

In other words, the girls may have required consistent stimuli for their learning to take place. This shows the degree to which they were dependent on teachers for help and indicates the level of their lack of independence and an inner locus of control. Although asking teachers may be helpful, it defeats the purpose of learning if learners constantly require this help. A degree of independence that may evoke the utilisation of different learning styles may help them grapple with the content until a certain degree of understanding is developed. Learners may need to have space in which different styles can be tried out until the most suitable one is adopted and utilised. That may inculcate positive and helpful perspectives on learning the concepts, as girls seem to succumb to negative and debilitating societal views and norms that associate males with success in technology subjects.

It seems, therefore, that the boys had an inner locus of control as opposed to girls, as they depended on their own devices to tackle the difficult concepts in Technology. Probably, boys may feel the need to exert more effort in the learning exercises, even if difficult parts of the content lie ahead. They do not easily give up or seek help at the slightest encounter with difficult content. That may enable them to explore different ways and means of deepening their understanding of the concepts. Trying out different approaches has the potential to assist learners in identifying the most suitable methods of studying the different content areas in the Technology learning programme.

The persistent manner in which boys approach the learning content may be attributed to societal expectations of their role in society. These expectations may require boys to overcome any difficulty on their own, instead of constantly seeking help from teachers and family, as that may show weakness (Msila, 2007). Therefore, societal pressures may have helped the boys in the study to develop coping strategies for tackling difficult technological concepts. These pressures may have groomed and honed their learning skills, styles, strategies and methods.

Q5: In which ways do your teachers assist you in dealing with the difficulties that Technology may pose?

Table 4.8 below reflects the themes formulated from the participants responses to Interview Question 5.

Table 4.8: In which ways do your teachers assist you in dealing with the difficulties that Technology may pose?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	They give opportunities for relearning
BY1		Work as an individual, in pairs and or groups
	GL2	Teachers help
BY2		The teacher uses varied demonstration techniques
	GL3	The teacher is skilled
BY3		The teacher encourages them
	GL4	Work on their own
BY4		Teachers encourage them to fulfil their dreams
	GL5	The environment is conducive
BY5		Teachers tell them about the importance of the subject

The respondents were asked in which ways their teachers assisted them in dealing with the difficulties that Technology may pose. Based on the collected data as depicted in Table 4.8 above, 2 out of 5 girls indicated that their teacher helped them, whereas 2 out of the 5 girls indicated that the teacher was skilled and helpful. Only 1 girl worked alone.

On the other hand, 1 out of 5 boys indicated that they worked as individuals, whilst 4 indicated that they benefitted from the varied skills of the teacher.

Figure 4.5 below is a graphical representation of the findings of Interview Question 5.

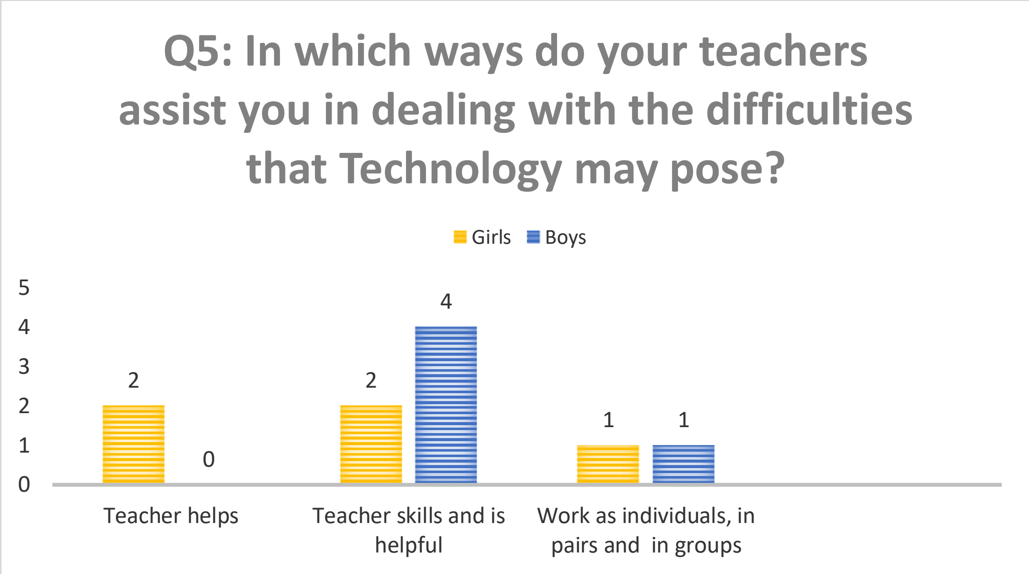


Figure 4.5: In which ways do your teachers assist you in dealing with the difficulties that Technology may pose?

Based on Figure 4.5 above, more boys than girls viewed the skills of their teachers as indispensable for the successful learning of Technology. More girls than boys seemed reliant on the help that teachers provided. However, both boys and girls seemed to agree to working on their own. In keeping with the girls' responses to the first four questions, it seems that the girls were mostly dependent on their teachers for the effective learning of technological concepts. However, boys seemed independent, as they could work on their own, in pairs and in groups. This corroborates the findings of the literature review that boys usually attach meaning to technology because society expects them to excel in it (Cook & Cook, 2014).

The degree of independence that boys show may make them explore different ways of learning the content, which brings them closer to understanding the concepts. They cram, make associations, seek definitions, construct meaning, connect new to old ideas and identify the usefulness of the content to their daily lives. In other words, the persistent manner in which they study the concepts enables them to broaden their understanding and if that happens, their perspectives on learning the concepts could change. However, girls may not be able to develop a solid grasp of the content and that may affect their perspectives and ability to deepen their understanding of the concepts.

Evidently, most learners (both boys and girls) rely on being stimulated by the teacher whose characteristics seem to play a pivotal role. This shows the usefulness of behaviourism that promotes the manipulation of environmental factors as key to effective learning (Boeree, 1998). It seems that effective learning of the concepts is contingent on teachers' character, skills and knowledge (Mapotse, 2015). Even though boys may show a greater degree of independence, they are also prone to seek help from teachers. This could probably explain the extent to which the perspectives of both boys and girls are affected by societal perspectives towards Technology and its concepts

Q6: Which strategies do you utilise in dealing with difficult parts of Technology?

Table 4.9 below reflects the themes formulated from the participants responses to Interview Question 6.

Table 4.9: Which strategies do you utilise in dealing with difficult parts of Technology?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Own learning from textbook
BY1		Own learning from textbooks and notes
	GL2	Own learning and memorisation of content
BY2		Own learning from textbooks
	GL3	Own learning from various sources
BY3		Assisted by family and use textbooks
	GL4	Own learning and use resources
BY4		Own learning in community (Gadgets)
	GL5	Own learning from textbooks and ask teachers
BY5		Own learning with the aid of dictionary

The respondents were asked which strategies they utilised in dealing with difficult parts of Technology. Both boys and girls largely depended on their own learning strategies and preferred related resources to clarify the important aspects of Technology. However, one girl memorised the content, which is a challenge, as this strategy would not necessarily help her with deep understanding of concepts in Technology (Schunk, 2012). She would regurgitate the learnt content with little or no understanding (Mechlova & Malcik, 2012). The nature of Technology requires understanding and the application of learnt content in unfamiliar environments to solve real-life challenges (DBE, 2011a). Regurgitation does not necessarily amount to effective learning of the concepts. There are parts of the subject where it could possibly work. However, the bulk of the content requires deep learning and the application of the learnt content in different contexts in order to deal with everyday technological challenges (DEB, 2011a).

Only 1 girl and 1 boy indicated that they used the prescribed textbooks for the learning of the concepts, whereas 1 girl indicated that she relied on asking the teacher for more information when there were inadequate resources for deriving more content on the concepts. Although 2 girls used various resources for the learning of the concepts, not a single boy preferred memorisation as a learning strategy, and 4 out of 5 boys preferred to use different resources to enrich their learning experiences.

Figure 4.6 below is a graphical representation of the findings of Interview Question 6.

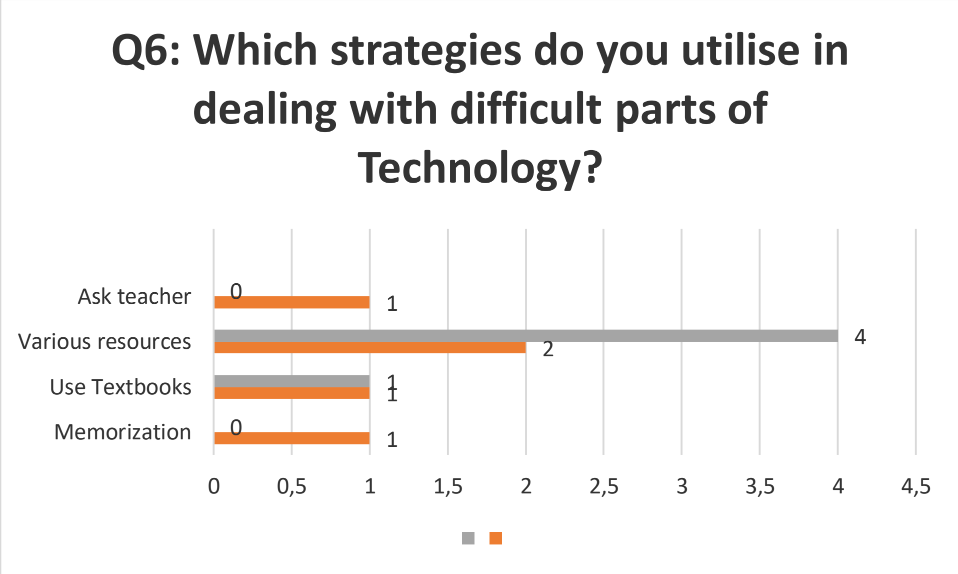


Figure 4.6: Which strategies do you utilise in dealing with difficult parts of Technology?

Based on Figure 4.6 above, boys were more adept at using various resources and strategies to learn technological concepts, compared to girls. That simply means that boys had developed a greater degree of independence and self-regulatory learning strategies enabling them to browse through different textbooks and other resources. If a learner is self-regulated, the likelihood is that more resources may be sought to enrich learning of content and concepts (Schunk, 2012). The use of few learning resources has the potential to limit the scope of content, which would prevent learners from exploring the content from diverse perspectives.

Thus, the boys relied on self-learning when using various resources, and not a single boy indicated consultation with teachers as a way of soliciting assistance. However, 1 out of 5 girls sought assistance from teachers, and one girl memorised content, which was not done by any of the boys. Memorisation is not a reliable learning strategy if deep processing of content is involved, as only surface learning takes place, which may help with remembering certain aspects of the content, but will not lead to full understanding of the concepts (Schunk, 2012). Strikingly, boys seemed versatile, as they also engaged in experiential learning as a way of better understanding the concepts underlying Technology (Jalinus et al., 2017). Experiential learning has the potential to facilitate learners' exploration of skills and learning from the feedback received after attempting to learn certain pieces of content (Jalinus et al., 2017). It is also educative to do experiential learning when experiments are done, as it may allow the learner to understand reactions to certain actions performed on particular materials (Jalinus, Nabawi & Mardin, 2017).

Thus, the boys seemed to use various ways of learning content, which would have enhanced understanding and internalisation of the content matter (Jalinus et al., 2017). In comparison with girls, their use of diverse effective learning strategies might have led to the development of positive perspectives on learning technological concepts. The expectations of society might have made them ready to exert effort and try out various strategies for understanding subject content. Moreover, their persistence in practising these different strategies would have led to learning success.

Q7: How do you apply different learning approaches in effectively studying and learning technological concepts?

Table 4.10 below reflects the themes formulated from the participants responses to Interview Question 7.

Table 4.10: How do you apply different learning approaches in effectively studying and learning technological concepts?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Individual and teachers
BY1		Textbook, self-assessment and different strategies
	GL2	Only available textbooks
BY2		Online material and other resources
	GL3	Summarise and memorise
BY3		Textbook, self-assessment and different strategies
	GL4	Summarise, mind-maps and memorise.
BY4		Textbooks, peers and group work (different strategies)
	GL5	Individual and teachers
BY5		Individual, peer and group work (different strategies)

The respondents were asked to indicate how they applied different learning approaches in effectively studying and learning technological concepts. Based on Table 4.9 above and Figure 4.7 below, two girls indicated that they worked as individuals and asked teachers for help where they face difficulties, whilst 4 boys indicated that they combined their learning approaches, including working on their own, in pairs or in groups. Moreover, 1 girl indicated that she depended entirely on the available textbooks and did not vary learning support material. Although 1 boy indicated that he used the Internet to download usable material for the enrichment of his knowledge of technological concepts, not a single girl mentioned the use of online material for learning. Lastly, girls demonstrated overreliance on summaries and memorisation as learning aids. In contrast, boys showed a greater dependency on a variety of learning styles, methods and strategies, compared to girls.

Figure 4.7 below is a graphical representation of the findings of Interview Question 7.

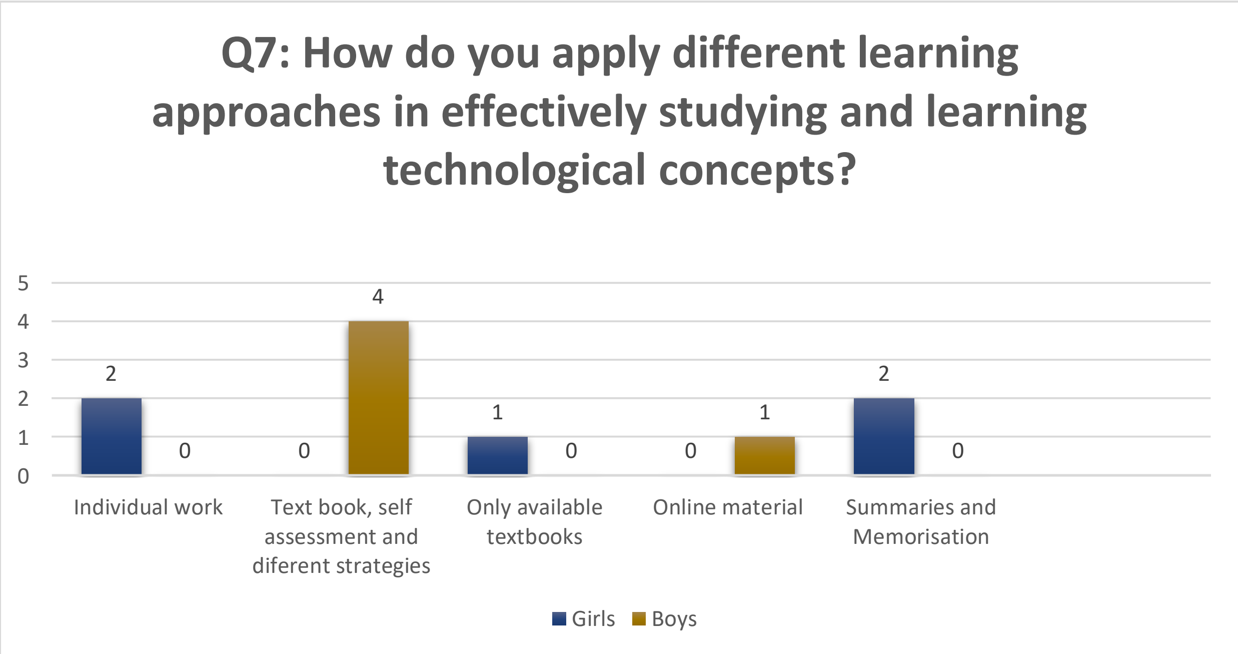


Figure 4.7: How do you apply different learning approaches in effectively studying and learning technological concepts?

Based on Figure 4.7 above, girls preferred individual learning methods, compared to boys who used a variety of learning methods and approaches. Apparently, girls preferred to use summaries and memorisation strategies to get along, whereas not a single boy chose these approaches. Instead, boys even tapped into online learning, as it provided more information than the available textbooks. In other words, boys seemed able to broaden their scope by using different learning materials so that they could identify common knowledge traits, which deepened understanding and led to concept formation and development. Girls did not pursue knowledge in this way, which may have contributed to the higher number of them resorting to memorisation at the expense of deep processing of meaning for better understanding.

Overreliance on teachers is also a drawback, as it may deprive learners of the opportunity to read the content repeatedly so that hidden content can be revealed, which may encourage them to pay more attention during the learning process because there would be no one to help them. Moreover, learning without depending on teachers may benefit learners, who would begin to use different strategies to attribute meaning to concepts and to apply them in different contexts for more effective understanding. The constructivist theory posits that teachers should allow learners to learn on their own so that they can master strategies for attaching meaning to concepts and only seek the help of teachers as a last resort (Ouyang & Stanley, 2014). Thus, teachers would not play an active role in the learning; the responsibility would be left to the learner.

The above observations demonstrate the effects of patriarchy on the learning of technological concepts. Many girls do not exert the amount of effort demonstrated by boys and rely on easy learning styles just to get along. However, boys use a variety of learning strategies to tackle the content in its complexity (Schunk, 2012). This could probably be attributed to various reasons, including society's patriarchal expectations of males and females (Mubeen et al., 2013; Van Rensburg et al., 1999).

Q8: Explain the way your teachers influence your learning of Technology.

Table 4.11 below reflects the themes formulated from the participants responses to Interview Question 8.

Table 4.11: Explain the way your teachers influence your learning of Technology

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Careers are used
BY1		Careers and jobs
	GL2	Promotes resilience
BY2		Encourages involvement
	GL3	Careers and jobs
BY3		Good character of the teacher and how the teacher teaches
	GL4	Careers and jobs
BY4		Careers and jobs
	GL5	Careers and jobs
BY5		Good character of the teacher and the manner he/she teaches

The respondents were asked to explain how their teachers influence them in learning the content and concepts underpinning Technology. The table above shows that 4 out of 5 girls indicated that they were influenced by the teachers' references to technology-related careers during their teaching. Only one girl learner indicated that the teacher encouraged them to be resilient when learning Technology, which is a challenging subject that requires needs time and patience.

Out 5 boys, 2 indicated that the prospect of technology-related careers inspired them to exert effort, as it linked up with their future aspirations. Only 1 boy out of the 10 respondents indicated that the teacher always encouraged learners to be involved in the learning process, which pushed them to do even more. Only 2 out of the 5 boys attributed their encouragement to their teachers' character and teaching. In other words, the teachers acted as a stimulus or a role model for successful learning of Technology and associated concepts. The teachers' behaviour and idiosyncrasies in dealing with the content and lessons seemed to be recognised and appreciated by these respondents. Moreover, they might have emulated their behaviour, which would have become a point of reference.

Figure 4.8 below is a graphical representation of the findings of Interview Question 8.

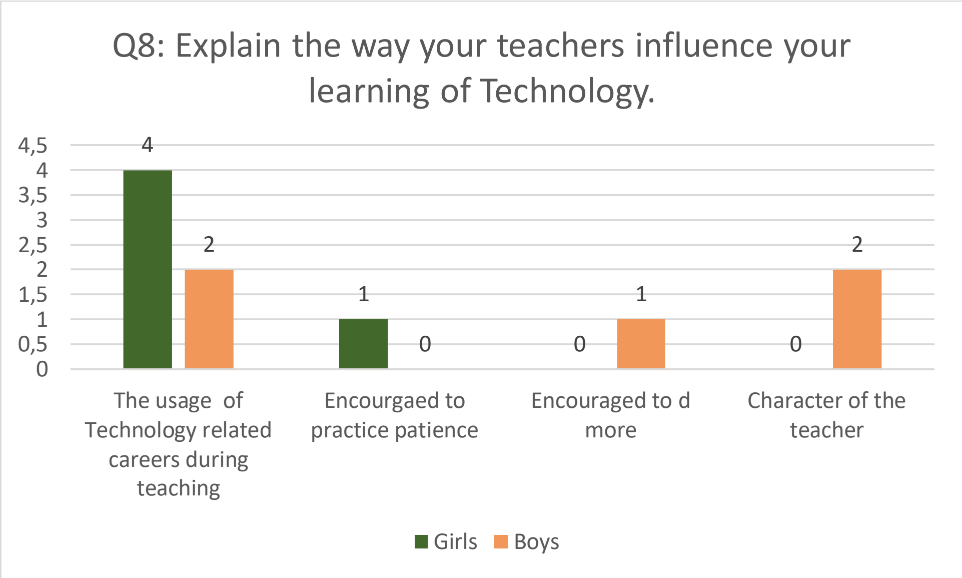


Figure 4.8: Explain the way your teachers influence your learning of Technology

From Figure 4.8 above, more girls than boys felt encouraged by the careers to which the teacher referred during lessons, although almost of boys agreed with that feeling. It seems that reference to practical and in-demand careers during the lessons has the potential to encourage learners to make an effort with their schoolwork. In fact, 6 out 10 learners mentioned that teachers referred to these careers when concepts related to them were used during the lesson, which means that learners may have been influenced by the practical implications of these concepts. The usefulness of these concepts to their future career prospects might have become an anchor point for more learning. The eagerness to pursue certain careers might have motivated them to put more effort into their learning. Although, this would have been an external form of motivation, it may have helped them to explore the concepts in ways that showed a greater degree of understanding. They would have known that if they failed or could not understand the concepts, their opportunities to pursue their preferred careers would have become minimised. To avoid that, they felt pushed to do everything possible to understand the concepts, thus developing positive perspectives on of what they were studying.

As stated above, 1 out of 5 girls felt encouraged by the teacher helping her grapple with the concepts in a successful manner. In fact, 1 out of 5 boys felt the same way, although the teacher encouraged him to do more and did not expressly indicate that he should practice patience. The mere fact that the teacher encouraged him indicates that patience, at some point, would have had to be practised. Therefore, both a boy and a girl believed that their teachers' encouragement helped them to endure the difficult parts of the subject, whereas 2 boys were encouraged by the teachers' characters and the way they taught and dealt with the concepts, which may have positively influenced the way they learnt the concepts. Even though no female respondent indicated the role of teacher characteristics, the fact that 3 out of the 5 girls felt encouraged by how teachers referred to technology-related careers during the lessons says a lot about their helpful character. Thus, it could be concluded that teachers' characters play an important role in encouraging learners to persist in learning technological concepts.

Q9: In your opinion, how do your parents motivate you in pursuing a technology-related career?

Table 4.12 below reflects the themes formulated from the participants responses to Interview Question 9.

Table 4.12: In your opinion, how do your parents motivate you in pursuing a technology-related career?

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Encouraging to work hard
BY1		Its value and possible careers
	GL2	Its value and possible careers
BY2		Its value and possible careers
	GL3	Encouraged to work hard
BY3		Its value and possible careers
	GL4	Its value and possible careers
BY4		Its value and possible careers
	GL5	Its value and possible careers
BY5		Its value and possible careers

The respondents were asked to indicate how their parents motivated them to pursue technology-related careers. Out of the 5 girls, 2 indicated that their parents encouraged them to work hard, whereas 3 out of the 5 girls and 5 out of the 5 boys indicated that they worked hard because of the possible career opportunities that learning technology subjects could provide.

Figure 4.9 below is a graphical representation of the findings of Interview Question 9.

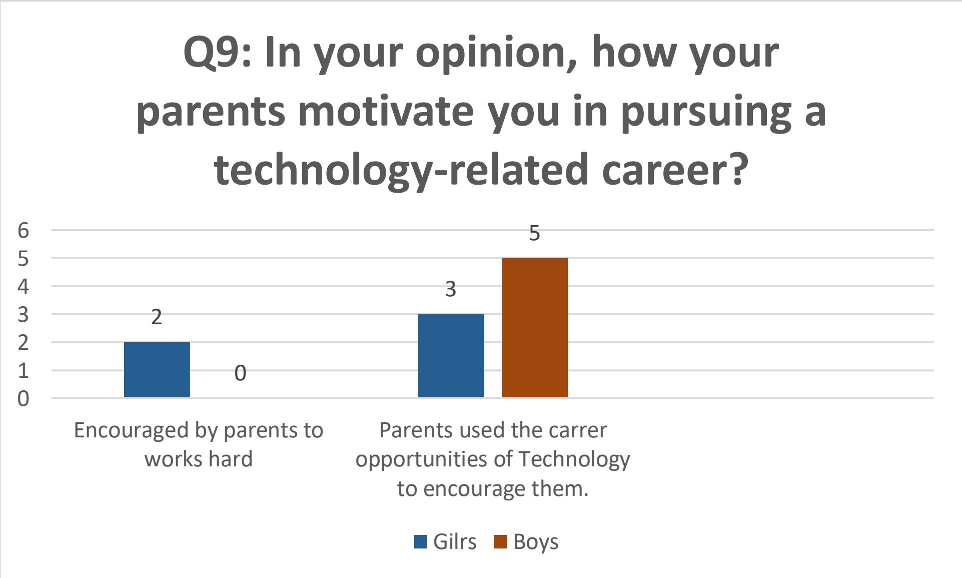


Figure 4.9: In your opinion, how do your parents motivate you in pursuing a technology-related career?

Based on Figure 4.9 above, it could be concluded that both the boys and girls were encouraged to study technological concepts because of the career opportunities that the subject could open for them. Their parents often indicated the various career opportunities that Technology could potentially provide, which might have motivated them to do more, as it is only through their success in the subject that they could pursue those careers. Thus, due to their parents' attitude, the participants who learnt Technology felt that it was valuable because it related to the world of work and provided information that they could use later on in life. Their parents' knowledge of the various careers linked to the subject most probably encouraged them to persevere and pass the subject, which would be an important milestone on the road to doing technology-related subjects at FET and tertiary level, which could lead to desirable careers. Thus, the learners were possibly eager to grapple with the technological concepts, not necessarily for the development of knowledge, but to qualify for technology-related careers.

With regard to the boys, the parents were sure that they would automatically pursue technology-related careers because they were males in the first place. In this regard, the boys seemed to be at an advantage in learning and succeeding in Technology, as they were supported and sustained by society (Muller et al., 2014). In other words, the boys had developed certain attitudes and perspectives towards the learning of Technology. In contrast, the girls needed more support and encouragement to be at the level of boys.

Q10: Your community has different needs; do you think Technology could play a role in your community? Explain your views/ feelings etc.

Table 4.13 below reflects the themes formulated from the participants responses to Interview Question 10.

Table 4.13: Your community has different needs; do you think Technology could play a role in your community? Explain your views/feelings etc.

Boys (Codes)	Girls (Codes)	Conceptual themes
	GL1	Technology could play a role in my community
BY1		Technology could play a role in my community
	GL2	Technology could play a role in my community
BY2		Technology could play a role in my community
	GL3	Technology could play a role in my community
BY3		Technology could play a role in my community
	GL4	Technology could play a role in my community
BY4		Technology could play a role in my community
	GL5	Technology could play a role in my community
BY5		Technology could play a role in my community

The respondents were asked if Technology could play a role in their community. Based on the on the above data, both boys and girls equally asserted that Technology had a role to play in their communities. Figure 4.10 below is a graphical representation of the findings of Interview Question 10.

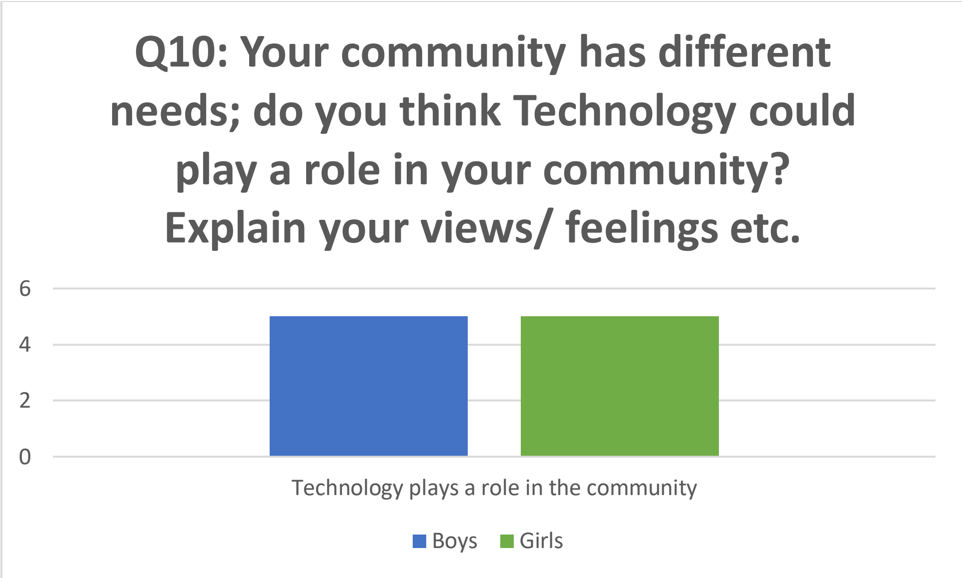


Figure 4.10: Your community has different needs. Do you think Technology could play a role in your community? Explain your views/feelings etc.

Based on Figure 4.10 above, all respondents agreed to the commercial value of Technology. Both boys and girls understood that Technology was useful in their lives. All the respondents viewed Technology as an important aspect of their lives. They may have then been motivated to pursue the subject, as it was part of their lives. This probably encouraged them to study and learn the concepts because the subject was important for their daily lives.

This, therefore, means that the perspectives of the community and society have an important role to play in the choice of subjects' learners take at schools. Their expectations based on their philosophy of life find expression in what their children will choose as school subjects and the career they will eventually pursue (Van der Vleuten, et al., 2016). However, this does not mean that girls have less aptitude than boys have for tackling technological concepts (Ardies et al., 2015a). The only reason that boys are at an advantage is that society has expectations of what boys and girls should do, which determines the support given to each gender as they grapple with technological concepts.

Had the girls in the study been given the same or more opportunities and support to study the technological concepts and excel in Technology as the boys, they would have performed as well as the boys, and the gender disparities would have been something of the past (Makgeru, 2016). The differences in the girls' and boys' performance and learning of technological concepts could be attributed to socialisation, culture, rearing practices, societal expectations, exposure to different worlds and the antiquated role given to the different genders (Mubeen et al., 2013; Van Rensburg et al., 1999). Therefore, a change in attitudes and perspectives towards learning Technology and it hallmark concepts may contribute to a high yield of females who excel in the subject (Muller et al., 2014).

The above data and its analysis revealed the extent to which perspectives and attitudes play a role in the development of different frameworks that determine boys' and girls' choices, learning, perceptions and perseverance in learning technological concepts. Below is the analysis of the data derived through the observation technique.

4.3.2 Data collected through observations

The observation cues were structured as shown in text box 4.3 below.

Textbox 4.3: Observation cues

- How do the learners expend effort in dealing with technological concepts?
- When they encounter difficulties, how do they deal with them?
- How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?
- Do they cooperate and work in groups and how is the spirit of the groups?
- Explain the state of learners' adeptness in applying various strategies in dealing with the learning of technological concepts?
- Do they show resilience and persistence in the face of difficulties? Explain your answer.
- What are the differences between boys and girls when they militate against difficulties arising from learning the technological concepts?
- How do learners differ based on the quintiles?
- How can socio-economic differences as factors in learning technological concepts influence quintiles?
- How does the family background influence the rate at which learners succeed in Technology?

CUE 1: How do the learners expend effort in dealing with technological concepts?

Table 4.14 below reflects the themes formulated from Cue 1.

Table 4.14: How do the learners expend effort in dealing with technological concepts?

(Codes)	Conceptual themes
S1	Engaged with the content
E2	Attentive and engaged with the content
QP3	Attentive and engaged with the content
EP4	Attentive and engaged with the concepts
TG5	Attentive and engaged with the content

All the learners appeared to be engaging with the content regardless of gender. They all listened attentively and were active in that they were involved with the concepts. Questions were also asked on the difficult or unclear aspects of the content or concepts. The teacher was welcoming and understanding of the learners' frustrations when they emerged. However, the extent of the girls' engagement was relatively less than that of the boys, who were visibly involved with the concepts. Most of the girls merely sought clarity, while most of boys went further by evaluating certain aspects of the design features, for example. Where boys dealt with the various features and support structures of design and processing principles, girls were interested in knowing only the principles. This observation supports the finding made through the interviews that the girls often applied surface learning and were not particularly interested in the formulation of new meaning and association or networks of knowledge, which are determinants of deep learning of the learning material (Ouyang & Stanley, 2014).

CUE 2: When they encounter difficulties, how do they deal with them?

Table 4.15 below reflects the themes formulated from Cue 2.

Table 4.15: When they encounter difficulties, how do they deal with them?

(Codes)	Themes
S1	Engaged peers
E2	Engaged peer but did not understand the concepts
QP3	Engaged peers and the teacher
EP4	Asked the teacher for clarity
TG5	Disengaged and uninvolved

Many of the learners engaged their peers and their teachers when they encountered confusing concepts. One learner engaged her peers but could not understand the concepts underlying the content. One learner disengaged and showed a lack of interest, as the content seemed too difficult for her understanding. This learner was from a quintile 1 school, which could probably have been the reason that the learner behaved in that way. Learners from quintile 1 schools mostly come from poor environments, and most of their parents are illiterate (Reddy et al., 2016). The likelihood is that she did not receive any help from home, or the home environment was not conducive and nurturing for the assimilation and understanding of technological concepts. This observation also supports one of the interview findings that the environment where learners are raised plays a key role in their social and cognitive development (Van Rensburg et al., 1999). In other words, learners that come from environments where academic development is encouraged are most likely to engage and succeed in their scholastic work because they are used to having a positive attitude and perspective towards learning at home. Therefore, it is not their gender that plays a role in their academic development, but the perspective of their environment that influences their upbringing and approach to academic work and scholastic achievement (Mubeen et al., 2013).

CUE 3: How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?

Table 4.16 below reflects the themes formulated from Cue 3.

Table 4.16: How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?

(Codes)	Themes	Quintiles
S1	Interpreted content in own words	03
E2	Sought clarity	04
QP3	Attentive and attempted all the questions	02
EP4	Practical application of theory	05
TG5	Attentive and attempted all the questions	01

Based on Table 4.14, most learners were engaged with the learning content. Answers to most of the questions were attempted. They also sought clarity on difficult parts of the content taught. Some attempted to apply the theory part of the concepts to solve real-life problems. Therefore, learners seemed interested in learning technological concepts. They engaged with the content and asked questions for better understanding. All the quintiles behaved the same.

CUE 4: Do they cooperate and work in groups and how is the spirit of the groups?

Table 4.17 below reflects the themes formulated from Cue 4.

Table 4.17: Do they cooperate and work in groups and how is the spirit of the groups?

(Codes)	Themes
S1	Work in pairs harmoniously
E2	Work in pairs harmoniously
QP3	Work in pairs harmoniously
EP4	Work in groups collaboratively
TG5	Work in pairs harmoniously

Based on Observation Cue 4, all the learners were able to cooperate and work harmoniously together. There was a collaborative effort in coming up with solutions to difficult parts of the content.

CUE 5: Explain the state of learners' adeptness in applying various strategies in dealing with the learning of technological concepts

Table 4.18 below reflects the themes formulated from Cue 5.

Table 4.18: Explain the state of the learners' adeptness in applying various strategies in dealing with the learning of technological concepts

(Codes)	Themes
S1	Able to use various strategies with ease
E2	Unable to vary the learning strategies
QP3	Unable to vary learning strategies
EP4	Able to adapt various strategies
TG5	One learning strategy is used

The analysis of Cue 5 revealed that few learners were able to vary their learning strategies. The majority was not able to adapt and used relative learning strategies for different parts of the Technology content. This mostly affected the girls and not the boys. In other words, boys applied learning styles, methods and strategies to learn that were different to those used by the girls (Schunk, 2012). This could probably be because the boys seemed more purposeful and ready to derive the meaning of the concepts for their value in the world of work, compared to the girls who appeared less determined (Makgeru, 2016).

It seems that most of the learners were not adept at using different learning strategies for learning the different Technology concepts and content. Reliance on one strategy may lead to an inability to understand the important concepts embedded in the content. This may confirm the perspective that Technology is a difficult subject and that only a few learners, especially boys, may succeed in it (Makgeru, 2016).

CUE 6: Do they show resilience and persistence in the face of difficulties? Explain your answer.

Table 4.19 below reflects the themes formulated from Cue 6.

Table 4.19: Do they show resilience and persistence in the face of difficulties? Explain your answer.

(Codes)	Themes
S1	Girls did not show resilience and never persisted
E2	Girls did not show resilience and never persisted
QP3	Boys did not persist and were withdrawn
EP4	They all persisted and were resilient
TG5	They all persisted and were resilient

CUE 6 enabled the researcher to observe whether learners showed resilience and were persistent in the face of difficult Technology content. Girls seemed to have challenges in dealing with difficult content. They gave up easily and the difficult content was skipped. Few boys lacked persistence and resilience. This confirms the findings of both the literature review and data collected through the semi-structured interviews that boys seem to be in a better position to deal with the technological concepts than girls, which is attributed to the societal expectations of them (Mubeen et al., 2013).

This finding confirms the fact that boys seem able to deal with difficult Technology concepts because it is expected of them to do so. As a result, boys are more resilient than girls are. Girls seem to confirm the idea that they are not meant to study Technology, as it is a male domain (Mubeen et al., 2013). However, then literature review indicated that learning is not entirely determined by the gender of the learners. Issues of societal expectations largely determine the amount of energy and time given to dealing with the content of any subject and learners' motivation to succeed (Schunk, 2012). Furthermore, differences in the way learners approach a learning task do not depend on gender attributes. They rather depend on the learners' application of learning strategies in keeping with the level of difficulty of a task (Schunk, 2012).

CUE 7: Explain the differences between boys and girls when they militate against difficulties arising from learning the technological concepts.

Table 4.20 below reflects the themes formulated from Cue 7.

Table 4.20: Explain the differences between boys and girls when they militate against difficulties arising from learning the technological concepts.

(Codes)	Themes
S1	Girls struggled with complex content
E2	More girls participated than boys
QP3	More girls were more active than boys
EP4	Both participated
TG5	Girls struggled

With the help of CUE 7, the researcher observed differences between boys and girls when they dealt with difficult concepts or content. Generally, girls struggled in dealing with sophisticated and complicated content. Boys would persist and work in groups. Girls may have participated in class, but they failed to deal with challenging aspects of the curriculum. This confirms the findings made through the interviews. It was found that girls are less adept at dealing with difficult aspects of content compared to boys, and this is mainly because of their self-beliefs determined by societal expectations. The literature review revealed that differences in learning are not due to gender, but to how society expects the different genders to behave, which affects the degree to which they persist and succeed in learning (Schunk, 2012).

Thus, girls seemed to lack resilience and the ability to use various strategies to deal with technological concepts. In contrast, boys seemed adept at using different and varied learning approaches that enabled them to succeed even in the face of adversity.

CUE 8: How do learners differ based on the quintiles?

The researcher observed the participation rate of learners from all five quintiles. It was observed that learners in the upper quintiles participated more than those in lower quintiles did. For example, learners in quintile 1 and 2 rarely participated in discussions. They preferred to work alone and to shy away from groups. This affected both males and females alike.

Learners in quintiles 1, 2 and 3 found it difficult to be eloquent and freely engage with the content, unlike their quintiles 4 and 5 counterparts. This may have been associated with the socio-economic and literacy levels of their parents (Mubeen et al., 2013). The environment from which they came may have been too docile and repressed for them to thrive in their educational endeavours. Their language development also seemed challenged, as they could not relate with concepts easily. They needed more time to get to grips with the essence of the concepts. They relied a great deal on dictionaries and textbooks even for basic information.

CUE 9: Explain how socio-economic difference is a factor in learning technological concepts.

With the help of CUE 9, the researcher observed how socio-economic differences influenced the learning of technological concept. The findings indicated that learners from sound socio-economic backgrounds seemed able to participate in the learning of technological concepts. There was no major distinction between boys and girls from such an environment. Their abilities could be associated with the fact that parents from well-to-do environments tend to be involved in the education of their children, whereas the parents of learners who attend no-fee schools remain distant from the educational situation (Van Rensburg et al., 1999). The involvement of more affluent parents may allow them the opportunity to detect learning challenges and give help. They may also provide additional learning materials to augment what the school has. Moreover, the payment of school fees may have a role in this situation. Ordinarily, schools in quintiles 3 to 5 charge school fees, which may bring about accountability on the learners.

CUE 10: How does the family background influence the rate at which learners succeed in Technology?

Regarding CUE 10, the researcher observed the association between family background and success in Technology. The finding of this cue was the same as that of Observations CUE 7, 8 and 9, which revealed that learners from more affluent family backgrounds performed better than those who came from poor backgrounds. This was probably because the parents of learners from privileged socio-economic backgrounds seemed more involved in the education of their learners. Moreover, they understood their roles in assisting and monitoring their children at home. However, learners who came from poor socio-economic backgrounds seemed to struggle, as their parents were not involved, and they had to fend for themselves.

4.4 IMPLICATIONS OF THE FINDINGS

The data collected through semi-structured interviews and observation yielded the following:

4.4.1 Implications of data collected through semi-structured interviews

- More boys than girls perceive Technology as a subject that could open prospective career opportunities.
- Boys have higher self-efficacy levels than girls do when they deal with difficult concepts in Technology.
- Boys prefer to work either alone or in pairs/groups, whereas girls demonstrate more reliance on teachers.
- More boys than girls practise resilience when dealing with the difficult parts of Technology.
- More boys than girls rely on cooperative learning approaches when dealing with difficult concepts in Technology. Girls are more adept at asking their teacher and do not rely on self/ peer/group teaching.

- Boys diversify their learning endeavours by using the Internet, textbooks and other technological gadgets. Girls seem more reliant on textbooks and help from teachers.

- Girls are dependent on teachers for the acquisition of content and concepts in Technology.

- Boys are more influenced by the character of the teachers than girls are. Girls are more inspired by the benefits of careers that Technology may open for them.

- More boys than girls prefer individual, peer and group work to overcome the difficult parts of Technology.

- Girls rely on limited study techniques, as compared to boys. They rely more on summarisation and the memorisation of content.

- Girls are more inspired by the careers that Technology may offer them than knowledge of the concepts. Boys aim for a deeper understanding of the concepts and view careers as the obvious culmination of the learning effort.

- Boys learn by practical involvement with the content, as compared to girls. They like to experiment and develop models. Girls are more abstract than boys are, as they rely on the textbooks for the learning of concepts.

4.4.2 Implications of data collected through observations

The above findings of the semi-structured interviews are supported by the data collected through the observation cues as summarised below.

- Both boys and girls feel Technology has a big role to play in their communities.

- Both boys and girls are actively involved in the learning of Technology. However, their activism is driven by different goals, namely boys engage with it for the knowledge and the ability to create something, while girls aim for the careers that Technology may offer.

- Parents of both boys and girls are usually engaged in helping the learners cope with the subject content and concepts. However, the quality of assistance differs in terms of the socio-economic and literacy levels of the parents.

- Boys vary their learning strategies more than girls do. They tend to identify the most suitable strategy in keeping with the perceived difficulty of a task. Girls rely on limited strategies that lead to surface learning.

- Boys demonstrate a greater degree of resilience and persistence than girls do.

- Both boys and girls in quintiles 1 and 2 schools have challenges in their active engagement with the content. The understanding of content is a huge challenge, which may be attributed to the socio-economic backgrounds of their schools' quintiles that are dominated by learners from the low-income group. The literacy levels of the parents are not comparable to those in quintiles 4 and 5.

- Socio-economic backgrounds play a pivotal role in the successful learning of technology concepts. Because of socio-economic factors, both boys and girls from quintiles 4 and 5 learn more successfully than learners from quintile 1 and 2 do.

- Family backgrounds also play a major role in learning technological concepts. More affluent family backgrounds play a role in the effective learning of any subject, including Technology.

4.4.3 Summary of findings in relation to the research questions

This summary of findings is based on data collected through the literature review, semi-structured interviews and observation cues. Each sub-question will precede the findings so that the discussion is directed to the core issues as shown below.

- **What are the grades 7 learners' perspectives on strategies for the effective learning of Technology?**

The findings have proved the following:

Societal expectations have a direct bearing on the perspectives of learners on learning technological concepts. The expectation that boys are the ones who are supposed to do STEM-related subjects has the potential to affect the manner in which they militate against the difficulties that the technological concepts may pose. Boys have proved to be persistent, and they largely use different learning resources to tackle the concepts in Technology. However, girls seem to struggle, and their persistence threshold is generally lower than that of boys. Girls also show greater dependency on the teacher for the learning of the concepts. They also memorise content as opposed to iteration for better and broader understanding.

Generally, boys use strategies that differ from those that girls use. That does not mean girls cannot use those strategies. Evidently, they do not attempt to use different strategies, as they mostly rely on memorisation. They also constantly solicit support from teachers. External motivation works for females, as against males who continuously try out different mechanisms to understand the content.

Indeed, societal expectations that seem to favour males over women in pursuing technology-related subjects ostensibly have an impact on the strategies that boys and girls would use to study Technology.

- **How do boys and girls perceive the development of certain perspectives on learning technological concepts?**

Boys and girls appear to have developed different perspectives on learning technological concepts. The different perspectives towards technology-related subjects seem to influence the perspectives of boys and girls on learning technological concepts. Societal perspectives and attitudes towards these subjects place males in a favourable position, compared to girls, when they attempt to learn the concepts. Boys seem to persist even if the concepts pose difficulties. However, girls seem more reliant on teachers, compared to boys. Generally, boys feel a greater need to be able to understand the concepts because technological careers are regarded by society as meant for males. Girls tend to resort to memorisation to keep up with boys. In other words, girls, at a general level, have proved to have poor perspectives on learning technological concepts.

- **How do grade 7 learners experience societal biases towards the effective learning of technological concepts?**

  Both boys and girls seem to be influenced by societal biases towards learning technological concepts. Societies' perspectives on STEM subjects seem to be transferred to learners who adopt these perspectives on learning the concepts in Technology. The learners' attempts to learn the concepts, the strategies, the approaches that they use and the enthusiasm that they show towards learning the concepts all seem to be dependent on and related to societal biases towards STEM-related subjects. Boys seem to enjoy the benefits of societal biases. Moreover, they are usually expected to fulfil certain expectations and behave in line with particular views, feelings and attitudes at the expense of females.

- **Which strategies could be suggested to help learners develop effective perspectives for the successful learning of technological concepts?**

  The following strategies are recommended:

  - Boys and girls need to be encouraged to use different strategies and approaches that are suited to the types of concepts to be dealt with at a given point in time.
  - Teachers should use equal positive reinforcement in the effort that both boys and girls exert in learning the concepts.
  - Self-regulatory learning approaches need to be used by both males and females.

- External motivation needs to be used in the context of internal motivation, and more focus should be given to girls who seem to experience greater challenges with regard to an inner locus of control.
- A variety of learning material needs to be utilised so that diverse views of certain concepts can be accessed for better understanding.
- Content that requires high order cognitive skills needs to be used for both boys and girls. Support should be given so that learners become self-regulated and able to learn on their own.
- Practical experiences for the practical application of concept-based operations need to be promoted for use by both boys and girls.
- Both males and females need to be equally encouraged to construct meaning out of the content they have learnt. That could be done by encouraging learners to, for example, explain, describe, critically evaluate/discuss, summarise and suggest solutions to certain occurrences. In addition, learners need to be encouraged to apply knowledge in different contexts.
- Both boys and girls could be paired in groups for the effective learning of the concepts. In these pairs/groups, they could be expected to exchange roles to demystify the myth that boys can learn the concepts better.
- The use of collaborative approaches may enable learners to explore the concepts on their own without the assistance of teachers and construct meaning or form connections between the known and the unknown.
- Both boys and girls need to use iteration so that the practical aspects of Technology can be experimented on over time until the deeper meaning is unearthed.
- Boys and girls could use self/group assessment so that they are in charge of their own learning. In doing so, the teacher needs to ensure that each pair or group comprises both males and females and that they are accorded the

opportunity to exchange roles to ensure equal treatment of the different genders.

4.5 CONCLUSION

This chapter identified the challenges that both boys and girls experienced in learning technological concepts in the area of the study. The underlying factors of the different perspectives, attitudes and perceptions of boys and girls towards the learning of technological concepts were unearthed. To that effect, themes were used to classify, encode and decode data in terms of common and uncommon trends. That gave the researcher the opportunity to associate the themes with the learners' perspectives, and attitudes.

The literature reviewed in Chapter Two was used to reflect on the veracity of the findings. The findings of the study corroborated the findings of earlier studies, i.e. boys are better off in learning technological concepts due, among other factors, to socialisation and societal expectations. Girls tend to view Technology as a subject that they need to do and pass for the careers it could provide, rather than for the knowledge that they could derive. Self-initiative on the part of girls is lacking, compared to boys when they deal with Technology. Moreover, family backgrounds, socio-economic factors and the schools' quintile play a major role in determining the extent to which learners successfully learn technological concepts. As a result, all these factors influence the perspectives of boys and girls towards Technology.

The next chapter will present an overview of the study, findings and recommendations. Suggestions for further study will also be made.

CHAPTER FIVE

INTERPRETATION OF RESULTS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter provides a summary of the findings made in Chapter Four. It also recommends possible initiatives that the Mpumalanga Department of Education (MDoE); the DBE; the education districts and circuits; educationists; parents; and teachers could consider when planning for the effective implementation of Technology as a specific subject in South Africa (SA). It will seek to give descriptive and interpretive recommendations on what schools and teachers should consider for the effective implementation of the Technology curriculum. Therefore, the attention of schools will be drawn to the important aspects of how technological concepts could best be taught and assessed. This will inform educational role players about the important role played by socio-cultural factors in the choices that learners make of the subjects that are taught at schools. Possible areas for future research in this field will also be elucidated for the expansion of knowledge in this regard.

This chapter consists of an overview of the study, findings and recommendations. The discussion in this chapter will shed light on the following:

- The nature of the perspectives of boys and girls towards the effective learning of technological concepts
- The way boys and girls could develop appropriate perspectives on learning technological concepts
- The way boys and girls could address negative perspectives on learning of technological concepts
- The extent to which certain perspectives assist or detract from the learning of technological concepts by boys and girls
- Strategies that could be employed in helping learners develop effective perspectives for the successful learning of technological concepts.

5.2 AN OVERVIEW

The coming into being of OBE system, the NCS and the CAPS of all the subjects in SA brought about changes in the way education was perceived, serviced, viewed and rendered. The continued reforms and strengthening of the curriculum has created both positive and negative perceptions from society, teachers, learners, parents, educationists and education authorities. These perceptions, perspectives and attitudes have invariably affected the way teachers teach and how learners learn because the changes came with new content, teaching methodologies, roles for teachers/learners, assessment methods and meaning to the teaching/learning processes. For example, the educator is no longer viewed as a bastion of knowledge that must be transferred but as a facilitator, a teaching and learning programme developer, a mediator of learning and an assessor (DBE, 1996). These new roles and functions come with attitudes and feelings that have the potential to influence the way the teaching act is viewed and experienced. As a result, a new crop of teachers with the necessary skills and knowledge has to come to the fore so that the new mandate can be carried out.

Therefore, educators are given the responsibility and authority to plan for teaching; arrange the learning content in ways that encourage learning; administer assessment; account to the education authorities for the progress reached in different learning areas; and ensure that learners acquire the necessary SKVS and attitudes embedded in the different subjects. Educators need to have the required SKVs to be able to help learners to navigate the content and concepts embedded in the different subjects. The modus operandi that teachers use has the potential to affect the way learners experience their learning. However, the social environment in which they are raised has a huge role to play in their subject choice, perseverance and inner locus of control in studying the concepts in STEM-related and other subjects. In other words, learners' perspectives and attitudes towards certain subjects are influenced by their socio-cultural environment and their experiences of learning in different classrooms.

In Chapter Four, the researcher analysed descriptive and interpretive data on the perspectives of boys and girls on learning technological concepts in the area of the study. In this chapter, the findings from the literature review, semi-structured interviews and observations are discussed.

5.3 INTERPRETATION OF RESULTS

The results of the study are discussed in two parts, namely the findings of the literature review and the findings of the primary study. The literature review findings support the researcher's interpretation of the study results.

Key findings from literature review are as follows:

- S&T are subjects that most countries offer learners with a view to the development of the nations' economies. Moreover, these subjects are combined with other subjects in different streams in line with the curriculum configurations in those countries (Muller et al., 2014).
- S&T subjects have become omnipresent in schools, continuing to determine the global economic configurations. In fact, the world has adopted technology as a way of life that assists with economic development (Muller, et al., 2014).
- Ordinary people also need technological devices for their livelihood (Ardies et al., 2015b).
- In varying degrees, most countries introduce S&T at the earlier stages of a child's education (Muller, et al., 2014).
- In South Africa, Technology is one of the compulsory subjects that learners need to do at the Senior Phase of the education system (DBE, 2011a).
- Technology prepares learners for subjects, such as Life Science, Physical Science, Mathematics, Mathematical Literacy, Agriculture and Computer Technology, which are offered at the Further Education and Training (FET) Band (DBE, 2011a).
- Socio, historical, economic and cultural factors tend to influence people's choice of S&T-related subjects, which determines the extent to which learners persist in studying those subjects (Makgeru, 2016).

- People attach many meanings to S&T, which largely depend on their earlier experiences of the subjects (predisposition) and the worldviews related to their social way of life, culture, ideology and philosophy of life (Muller et al., 2014).

- The social milieu in which boys and girls find themselves has different expectations from them, which is manifested in the different achievement levels in S&T of boys and girls, which is based on societal worldviews (Makgeru, 2016).

- The differences between girls and boys in their choice of S&T subjects is, therefore, attributed to socialisation because boys and girls are traditionally viewed as individuals who are endowed with different intellectual and cognitive abilities (Reddy et al., 2016).
- Different societal expectations from male and females seem to contribute to the different benefits that boys enjoy at the expense of girls, and society seems poised to entrench and sustain these expectations (Muller et al., 2014).

- Society develops and sustains different gender-based perspectives and attitudes, which has the potential to influence the manner in which learners exert effort in learning S&T (Muller et al., 2014).

- Society inculcates certain patriarchal perspectives in boys and girls, which has a tendency to influence their choice of school subjects. What learners make of S&T subjects depends on societal perspectives of what is expected of males and females in a socio-cultural environment (Majumder, 2015).

- Perspectives are strong human tendencies that are influenced by people's beliefs and experiences over a protracted period (Collins English Dictionary, 2017). Perspectives, therefore, play a pivotal role in influencing what learners make of the subjects that they pursue at school level (Wallace & Priestley, 2011).

- Societies have different perspectives on the aim and objectives of an education system, which influences the subject that learners to take and excel in (Muller et al., 2014)

- The perspectives that society develops of different phenomena in their social milieu are driven by the attitudes society would have developed through its encounter with the phenomena in different contexts over time (Blazar & Kraft, 2017).

- Attitudes, like perspectives, have a major role to play in the successful learning of any school subject, and they also influence the level at which certain subjects can be managed by both boys and girls (Muller et al., 2014).

- Attitudes, cognition, self-efficacy, metacognition and perspectives determine the extent to which learners choose, learn and persist in learning the different subjects of any school curriculum (Organisation for Economic Development [OECD], 2004).

- SA shares geographical borders and similarities with countries such as Swaziland and Botswana in that Technology is offered in their curriculum, although at different levels (UNESCO, 2017).

- Even though SA shares boundaries with these countries, its performance in S&T is lower, which is probably because these countries do not offer these subjects as stand-alone subjects at the primary school level (Parliament of the Republic of South Africa, 2016).

- All countries that offer Technology as a stand-alone subject or in combination with other subjects experience unique challenges in the successful implementation of the subject, which is associated with the quality of skills, knowledge and perspectives that educators have in teaching the subjects (Reddy, et al., 2016; Kok & Schoor, 2014).

- Generally, the performance of both girls and boys in S&T in these countries is skewed in favour of boys who are perceived differently from girls (Leahy & Phelan, 2014).

- At elementary school level, girls seem cognitively more advanced than boys do, but as they progress in the school system boys catch up with girls, which is attributed to socio-cultural expectations from boys and girls. Society has a tendency to expect boys to perform in technology-related subjects, as opposed to girls, and that perspective influences their performance in those subjects (Jensen-III, 2015).

- Boys and girls are biologically different, but performance in school's subjects is largely more dependent on socialisation than physiological differences (Jensen-III, 2015; Cook & Cook, 2014).

- These differences in the performance of both males and females in Technology-related subjects are generalised, as countries such as Ireland, Eswatini, Botswana and Ghana are in the same position. The reasons for such differences are largely related to socialisation and different expectations from girls and boys (Fegan, 2016; Udousoro, 2012; Mthethwa, 2014; Majgaard & Mingat, 2012; UNESCO: 2017).

- The perceived usefulness of Technology tends to influence the degree to which emphasis is laid on learning these subjects over others, and that affects the choice learners make in pursuing other related subjects at school and careers in the world of work (Vishai, 2014).

- The beliefs that people have in learning Technology, its perceived usefulness, and the manner in which society raises children (boys and girls) invariably influence the manner in which boys and girls learn and succeed in learning technological concepts in many school systems (Virtanen et al., 2015).

- International studies have confirmed the fact that home background and the characteristics of the community have a major role to play in the academic achievements of the different genders (OECD, 2007).

- Education is one of the commodities that countries, such Ireland, Ghana, Eswatini and Botswana, target for the preparation of future generations by designing education systems and curricula that prioritise S&T and help in the quest for a STEM curriculum (Muller, et al., 2014) that will give them a competitive edge.

- There are many theories of learning and their usefulness depends, inter alia, on the complexity of the learning task and the purpose for learning (Mechlova & Malcik, 2012).

- Those theories of learning have been developed in a quest to find the actual nature of learning, and such an endeavour does not stop with modern theories of learning (Mechlova & Malcik, 2012; Ouyang & Stanley, 2014).

- Attitudes are often learned from others and have a tendency to make members of a group similar in the way they observe and approach a learning task (Albarracin et al., 2018).

- Despite the perspectives that are shaped in learners' homes and social environment, girls have shown higher performance in careers related to STEM than boys if they are given both the opportunity and support (Sanders, 2005).

- Little is known about student and teacher variables that play a significant role in the development of attitudes towards Technology (Ardies et al., 2013). However, it is known that attitudes play a role in the learning of subjects such as Technology and related subjects (Ardies et al., 2013).

5.3.1 Interpretations from semi-structured interviews

The following was revealed through semi-structured interviews:

- Four 5 girls, against 5 boys, chose Technology because they believed it would open career opportunities for them. More boys than girls chose the subject because of its perceived usefulness, while only 1 girl chose it because of other factors, including the character of the teacher. Therefore, it seems that boys are influenced by society to love technology-related subjects because it is believed that they may lead to careers that men should follow. Girls are not influenced to the same degree as boys. This affirms the findings of the literature review that MST subjects are viewed as a sole preserve for males (Sanders, 2005).

- Three girls, compared to 2 boys, sought help from their teachers when confronted with difficult concepts in Technology, and 3 boys exercised a degree of independence when learning technological concepts, compared to 2 girls. Seemingly, boys are expected by society to exercise a degree of autonomy and independence when faced by difficult situations. Moreover, they are considered as competent to pursue careers that learning technology subjects opens to them (OECD, 2007). These expectations may push boys to show independence and competence in class, whereas girls often rely on assistance from teachers. They view themselves as inadequate when learning a difficult subject like Technology.

- Four girls, compared to 2 boys, considered dropping Technology when faced with difficult concepts during learning. Therefore, most of the girls felt it was difficult to persevere in the face of challenges when dealing with technological concepts. This observation was expected because society does not necessarily expect girls to perform in such a subject, and thus they are influenced by society’s perceptions when learning it (OECD, 2007). Society’s perspectives on difficult subjects that are considered for certain groups significantly influences learners’ perspectives, attitudes and success as well as the way they learn (Ardies et al., 2013).

- One girl indicated that she memorised difficult concepts in Technology, whereas not a single boys used that strategy. Instead, boys indicated that they used various learning strategies to grapple with the different content in Technology. Therefore, girls may feel compelled to do Technology with the result that they memorise the concepts that they do not understand. Not only does this strategy discourage critical and creative thinking, but it also promotes alienation and is counterproductive to learning concepts for assimilation, accommodation and understanding (Mechlova & Malcik, 2012).

- Three girls, against 1 boy, usually sought help from home when faced with difficult technological concepts. Therefore, boys may be more independent in tackling difficult technological concepts than girls who rely on their parents and teachers. Boys seem to command a higher degree of independence than girls. Evidently, this comes from the society they live in. Patriarchal society begets patriarchy. Unfortunately, girls are at the receiving end.

- Two girls, against 4 boys, considered their teachers as skilled individuals, and therefore helpful. This was probably because they believed that their learning was dependent on teachers rather than on their own individual initiative to use different learning approaches, as society expects boys to do (OECD, 2007). Asking for help from teachers is not an issue, but if learning depends entirely on that, it becomes a serious problem (Mechlova & Malicik, 2012).

- Four girls, against 5 boys, used varied learning strategies and resources to learn the difficult parts of Technology. Thus, boys appear to demonstrate a more developed inner locus of control when learning technological concepts, compared to girls. They use individual and diverse learning styles, skills, methods and strategies to contend with the difficulties of Technology.

- 2 girls, compared to 3 boys, used individual and pair work during studying. Therefore, boys appear to be more adept at working as individuals or in pairs, compared to girls. Girls seem more reliant on others for learning than boys. This reliance may come to the fore because of the belief that they need others to perform. The belief is that they cannot do it on their own. Their success is, therefore, dependent on the help of teachers and parents. However, boys feel more in control, as society is behind them, which makes them more independent than girls.

- Four girls, against 2 boys, were influenced by the teachers' reference to technology-related careers during the teaching of technological concepts. Therefore, more girls than boys may be inspired to learn technology because of the careers that they may pursue. They might not be interested in gaining knowledge but learn the subject because there are lucrative careers related to it. Boys are also influenced by the careers that learning Technology offers. The difference is that, boys view those careers as being careers for males, and therefore they are not necessarily influenced by teachers referring to them. The whole of society is behind them, and they know that they will eventually obtain technology-related employment.

- Two girls, against 4 boys, were encouraged to work hard by their parents because of the career opportunities that Technology provides. Societal encouragement of boys at the expense of girls further perpetuates the disparities in the performance levels of the different genders.

- All the boys and girls in the study believed that Technology had a role to play in their communities. This implies, therefore, that learners may understand that a subject like Technology plays a role in their livelihood. However, this view does not translate to the actual learning of the concepts due to biased societal expectations and perceptions at the expense of girls.

- Both boys and girls could successfully learn technological concepts (Ardies et al., 2013). The difference between them is related to the manner society treats and views certain subjects. If society feels that MST subjects are meant for boys, that perception becomes ingrained in the mentality of both boys and girls, leading to different levels of achievement when they attempt the subject. Moreover, society's perspective would influence leaners to the extent that a debilitating worldview would be confirmed. The different genders would then behave in line with that worldview, and any evidence to the contrary would be regarded as an exception than the norm.

5.3.2 Interpretation from observations

- Both boys and girls engage actively in the learning of technological concepts.

- More boys than girls engage their teachers in the learning of Technological concepts. They also actively engage in peer learning for enhanced understanding.

- Learners from quintile 1 and 2 seem reluctant to engage teachers and peers in the learning of the technological concepts.
- Both boys and girls are enthusiastic in learning technological concepts.
- Both boys and girls cooperate and attempt to work in groups during learning. However, more boys than girls show enthusiasm in tackling the concepts and experiments.
- More boys than girls apply various strategies to understand technological concepts or content. Boys demonstrate greater degrees of perseverance and resilience in learning the difficult parts of Technology.
- More boys than girls exercise resilience and perseverance in tackling difficult technological concepts. Boys do not give up easily, even if the concepts are difficult to tackle.
- More girls than boys struggle in tackling difficult technological concepts. Girls rely more on information they solicit from their teachers than independent working. Boys are more independent than girls are, even in tackling confusing aspects of the content.
- Learners from quintile 4-5 participate more actively than those who are from quintiles 1-3. Those from quintiles 4-5, regardless of gender, demonstrate a greater degree of independence and openness in dealing with technological concepts.
- Socio-economic factors play a role in the manner in which both boys and girls participate in their learning. Learners from poor socio-economic background do not perform as well as those from better socio-economic backgrounds.
- Socio-economic factors and the schools' quintile contribute to the degree to which learners participate in learning technological concepts. Therefore, their home environment determines their participation in learning.
- Learners from affluent family backgrounds perform better in learning technological concepts than those from poor family backgrounds.

5.4 CONCLUSION

5.4.1 Conclusion to the study

This study attempted to answer the main research questions and sub-questions. The purpose, aim and objectives of the study were also addressed. Notably, the perspectives of boys and girls on learning technological concepts were discerned, and associated factors were identified. The different approaches that both girls and boys use in studying technological concepts were identified and explained. The role of the teacher in the successful learning of technological concepts was also identified. Teachers play a pivotal role in how learners, both boys and girls, learn certain concepts embedded in different subjects. In addition to the character or gender of the teacher, socio-economic factors have a significant role to play on how learners learn. Learners from affluent family backgrounds engage with the learning content freely, compared to those from poor family backgrounds. The same happens with learners from poor schools. They are reluctant to engage with the learning matter, as is the case with those from quintiles 4-5.

Strategies that could be employed in mitigating the negative effects of certain perspectives towards the learning of technological concepts were mooted. Society plays a significant role in shaping the attitudes and perspectives of most people towards the learning of MST subjects. In dealing with such challenges, a broader and on-going advocacy campaign in the form of seminars and workshops needs to be considered so that perspectives may change for the benefit of the girl-child.

5.4.2 General conclusions

The following conclusions based on the research journey travelled are presented:

- Many states offer technology-related subjects at the elementary phase of their school systems.
- Technology subjects are configured differently from state to state, depending on their socio-economic, vocational and technical need
- All countries that offer technology-related subjects view them as being able to equip their population for its general economic development.

- Most countries experience gender disparities in the learning of technological concepts.
- Society seems to play a major role in influencing girls and boys to choose Technology as a subject.
- Socio-economic factors play a role in the successful learning of Technology on the part of both boys and girls.
- Teachers who teach Technology have the potential to influence the choice that learners make about the learning of Technology.
- Boys seem more independent and self-reliant in learning Technology, compared to girls.
- Boys seem more active in learning Technology, compared to girls.
- Boys demonstrate perseverance and resilience in learning Technology, compared to girls.
- Boys use more strategies in learning technological concepts than girls.
- Girls choose Technology because they believe it opens career opportunities.
- Boys tend to study Technology more for its value than merely for the career opportunities it offers.
- Patriarchy plays a role in learners' decision to pursue Technology.
- Girls associate more easily with female Technology teachers than they do with male teachers.
- Boys are less motivated by the character or gender of the teacher when they are taught Technology.
- Socio-economic factors play a major role in the successful learning of Technology.

- Quintiles 1-3 schools seem to experience challenges with the successful implementation of Technology.

- Society plays a role in the decision that learners take regarding subjects they might want to pursue.

- A less affluent society tends to breed inactive and less enthusiastic learners.

5.5 RECOMMENDATIONS

The following recommendations are made:

- Parents of learners at the Intermediate Phase of the SA school system, regardless of gender, need to be schooled on the usefulness of Technology so that they persuade their learners to give Technology the attention it deserves.

- A dedicated program for the development of teachers of Technology needs to be considered and updated on a continuous basis so that they can be aware of the latest trends and challenges.

- The capacity building workshops run by the DBE, the Provincial Education Departments (PEDs) and the districts need to be responsive to the current needs of teachers and the curriculum. After the administration of each formal assessment, teachers need to do item analysis so that intervention and workshop programs can incorporate the findings in a bid to improve the performance of the subject.

- PEDs need to treat Technology in the same way as they treat Physical Science, Mathematics, Mathematical Literacy and Life Sciences. The perspective that is displayed in the treatment of Technology must change so that the subject is given consideration in terms of budget, resources, technology laboratories, teacher development initiatives, skills development, and so on.

- Teachers and education authorities need to initiate an on-going process of a need's assessment and analysis so that the challenges of Technology can be fully understood.
- Female teachers need to be encouraged to teach Technology, as learners tend to associate the subject with the individual who teaches it. Female teachers would change the perspective of girls towards Technology.
- Female Technology teachers need to be trained in appropriate methodologies of teaching technological concepts. Thus, if there are many female teachers who teach the subject, the myths and negative perspectives towards the subject will be eradicated.
- Male and female teachers need to be encouraged to alternate when teaching technological concepts so that learners can realise that both males and females are at an equal footing in the teaching of the subject.
- Deep learning strategies such as interpretation, evaluation, association, paraphrasing, summarisation and mind maps need to be considered for a deeper processing of technological concepts by both boys and girls. Surface learning tends to inculcate memorisation of the content that might be regurgitated with minimal understanding.
- Both male and female teachers need to teach learners the skills to make models (practical tasks) to minimise overreliance on conceptual teaching so that learners experience the diverse nature of Technology.
- The DBE and the PEDs need to embark on an advocacy campaign to teach society about the importance of Technology so that the negative perspectives could be changed. Female operatives should preferably conduct such campaigns so that society could realise that girls could also be good at Technology.
- Teachers need to pair boys and girls when activities are done. Pairing will inculcate feelings of togetherness and the sharing of expertise, resulting in the development of resilience and perseverance.

- Teachers should form groups that are headed by females so that they are given an opportunity to demonstrate on behalf of the group.

- Boys and girls should alternate when they do experiments so that girls' confidence and self-esteem are developed.

- Schools in quintiles 1-3 need to be given more attention in terms of skills development so that the confidence of both teachers and learners' is elevated for active involvement in class activities.

- Learners from a low-socio-economic background need to be profiled for extra assistance.

- Technology-aligned career exhibitions need to be conducted, and girls should be preferred in staging them so that society and girls could realise that they could also take Technology as a school subject.

- Advocacy campaigns in the form of workshops, roadshows, meetings, seminars and so on need to be considered for broader community (societal) involvement in the successful learning of Technology and other subjects.

- Schools' open days should also be used to teach parents how to assist their children in learning technological concepts.

5.6 AREAS FOR FURTHER RESEARCH

The study was undertaken to investigate the perspectives of boys and girls on learning technological concepts in schools of the Gert Sibande Education District. The outcomes of the study might form the basis for other related studies to be conducted in the field, as the data described and discussed in this research report provided invaluable information that could be used to understand how girls and boys view the learning of technological concepts. It also provided an idea on how other related factors sustain or detract the effects of negative perspectives towards Technology as a subject.

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APPENDIX A: DAILY ACTIVITIES PER DAY

The activities below will take place per school per day in the following identified schools:

<u>Day 1. Monday the 6th of May 2019</u>

1.1 Arrive to school to meet school's SMT and provide purpose of the visit

1.2. Requesting consent forms signed by parent and participant

1.3. Class observations during Technology lessons

1.4. Interview learners.

<u>Day 2. Tuesday the 7th of May 2019</u>

2.1 Arrive to school to meet school's SMT and provide purpose of the visit

2.2. Requesting consent forms signed by parent and participant

2.3. Class observations during Technology lessons

2.4. Interview learners.

<u>Day 3. Wednesday the 8th of May 2019</u>

3.1 Arrive to school to meet school's SMT and provide purpose of the visit

3.2. Requesting consent forms signed by parent and participant

3.3. Class observations during Technology lessons

3.4. Interview learners.

<u>Day 4. Thursday the 9th of May 2019</u>

4.1 Arrive to school to meet school's SMT and provide purpose of the visit

4.2. Requesting consent forms signed by parent and participant

4.3. Class observations during Technology lessons

4.4. Interview learners

<u>Day 5. Friday the 10th of May 2019</u>

5.1 Arrive to school to meet school's SMT and provide purpose of the visit

5.2. Requesting consent forms signed by parent and participant

5.3. Class observations during Technology lessons

5.4. Interview learners

APPENDIX B: A LETTER REQUESTING PARENTAL CONSENT FOR MINORS TO PARTICIPATE IN A RESEARCH PROJECT

Dear Parent

Your _____________<son/daughter/child> is invited to participate in a study entitled **Boys and girls perspectives on learning Technology education concepts: a case study of primary schools.**

I am undertaking this study as part of my master's research at the University of South Africa. The purpose of the study is to understand the perspectives of boys and girls on learning technological concepts and the possible benefits of the study is the improvement of Teaching and Learning of Technology subject. I am asking permission to include your child in this study because he/she meets the objectives and aims of the research study. I expect to have nine other children participating in the study.

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

- Take part in an interview which will take place at 13h00
- Individual interviews will be conducted, and each participant will be accorded approximately 1hour.
- The lesson will be observed, and audio and video recording will be used.

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

There are no foreseeable risks to your child by participating in the study.

The only risk that participants may experience is being interviewed and observed. No undue influence that may be exerted to them. All participants will sign the consent forms.

Your child will receive no direct benefit from participating in the study; however, the possible benefits to education are the knowledge which will be obtained in the study and will be used in addressing the difficulties that learners are confronting in attempting Technology as subjects in Senior Phase of the South African education system

Neither your child nor you will receive any type of payment for participating in this study.

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

The study will take place during regular classroom activities with the prior approval of the school and your child's teacher. However, if you do not want your child to participate, an alternative activity will be available.

In addition to your permission, your child must agree to participate in the study and you, and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation in the study will be stored securely on a password locked computer in my locked office for five years after the study. Thereafter, records will be erased.

The benefits of this study are the knowledge which will be obtained in the study and will be used in addressing the difficulties that learners are confronting in attempting Technology as subjects in Senior Phase of the South African education system.

There are no Potential risks involved because the observations and interviews will take place in schools where learners find themselves on daily basis. They will not be exposed to unfamiliar and unfriendly environments

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

If you have questions about this study please ask me or my study supervisor, Prof T.A Mapotse, Department of Science and Technology, College of Education, University of South Africa. My contact number is 0733753471 and my e-mail is fpdlamini2@gmail.com. The e-mail of my supervisor is mapotta@unisa.ac.za Permission for the study has already been given by Department of Education.

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

Name of child: ________________________________

Sincerely

____________________	____________________	________________
Parent/guardian's name (print)	Parent/guardian's signature	Date
FANZA PHILLMON DLAMINI	FPDlamini	03/04/2019_______
Researcher's name (print)	Researcher's signature	Date

APPENDIX C: LETTER REQUESTING ASSENT FROM LEARNERS IN A PRIMARY SCHOOL TO PARTICIPATE IN A RESEARCH PROJECT

Dear learner, Date______________

My name is Fanza. Phillmon Dlamini and would like to ask you if I can come and watch you do Technology with your teacher and interview you after that. I am trying to learn more about how children do Technology with their teachers and how do they feel about the subject.

If you say YES to do this, I will come to interview and watch you when you are with your teacher doing Technology. We will go to the separate office and I will interview you for one hour. I will not ask you to do anything that may hurt you or that you don't want to do.

I will also ask your parents if you can take part. If you do not want to take part, it will also be fine with me. Remember, you can say 'yes', or you can say 'no', and no one will be upset if you don't want to take part or even if you change your mind later and want to stop. You can ask any questions that you have now. If you have a question later that you didn't think of now, ask me next time I visit your school.

Please speak to mommy or daddy about taking part before you sign this letter. Signing your name at the bottom means that you agree to be in this study. A copy of this letter will be given to your parents.

Regards

Teacher ______________________

Your Name	**Yes, I will take part** 	**No, I don't want to take part** 
Name of the researcher **Mr F.P Dlamini**		
Date		
Witness		

APPENDIX D: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN MPUMALANGA PROVINCE

Title of the research

Boys' and girls' perspectives on learning Technology education concepts: a case study of primary schools

Date 08 March 2018

The Head of Department
Mrs M.O.C Mhlabane
HOD: Department of Education
Mpumalanga province
Contact no: 0137665520
Email address: www.mpumalanga .gov.za

Dear Mrs M.O.C Mhlabane

I, Fanza Phillmon Dlamini am doing research under supervision of Professor T.A Mapotse, a Professor in the Department of Science and Technology, towards an MSc in Technology Education at the University of South Africa. We have funding from Osizweni for paying registration and tuition fees and another one from UNISA for paying for the research activities and attending contact sessions. I request to conduct research with grade 7 Technology learners at Msukaligwa circuit in Gert Sibande district of Mpumalanga province. **The title of the study is, "Boys' and girls' perspectives on learning Technology education concepts: a case study of primary schools"**

The aim of the study is to seek to understand the perspectives of boys and girls on learning technological concepts

Your school has been selected because it meets the objectives and aims of the research study.

The study will entail qualitative research and 10 participants will be interviewed and observed on how they view and learn technological concepts. The equal number of learners would be effectively drawn, from schools in the five quintiles. In other words, two learners will be sampled from each quintile. Purposive sampling procedure will be used in choosing participants.

The benefits of this study is the knowledge which will be obtained in the study and will be used in addressing the difficulties that learners are confronting in attempting Technology as subjects in Senior Phase of the South African education system

There will be no potential risks involved because the observations and interviews will take place in schools where learners find themselves on daily basis. They will not be exposed to unfamiliar and unfriendly environments

There will be no reimbursement or any incentives for participation in the research.
Feedback procedure will entail giving written feedback to teachers, which may help change, their attitudes and approaches in teaching Science and Technology. Parents of learners will also get appropriate feedback. Such feedback will assist them to aid their learners to learn and understand technological concepts.

Yours sincerely

_________________________ (Insert signature of researcher)

Dlamini Fanza Phillmon

Subject advisor for Technology (Researcher)

APPENDIX E: RESPOND FROM MPUMALANGA DEPARTMENT OF EDUCATION

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Building No. 5, Government Boulevard, Riverside Park, Mpumalanga Province
Private Bag X11341, Mbombela, 1200.
Tel: 013 766 5552/5115, Toll Free Line: 0800 203 116

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

Mr Fanza Philmon Dlamini
Email: fpdlamini2@gmail.com
073 375 3471

RE: APPLICATION TO CONDUCT RESEARCH: MR FANZA PHILMON DLAMINI

Your application to conduct research study was received and is therefore acknowledged. The tittle of your research project reads:**" Boys and girls perspectives on learning Technology education concepts: a case study of primary schools"**. I trust that the aims and the objectives of the study will benefit the whole department especially the beneficiaries. Your request is approved subject to you observing the provisions of the departmental research policy which is available in the department website. You are requested to adhere to your university's research ethics as spelt out in your research ethics.

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

For more information kindly liaise with the department's research unit @ 013 766 5476/5148 0r a.baloyi@education.mpu.gov.za

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

MRS MOC MHLABANE
HEAD: EDUCATION
08/ 5 / 18
DATE

MPUMALANGA

APPENDIX F: REQUEST FOR PERMISSION TO CONDUCT RESEARCH FROM SMT AND SGB

Title of the research:

Boys' and girls' perspectives on learning Technology education concepts: a case study of primary schools

Date: 02 May 2019

The SMT and School Governing Body
Care of the principal

____

____

Email address: _________________________

Dear ____

I, Fanza Phillmon Dlamini am doing research under supervision of Professor T.A Mapotse, a Professor in the Department of Science and Technology, towards an MSc in Technology Education at the University of South Africa. We have funding from Osizweni for paying registration and tuition fees and another one from UNISA for paying for the research activities and attending contact sessions. We are inviting your grade 7 learners at your school to participate in a study entitled Boys and girls perspectives on learning Technology education concepts: a case study of primary schools

The aim of the study is to seek to understand the perspectives of boys and girls on learning technological concepts. Your school has been selected because it meets the objectives and aims of the research study.

The study will entail qualitative research and 10 learners will serve as participants and they will be interviewed and observed on how they view and learn technological concepts. The equal number of learners would be effectively drawn, from schools in the five quintiles. In other words, two learners will be sampled from each quintile. Purposive sampling procedure will be used in choosing participants.

The benefits of this study are the knowledge which will be obtained in the study and will be used in addressing the difficulties that learners are confronting in attempting Technology as subjects in Senior Phase of the South African education system.

There will be no potential risks involved because the observations and interviews will take place in schools where learners find themselves on daily basis. They will not be exposed to unfamiliar and unfriendly environments

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

Feedback procedure will entail giving written feedback to teachers, which may help change, their attitudes and approaches in teaching Science and Technology. Parents of learners will also get appropriate feedback. Such feedback will assist them to aid their learners to learn and understand technological concepts. All applicable ethical requirements will be observed. To that effect, confidentiality and anonymity of participants will be maintained at all levels of this research project.

Yours sincerely

FPDlamini ____________________ (insert signature of researcher)

Dlamini Fanza Phillmon

Subject advisor for Technology (Researcher)

PERMISION GRANTED YES…. Or NO….

Principal's Name---

Signature…………………………. Date…………………….

APPENDIX G: INTERVIEW QUESTIONS

1. What are your views and feelings in studying and learning technological concepts?
2. How do you deal with difficult concepts in Technology?
3. Has it ever happened that during learning you decided to give up and how did you deal with that?
4. If you come across difficulties during learning technological concepts, how do you deal with them?
5. In which ways do your teachers assist you in dealing with the difficulties that Technology may pose?
6. Which strategies do you utilise in dealing with difficult parts of Technology?
7. How do you apply different learning approaches in effectively studying and learning technological concepts?
8. How do your teachers influence your learning of Technology?
9. In your opinion, how do your parents motivate you in pursuing technological related careers?
10. Your community has different needs; do you think Technology could play a role in your community? Explain your views/ feelings etc.

APPENDIX H: OBSERVATION CUES

1. How do the learners expend effort in dealing with technological concepts?
2. When they encounter difficulties, how do they deal with them?
3. How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?
4. Do they cooperate and work in groups and how is the spirit of the groups?
5. What is the state of learner's adeptness in applying various strategies in dealing with the learning of technological concepts?
6. Do they show resilience and persistence in the face of difficulties? Explain your answer.
7. What are the differences between boys and girls when they militate against difficulties arising from learning the technological concepts?
8. How do learners differ based on the quintiles?
9. How do socio-economic differences as a factor in learning technological concepts influence quintiles?
10. How does the family background influence the rate at which learners succeed in Technology?

APPENDIX I: DATA COLLECTED THROUGH SEMI-STRUCTURED INTERVIEWS

1. Explain your views and feelings of studying and learning technological concepts.

- GL1"I enjoy studying Technology concepts they give me a chance learn more about Technology".
- BY1 "I enjoy Technology because when I grow up I want to an electrical engineer"
- GL2 "It's nice to know how to build stuffs and the machines that works".
- BY2 "Technology can help us become archaeologist or mechanical engineers"
- GL3 "Me I found Technology very interesting because every in our days is done in Technology, we have a very good teacher"
- BY3 "It's interesting because it makes our lives in our modern days easier".
- GL4 "I feel happy when I'm learning Technology because it's a subject that I like, because it's a subject that matches with my career".
- BL4 "I like Technology because it teaches me about things that I like, careers like electrical engineering, I like working with electricity".
- GL 5 "I study Technology because I like it and provide people with better jobs" (girl)
- BY 5" I like Technology-related careers".

2. How do you deal with difficult concepts in Technology?

- GL1 "When I didn't understand, I go to my teacher and she explains everything for me".
- BY1 "I just go to the library to get an information and if I don't get it and then got to the teacher".
- GL2 "I tried to break it down and learn more".
- BY2 "I have tried out or wrote down what I have or need to do that can make me understand what I don't understand very well, I can ask a teacher or my parents".
- GL3." We have never been in this situation our teacher explains all the concepts very well".
- BY3 "By asking questions so as to understand the work which are difficult"?
- GL4. "I discover it or find it in the meaning if I don't get it then I ask from the teacher"
- BY4. "Sometimes I ask my brother who is at the high school but at some other times I can work on my own".
- GL5. "I open my dictionary and ask the teacher".
- GL5 "I study them thoroughly until I understand very well".

3. Has it ever happened that during learning, you decided to give up and how

did you deal with that?

- GL1. “Yes, it has once happened, and I went to my friend and he advised me and then he said we must go to the teacher, she will give a better advice because she knows better”.
- BY1.” It has ever happened and then I asked my mother and she told me how I should defend myself from that”.
- GL2. “I tried to memorise what I have learnt and study more”.
- BY2 “It had happened sometimes, I realised that if I give up how I’m going to have a better future, then I think that if I give up on a test how am I going to get a pass mark”
- GL3“It had happened, but we have a good Technology teacher, he motivated me to not give up”.
- BY3. “It has happened, and I remembered the reason why I started? And that reason encouraged me to go on and see what the outcome will be”
- GL4. “It has never happened, because like the subject”
- BY4” Yes, sometimes it happened but I ask for help from my brother to assist me on the things which are challenging me”.
- GL5 “Yes, but my friends advised me to not give up but study thoroughly”.
- BY5 No, when it come, I think about the benefit after getting the Technology-related qualification.”

4. If you come across difficulties during learning technological concepts, how do you deal with them?

- GL1 “Sometimes if I don’t understand I go to my elder sister who had also learnt Technology and she assist me”.
- BY1 “I just ask for clarity from my teacher if there is something I don’t understand, and she will tell me”.
- GL2“I tried to get more help from my parents and teachers”.
- BY2 “I’m going to internet and search for information or go to the elder person to assist me, in most of the time; I go to my sister to ask for help”.
- GL3. “I study and read hard and ask our teacher, and then he will explain for us”.
- BY3. “I do research and ask questions about the things that I don’t understand or that makes it difficult for me to learn”.
- GL4 “I ask for the help from the teacher or my father who is working at ESKOM as a civil engineer”.
- BY4 “I and my friends work together and get the solution to problem”.
- GL5 “I skip the difficult questions”
- BY5 “I study harder until I get the answers and understand the work well’

5. In which ways do your teachers assist you in dealing with the difficulties

that Technology may pose?

- GL1. They just ask if the class had understood and if you say no, she will start to explain again.
- BY1. “If I don’t understand, I work individual and if I’m challenged, I work in pair or in group with other learners”.
- GL2. “My teachers help me by explaining the difficult work and help me understand”.
- BY2. “The teacher brings the materials and shows how to do things and she demonstrates in front of us so that we will observe how to do it, she also explains all the new concepts until we all understand”.
- GL3. “He knows how to explain everything until it gets into our heads”.
- BY3.” He just tells you that Technology is difficult, and you need to put more efforts in order to understand the work”.
- GL4 “I take the rough papers and draw some circuit diagrams or try to find at home if the connection is parallel or in series”.
- BY4. “The teacher encourages us to study hard in order to make our dreams come true”.
- GL5. “The school environment encourages us teacher are teaching us”.
- BY5.” The teacher tells about the importance of the subject”.

6. Which strategies do you utilise in dealing with difficult parts of Technology?

- GL1. I take textbooks and learn more or go to the teachers and ask for clarity on the difficult concepts.
- BY1. I take textbook study and answer questions also read notes from the teacher and if I come across difficult questions, I ask my teacher.
- GL2.” My studying its usually different but I use to memorise it talk it louder”
- BY2. “When we are writing a test, I start in some days in advance and not one day before writing of test, I give myself enough time to study or learn”.
- GL3. “Since we have a good teacher, I will use Technological gadgets to understand Technology
- BY3. “I go to my sister and she assists me”.
- GL4. “I take the rough papers and draw some models.
- BY4. “When I want to make a circuit diagram, I only have to find the material and I will go house to house till I get it”
- GL5. “I listen very well from the teacher when teaching”
- BY5. “I use the dictionary”

7. How do you apply different learning approaches in effectively studying and learning technological concepts?

- GL1 I work individual sometimes if I don’t understand we work in pairs.
- BY1 I take a textbook study it and answer the questions, also read notes from the teacher and if I come across the challenging question, I ask clarity from my teacher.
- GL2. “It depends on what you learn and in learning different stuffs and I use different strategies”.
- BY2. “I need space to study alone and if I come across with difficulties I ask for assistance from my mother”
- GL3 “We read and summarise or use mind maps”
- BY3.” I read and memorise”
- GL4. “I take the rough papers and draw circuit diagrams from the drawings
- I can understand”.
- BY4. “I go to library to study and write my work or when I’m at school I work with my friends”.
- GL5. “I use a dictionary to find meaning of new words”.
- BY5. “I Study my books until I understand well”.

8. Explain the way your teachers influence your learning of Technology.

- GL1.” He introduces us to Technology careers”.
- BY1. “Our teacher tells us that Technology help preparing us for better jobs”.
- GL2. “My teacher teaches us not to give up and he show us how to learn”
- BY2. “She influences us to learn and participate in class.
- GL3. “Our teacher told us that this subject open for us the gates to get better job opportunities”.
- BL3. “We have a very good Technology teacher, he explains very well, in such a way that everything gets into our heads and visible teaching aids”.
- GL4. “Our teacher tells us to work harder in order to make our dreams come true”.
- BY4. “Our teacher tells us not to give up, because we are preparing our future and it would brighter if we work harder”.
- GL5. “Our teacher tells about the job opportunities related to this subject”.
- BY5. “Our teacher love this subject and he attends all his periods”.

9. In your opinion, how your parents motivate you in pursuing technological related careers?

- GL1. “They say I must work harder Technology is difficult for girls”
- BY1. “My parents Technology is good subject that can make me get better job”.

- GL2. “My dad is an IT specialist; see him with cameras and other technological stuffs”
- BY2. “At home they encourage me to become an archaeologist because I’m able do things”
- GL3. “They tell me that I can be the best that I want to be”.
- BY3. “They told me to keep on working hard and make a difference in people lives using Technology”.
- GL4. “My parents want me to be an electrical engineer”.
- BY4. “My father wants me to be a doctor, but I want to the electrician”.
- GL5. “My parents want me to be the quantity surveyor”.
- BY5. “My parents want me to be a miner”.

10. Your community has different needs; do you think Technology could play a role in your community? Explain your views/feelings etc.

- GL1. “Yes, it can help solving littering problem by recycling plastics, bottles and papers”.
- BY1. “Technology can be a solution to our daily problems, for example if there is a lack of network, Technology can be used to build a cell phone tower”
- GL2. “Yes, it can help them to build their own stuffs and sorting their own problems”
- BY2. “Yes, Sir Technology can play a big role for example there is no network, then Technology can help us on that”
- GL3. “Yes, it could help us, because most jobs Technology, I think it will play a big role in people’s lives”.
- BY3. “Yes, it could help them, because with Technology you could do anything you like to do”
- GL4. “Yes, some of the community need electricity and Technology can address those needs”.
- BY4. “Yes, sometimes in our community electricity can be a problem therefore by becoming an electrician I can solve that problem”.
- GL5. “Technology can bring the solution to the existing problems in the community like diseases, Technology investigate find medicines for curing diseases”.
- BY5. “Technology can identify community problems and come up with solutions”

APPENDIX J: DATA COLLECTED THROUGH OBSERVATION TECHNIQUE

1. How do the learners expend effort in dealing with technological concepts?

S1. Most of the learners both boys and girls raise their hands to respond to the questions asked.

E2. All the learners were listening attentively and trying to find or observe the patterns of the magnetic fields.

QP3. Learners were eager to know the two ways of connecting a circuit.

EP4.All the learners were listening attentively to the instruction on making an electro-magnet. They asked questions to find clarity from their educator where they were not having a clear understanding. They also asked for materials and tools for making the electromagnet.

TG5. Learners were excited and willing to work with the tools and material brought by at the teacher in the class.

2. When they encounter difficulties, how do they deal with them?

S1. Most of the learners use to discuss and whisper their responses with their peers sitting next them. Then respond to the question asked.

E2. Learners were unable to establish the patterns that have been formed by the iron fillings and the types of magnets that they discuss with their pairs.

QP3 When they come across with difficult concepts they discuss or work as pairs or ask for clarity from the teacher.

EP4. They raise their hands and ask for assistance from their educator.

TG5. When given a difficult task to do, they make noise, without and only few of them would come up with correct responses.

3. How do learners show enthusiasm in withstanding the difficulties that technological concepts may pose?

S1. They tried by their all means to come up or formulate their own understanding of the concepts. Some were correct, and some were wrong.

E2. Learners showed their enthusiasm by asking for clarity seeking questions from their teacher and ask for extra material for the appropriate observation of the magnetic fields and observation of the patterns formed by the iron fillings.

QP3. Learners were prepared to listen to the teachers, they were so quiet and answered all the questions asked by the teacher.

EP4. Learners were eager to prove and understand what was said theoretically. They want to apply it practical by making the model of an electro-magnet, using tools and material. They were sharing ideas on how to approach the task.

TG5. Learners were willing to learn, and they answered all the questions asked.

4. Do they cooperate and work in groups and how is the spirit of the groups?

S1. Learners were able to work in pairs and in groups in doing the given tasks or attempting activity of assembling the electrical circuit.

E2. Learners worked in pairs and groups and they listened to the teacher when giving some instructions.

QP3. Learners worked in pairs in order to arrive to the questions asked by the teacher

EP4. Learners work co-operatively in groups on making an electro-magnet. They shared ideas on how to approach the task.

TG5. Learners worked well in their groups.

5. Explain the state of learners' adeptness in applying various strategies in dealing with the learning of technological concepts?

S1. The question and answer method were used, and it fitted very well because all lesson participated or were engaged in the lesson.

E2. Learners attempted to give the definition of magnet and magnetic fields and some were correct, and some were wrong. They gave correct answer when they work as the group.

QP3. The teacher made use of a telling and demonstration method and some of the learners were drowsy and sleeping.

EP 4. All learners were listening attentively to the instruction on making an electromagnet. They asked questions to find clarity where they not clear.

TG5.Some learners were using dictionaries and in order to understand the new concepts.

6. Do they show resilience and persistence in the face of difficulties?

Explain your answer.

S1. The group which was dominated by girls struggled to assembly the electrical circuit. The one dominated by the boys enjoyed the activity and assembled the circuit quickly.

E2. When it became difficult, they use to be quiet and think they wrote correct responses. Boys were faster than the girls in writing the answers or in answering the questions.

QP3. More girls were participating more than the boys and the teacher ended up saying electricity is a boy thing and why are they not participating well.

EP4.When the group, encounter some difficulties they for help from the group seated next to them or from the educator.

TG.5 learners to discuss questions as group and assisted each other until they arrive to the correct responses.

7. Explain the differences between boys and girls when they militate against difficulties arising from learning the technological concepts

S1. When the question gets difficult or abstract and need higher order thinking girls struggled to participate and boys would participate actively

E2. Boys seem to be familiar to the magnets and concepts magnetic fields because sometimes they play with them and girls were struggling.

QP3. Many girls were participating more than boys.

QP4. Girls were more active than the boys

TG5. Both girls and girls were participating equally on the tasks given.

8. How do learners differ based on the quintiles?

At higher quintiles, learners participated very well, and at the lower ones, participation deteriorated.

9. Explain how socio-economic differences as a factor in learning technological concepts can influence quintiles?

Learners who came from affluent socio-economic backgrounds participated well because their parents assisted them with their schoolwork. They were also exposed to technological gadgets, which could assist them in accessing the information needed at school.

10. How does the family background influence the rate at which learners succeed in Technology?

Children who were staying with educated parents performed well at school because those parents usually gave their children positive motivation and they assisted them with schoolwork.

APPENDIX K : PROOFREADING CERTIFICATE

ONE STOP SOLUTION

Professional Editing Services

Proofreading Certificate

It is hereby certified that this dissertation has been proofread and edited for spelling, grammar and punctuation by a professional English language editor from www.OneStopSolution.co.za

Client

FANZA PHILLMON DLAMINI

Boys' and girls' perspectives on learning technology education concepts: a case study of primary schools

Submitted in fulfilment of the requirements for the degree of
Master of Science
at the University of South Africa

Editor

Dr. Maureen Klos

Name

Signature

04 May 2021

Date

I cannot guarantee that the changes that I have suggested have been implemented nor do I take responsibility for any other changes or additions that may have been made subsequently. The track changes of the language editing will be available for inspection upon enquiry, for a period of one year.

Contact

One Stop Solution
18 Woltemade str
Kabega Park
Port Elizabeth
6045

Redène Wynand
076 481 8341 / 060 520 1047
www.onestopsolution.co.za

APPENDIX L: LANGUAGE TRANSLATION CERTIFICATE

AFROLINGO
Bridging you to Africa

Certificate of Translation

To Whom It May Concern

We, Afrolingo, certify that the enclosed document in Zulu Language entitled "ABSTRACT TO BE TRANSLATED TO ISIZULU" Is true and accurate translation from English Language which, to the best of our knowledge, reflects the meaning of the original document.

Date: Tuesday, 17 September 2019

Signed on this date: Tuesday 17-09-2019

Translator's Name and Signature:
Afrolingo

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W: www.afrolingo.co.za
A: Ground Floor, Liesbeek house, River Park, Cape Town, South Africa

APPENDIX M: ETHICS CLEARANCE CERTIFICATE

UNISA | university of south africa

UNISA ISTE ETHICS REVIEW COMMITTEE

Date 4 March 2019

ERC Reference # : **2019_CGS/ISTE+04**
Name: FANZA PHILLMON DLAMINI
Student #: 61280542

Dear Mr Fanza Phillmon Dlamini

Decision: Ethics Approval from 4 MARCH 2019 to 4 MARCH 2022 (Humans involved)

Researcher(s): Mr Fanza Phillmon Dlamini
Tel: 0178819905
e-Mail:fpdlamini2@gmail.com
Postal address: P.O Box 474, Dundonald, 2336

Supervisor (s): Prof Mapotse T.A
Tel: 0127997007
e-Mail: mapotta@unisa.ac.za

RECEIVED
2019 -03- 04
OFFICE OF THE EXECUTIVE DEAN
College of Science, Engineering and Technology

Working title of research:

Boys and girls perspectives on learning technology education concepts: A case study of primary schools

Qualification: MSc in Technology Education

Thank you for the application for research ethics clearance by the Unisa ISTE Ethics Review Committee for the above mentioned research. Ethics approval is granted for **3 YEARS**.

*The **low risk application** was **expedited** by the ISTE Ethics Review Committee on 4 MARCH 2019 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.

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

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 **ERC** 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, accompanied by a progress report.
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 require additional ethics clearance.
7. No field work activities may continue after the expiry date (**4 MARCH 2022**). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2019_CGS/ISTE+04** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature Padayachee
Chair of ISTE ERC : Prof K Padayachee
E-mail: padayk@unisa.ac.za
Tel: (012) 429-6191

Signature BBMamba
Executive Dean : Prof B Mamba
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