TECHNOLOGY LITERACY FOR TEACHERS IN RURAL SCHOOLS: CONSTRUCTING KEY CONCEPTS IN TECHNOLOGY EDUCATION FOR TEACHERS IN THE ILEMBE DISTRICT

BY

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Technology literacy for teachers in rural schools: constructing key concepts in technology education for teachers in the Ilembe district

by

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ABSTRACT

This study is concerned with technology education, which is a vital aspect of South Africa's development in commerce, industry and research. For effective teaching of the subject Technology, educators need to be able both to understand and to apply key technological concepts, so that they can facilitate the development of these competencies by learners. In rural districts such as Ilembe, scholastic achievement is low, and the teachers themselves often do not possess the requisite technological expertise to pass on to learners, and lack the necessary technological pedagogical conceptual knowledge (TPACK) to inform teaching practice. It is the contention of this study that these concepts might be modelled for teachers by a combination of theoretical input and experiential learning, which is illustrated with reference to an educator training session with a selected group of teachers from the Ilembe district. This study therefore describes how the development of key concepts in technology education was facilitated and provides the results of this intervention. Working within the social constructivist paradigm and using a case study methodology, the researcher carried out an educator survey, in-depth interviews and a pre-test questionnaire to gather data about implementation of technology education as well as the specific areas in which teachers expressed a need for support. The researcher then designed and conducted an intervention comprising a one-day departmental training session for a large group of Technology teachers in which technical processes and an appropriate pedagogy for teaching these were modelled. A post-test questionnaire indicated that the intervention had been effective in communicating key concepts in technology education as well as improving pedagogical skills. This study is thought to be of value, as it describes not only the nature of an effective intervention but also a methodology for arriving at an intervention which will suit the context, purpose and target audience involved. The study contributes to the body of knowledge in the field of technology education by proposing a teacher developmental model comprising a District Based Professional Learning Community (DBPLC).

PREFACE

DECLARATION OF ORIGINALITY

I, Rohith Rambrij, declare that this thesis is my own work and all the sources used or quoted have been indicated and acknowledged by means of complete references. The only form in which this work has previously been published is in the educator training workshops run by the researcher.

SIGNED: ________________________ DATE: 12 August 2018

REFERENCING STYLE USED

The referencing style used is that given in the *Referencing guide: Harvard referencing style* (Mitha *et al.* 2016). *EndNote 8* was used to generate the Reference list, using the DUT Harvard EndNote style 2015.

CONVENTIONS USED

The terms “technology” and “technology education” are printed in lower case (except as first word of a sentence or indented list, or when capitalised in verbatim citations). However, the school subject “Technology” has its first letter capitalised to avoid confusion (see Mpotse 2012: 1).

DEDICATION

In memory of my late parents Mr and Mrs Balasur Rambrij and my late sisters, who taught me to remain humble at all times and to remember the less fortunate.

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DECLARATION CERTIFICATE OF ENGLISH LANGUAGE EDITING

This is to certify that I have edited the body of the thesis:

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DISCLAIMER

Whilst the English language editor has used electronic track changes to facilitate corrections and has inserted comments and queries in the right-hand column, the responsibility for implementing changes in the final, submitted document, remains the responsibility of the candidate in consultation with the supervisor/promoter.

ACRONYMS

CAPS - Curriculum and Assessment Policy Statements
CK - Content knowledge
CPTD - Continued Professional Teacher Development
CAT - Computer Applications Technology
CHE - Council on Higher Education
CHET - Centre for Higher Education Transformation
DBE - Department of Basic Education
DBPLC - District Based Professional Learning Community
DHET - Department of Higher Education and Training
EC - European Commission
EFAGMR - Education for All Global Monitoring Report
EMIS - Education Management and Information Systems
ET- Educational Technology
FET- Further Education and Training
GET - General Education and Training
HEI - Higher Education Institute
HESA - Higher Education South Africa
HOTS - Higher Order Thinking Skills
HSRC - Human Science Research Council
ICT - Information and Communication Technology
IDMEC - Investigate, Design, Make, Evaluate, Communicate
IKS - Indigenous Knowledge Systems
ISPFTED - Integrated Strategic Planning Framework for Teacher Education and Development
IT - Information Technology
ITE - Initial Teacher Education
KZN - DoE- Kwazulu Natal Department of Education
KZN - Kwazulu–Natal
LOLT- Language of learning and teaching

LTSM - Learning and teaching support materials

Mini-PAT- Miniature peer assessment tool

MKO - The More Knowledgeable Other

NCS - National Curriculum Statements

NDP- National Development Plan

NEEDU - National Education Evaluation and Development Unit

NQF - National Qualifications Framework

PCK - Pedagogical content knowledge

PLC - Professional learning community

PTDI - Provincial Teacher Development Institute

SACE - South African Council of Educators.

SACMEQ - Southern African Consortium for Monitoring Educational Quality

SA-SAMS - South African Schools Administration and Management Systems

SBPLC - School Based Professional Learning Communities

SPSS - Statistical Package for Social Sciences

STEM - Science, Technology, Engineering and Mathematics

TE -Technology education

TIMSS - Trends in International Mathematics and Science Study

TPACK - Technological pedagogical content knowledge

TVET - Technical Vocational Education Training

UNESSCO - Unite Nations Educational, Scientific and Cultural Organisation

ZAD - Zone of Actual Development

ZPD - Zone of Proximal Development

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Chapter 1 first sets the research in context in terms of the need for technology-skilled citizens in South Africa, the importance of properly trained educators, the need for teacher development programmes, the problems facing provision of skilled educators, and the crisis indicated by matric results. It next looks at the research problem to be investigated in this study, and the aim and objectives of the research. After providing definitions of key terms, comprising technology, technology education, teacher and learner preparedness, conceptualisation of technology and practical application of technology, the main themes of the research are identified. After suggesting the value of the research and new contribution to knowledge, the chapter concludes with an overview of subsequent chapters.

1.2 Context of the research

This section will set the context of the research in terms of the following key aspects:

- the need for technology-skilled citizens in South Africa;
- the importance of properly trained teachers;
- the need for teacher development programmes;
- the problems facing provision of skilled teachers; and
- the crisis indicated by matric results.

1.2.1 The need for technology-skilled citizens in South Africa

The headline, “We don’t need no education, just jobs”, which appeared in the Sunday Tribune (Nkomo 2016: 17), sums up the very sad state of employment opportunities in South Africa. Education is considered a key that opens doors and eliminates poverty, unemployment and other social issues like crime, yet more graduates are struggling to find jobs, and the unemployment rate keeps rising. A bleak future was already being forecast for 2016, with the job crisis anticipated to worsen in 2017 (Dlamini 2017; Menon 2017), based on forecasts by commercial business, construction and mining sources and various economists, as well as spokespersons of the Congress of South African Trade Unions (COSATU) and the South African Federation of Trade Unions (SAFTU). Some of the reasons given for the joblessness were a lack of skills and skills transfer (Nkomo 2016: 17). This is supported by the results of the Executive Opinion Survey carried out by the world Economic Forum, which ranked South Africa's science and mathematics education last out of one hundred and forty-eight economies that were surveyed; poor maths and science education were seen as being at the heart of South Africa's skills problem (Moodley 2014).

This sentiment is supported by Deputy Minister of Basic education, Mr Enver Surty, during his visits to the Northern Cape Adcorp Technical Training Campus in Welkom, where he stated:

> Education is not purely academic. There is a technical aspect which is critical. South Africa is lacking in certain critical skills and often has to import skills. It is through a focus on skills development through technical schools and TVET colleges – that the country will be able to grow its own timber (South African Government Media 2015).

This extract shows that there needs to be a link between what happens at schools and the requirements of the economy. TVET enrolment shot up to more than 700 000 from nearly 360 000 in 2010, owing to the drive of the then Minister of Higher Education and Training, Dr Blade Nzimande, to attract more matriculants to TVET colleges; however, high youth unemployment figures meant that an equally high number of TVET graduates still remain unemployed (Nkosi 2017: 3). KwaZulu-Natal MEC for Finance, Belinda Scott, highlighted the issue of the unemployment rate in Kwazulu-Natal, which remains at 25.9%, with 50% of the youth being unemployed (South African Government Media 2017). Yet, international recruitment for technical jobs remains high, putting into question the employability of mainly marginalised black African youth, which suggests that not only qualifications, but prior work experience in industrialised countries, is required by industry. Erasmus and Breier point out (2010: 2) that international recruitment can cause dissatisfaction and even prompt emigration of skilled local staff, exacerbating the skills shortage in undeveloped countries.

Technology education needs to be viewed in the social context of a post-liberation country in which technological knowledge and skills urgently need to be developed in the new generation. Consequently, jobs will be available for future generations to address the serious social ills of poverty, unemployment and crime, and a skilled workforce will be available to transform the country into a global role player, rather than a country downgraded to “junk” status (Brown 2017). South Africa has been part of the global village since the fall of Apartheid in 1994, and is currently ranked 47 out of 138 countries on the global competitive index framework (Schwab 2016: 5-8). With the ushering in of the fourth industrial revolution, technology and innovation are increasingly driving development and the country need to produce citizens who can think critically, and possess high level of knowledge skills to be competitive in the changing workplace.

1.2.2 The importance of trained educators

There is a shortage of teachers, especially teachers of the subject Technology worldwide, and it is predicted that it will continue to increase (kindly refer to the Preface, p. ii, for use of capitalisation for “Technology”). Education scholars in South Africa also concur that there are shortages of teachers in schools **in** the country (Makgato and Khoza 2015). In their Report on the National Review of Academic and Professional Programmes in Education, the Council on Higher Education (CHE) found that supply did not meet demand in some provinces (Council on Higher Education 2010: 10). Even more seriously, the Centre for Development and Enterprise (CDE) examined South Africa’s teacher supply and demand for the next decade and found that South African teachers are not adequately matched to subjects or schooling phases (Bernstein 2015: 22-24).

Even when teachers are matched to subjects or schooling phases, the quality of instruction may be poor. As Makgato (2014: 3689) points out, “Teachers are the key to good education and they are also the key to poor education.” It is educators who are blamed for failing to equip their learners with the knowledge and skills needed to keep up with the changing technological world (Reddy, Ankiewicz and De Swardt 2005: 32). The blame is acknowledged by the Department of Higher Education and Training (DHET) in the following quotation:

> While it must be recognised that a wide variety of factors interact to impact on the quality of the education system in South Africa, teachers' poor subject matter knowledge and pedagogical content knowledge are important contributors (South Africa. Department of Higher Education and Training 2011: 4).

According to Mji and Makgato (2006), studies were undertaken which identified a number of shortcomings in the teaching and learning of mathematics and science in South Africa. They cite the Third International Mathematics and Science Study (TIMSS) conducted in 1995, in which South Africa participated with forty-one others, and report that South African learners came last with a mean score of 351. They further state that outdated teaching practices and a lack of basic content knowledge have resulted in poor teaching standards. The poor standards have also been exacerbated by a large number of under-qualified or unqualified teachers who teach in overcrowded and non–equipped classrooms. All of these factors have contributed to a cycle of mediocrity (Mji and Makgato 2006). The Department of Basic Education (DBE) revealed in Parliament that there were 2875 unqualified or under-qualified teachers in KwaZulu–Natal in 2016, the majority being in rural KwaZulu–Natal (Savides 2017).

The young generation is entering a world which is changing in all spheres: scientific and technological; political; economic; social; and cultural. The status of education is changing. Once seen as a factor of unity and integration within societies, capable of overcoming social and economic differences and distinctions, it is increasingly becoming a source of differences and distinctions between societies in global economy which rewards those who possess more advanced skills and limits the opportunities of those who do not. Educators are key to improving the status of education and changing the lives of the young generation to face the future with confidence and eliminate poverty, unemployment and other social issues like crime (UNESCO 2000). According to the Global Monitoring Report 2015, education, if delivered well, enables people to fulfil their individual potential and to contribute to the economic, political and social transformation of their countries. The report further places at its centre quality teachers who are capable of delivering a curriculum that provides learning opportunities for all children and youth (UNESCO 2015).

It is evident from these reports that educators form the backbone of all progressive societies wanting to progress in the 21^{st} Century. Since the entry of South Africa into the global village the expectations of the country to produce technicians, engineers and artisans has increased. According to Van Broekhuizen (2016: 3-4), currently there is a critical shortage of 20 000 - 30 000 educators; of these, there is an absolute shortage of qualified teachers and a relative shortage of qualified teachers who can teach specific subjects (e.g., mathematics and physical science) and /or who can teach specific languages. As already mentioned, most of the skills shortage is in the area of mathematics, science and Technology, and the majority of the vacancies to fill these posts are in the rural and deep rural areas of KwaZulu-Natal (Savides 2017).

Following the announcement of the country's matric pass rate of 72.5%, the Department of Basic Education (DBE) has acknowledged that teachers are not properly equipped for subjects they teach at times. According to the Department's Director-General Mathanzima Mweli, there are instances in which a candidate's experience and qualifications do not match the requirements of the job, and this impacts on the quality of teaching the learners receive. Since the department has been experiencing difficulty in getting teachers who are suitably qualified in mathematics and science, it has been sourcing some teachers from neighbouring countries (Magwedze and Nicolaides 2017).

The time that most teachers undergo intensive in-service teacher training is when they study for their teaching qualifications, and their teaching practice is monitored by their supervisors from either the universities or other teaching training institutions. Once they leave the respective institutions they are not recalled to upgrade their knowledge and skills, since teacher development is an ongoing process. In South Africa this problem is further compounded by the closure of teacher training colleges by the Department of Education and the implementation of outcomes-based education (OBE) with the inclusion of new learning areas to the curriculum. Educators who are agents of change are able to embrace 21st Century curriculum and implement it in line with the goals of the National Development Plan.

1.2.3 The need for teacher development programmes

According to the budget address by Finance Minister, Belinda Scott, Kwazulu-Natal allocates the largest portion of the provincial budget to the Department of Education, which receives 41.2% over the Medium Term Expenditure Framework of R47 477 billion (South African Government Media 2017). The focus over the Medium Term Expenditure Framework is in improving curriculum delivery.

Teachers are often the subject of criticism for their role in the non-achievement of the educational objectives or paradoxically, as persons with whom educational systems and processes cannot dispense. International renewal movements have not excluded teachers. In many instances the poor quality of public education is laid at the door of the teaching corps. In Canada, for example, it is reported that, although teachers' achievements are neither recognised nor rewarded, they are at the same time held accountable for all shortcomings in public education, including those beyond their control (Pretorius 2008).

Yet teachers are recognised as "necessary" companions on the road to improving education. Teacher-development programmes are an important pre-requisite for teachers to learn new knowledge and skills and to be fully informed of the new policies in place, such as the National Development Plan (South Africa. National Planning Commission 2010), and White Paper 7 on e-learning (South Africa. Department of Education 2003), including current trends and practices in education. If this is done in a well-planned and organised manner, it will inspire and energise educators to "buy into" the programme and will contribute towards eliminating many of the challenges. The process begins with the foundation phase (Grade R - Grade 3) teachers, and continues all the way up to the Grade 12 teachers who contribute to help to build the foundations for future generations of educators and artisans. It is also important for the government of the day, via the Department of Education, to get value for money from its investment in education by getting the desired results.

1.2.4 The lack of highly trained and skilled Technology teachers

Technology teachers are supposed to have expert content knowledge, both theory and practical, combined with pedagogical content knowledge, knowledge of the curriculum, technological content knowledge and knowledge of assessment strategies in order to deliver the curriculum effectively. The foundations of education are built on the shoulders of highly skilled and trained educators, who provide the platform for learners to experiment with career choices as early as grade R, and who later on in their schooling careers, recall these experiments to make career choices. On the basis of data available Mda concludes that South Africa has a great need for "quality teachers to offer quality education" (2010: 6) which it has not provided; a conclusion supported by Bloch (2007) and Metcalfe (2008). Metcalfe (2008) cites quality of teachers as the most significant element affecting learner performance, poor conceptual knowledge, poor grasp of subjects taught, high level of errors in lessons delivered, and low expectations of learners, which become a self-fulfilling prophecy. Bloch (2007: 6) emphasises teachers' poor subject knowledge, the limited time they spend on teaching, and poor discipline as being particularly problematic. He sums up the situation by saying that, in failing to achieve quality delivery of education, the education system is working only for the small number of learners who have access to quality schools. Shepherd (2015: 21) makes the point that mere content knowledge on its own is useless, and that, while deep subject knowledge is important, it is more important that teachers have the ability to transfer that information in a meaningful way to learners. Thus teachers need "higher level training" by people who not only know more about the subject but more about how to teach it.

The key to learners making positive choices in meeting the vocational skills challenges of the 21st Century is a body of highly trained and skilled teachers. These teachers will also possess the knowledge and skill to guide learners to make the correct subject choices by identifying the potential of learners early on in the General Education and Training band.

However, continual curriculum changes have taken their toll on teacher expertise. Studies have been conducted on teachers' experiences of curriculum implementation, for example, OBE, Curriculum 2005 and the Revised National Curriculum Statement. According to Carl (2002: 172), the extent which a new curriculum is successfully implemented depends on whether participants are properly briefed, whether they have been sufficiently prepared for change, and whether they are sufficiently motivated to effect change. A study by Mdutshane (2006) aimed to investigate teachers' theoretical understanding of the curriculum and to identify the teaching and learning strategies they used during the implementation of Curriculum 2005. She concluded that teachers did not have a clear knowledge of the theories and principles underpinning the new curriculum. A later study by Thaanyane (2010) found that teachers had not been trained adequately on how to implement their subject (business education), and that not many of the teachers had been involved in designing the new curriculum, which must have been a demotivating factor. Teachers were also not trained in the requisite teaching methods, as there was an assumption that they would not experience problems implementing the new syllabus. As a result, they found it difficult to implement the new syllabus and resorted to using previous teaching methods. Makgato's (2012) study on teachers in urban, semi-urban and rural schools showed that they did not have the requisite content knowledge to teach Technology, that they were not adequately trained to teach it, and that a mismatch was evident in their use of teaching approaches.

In 2008, the Vice President on Education of the South African Democratic Teacher's Union (SADTU) Vice President on Education, Tseli Dipholo, warned that the union believed that about 60% of the country's teachers did not understand the new curriculum and that this was leading to a crisis (Jooste 2008: 5). In 2017, the SADTU General Secretary, Mugwena Maluleke, said the problem was not teachers who were qualified, it was that they were being allocated to a different subject: the real problem was "misallocation of resources" (Savides 2017). The high failure rate that this country experiences can be attributed partially to this lack of understanding about teacher allocation. The problem of solving the skills crisis is further exacerbated by emigration, early retirements, deteriorating working conditions and HIV/AIDS.

According to Pretorius (2008: 167), it is essential that relevant education is provided for societies such as South Africa, which are being “continually transformed by political change, new technology, economic globalization, demographic shifts and workplace restructuring”. Pretorius also points out that, in the face of international competition, education is seen as a key factor in the survival of struggling economies. Yet in 2014, based on various sources, Pretorius (2014: 348) reported that 80% of South Africa’s schools could be viewed as “dysfunctional”.

1.2.5 The crisis indicated by matric results

Education MEC, Mthandeni Dlungwana, stated during his budget speech that his department was focussed on achieving nothing less than a 76% matric pass rate for the class of 2017 (Masuku 2017: 3). As part of the department’s focused strategy to further improve the results, the department was placing special attention on schools in uMlazi, Pinetown and Ilembe (see the map of the Ilembe District in Figure 1.1). The Ilembe district had the most schools with a 0% pass rate. This resulted in the district director being redeployed. The teacher unions also raised concerns about the teacher shortages as it further reduced the quality of education. Bheki Shandu, South African Democratic Teachers Union (SADTU) Deputy Secretary, stated that the 76% target was possible only if it was accompanied by teacher development (Masuku 2017: 3). Democratic Teacher’s Union (SADTU) Vice President on Education warned that the union believed that about 60% of the country’s teachers did not understand the new curriculum and that this was leading to a crisis.

In 2016, 169 023 full-time and 37 915 part-time candidates sat to write the National Senior Certificate examinations across KwaZulu–Natal, and the province achieved a pass rate of 69.5% (Stolley 2017). Ilembe District had 10 546 entries, 5528 learners passed and 5018 failed. The District achieved a pass rate of 52.42%. It also had the most number of schools - three (3) - with 0% pass rate in the province (Stolley 2017). Of the twelve districts, Ilembe District was the worst performing. Statistics obtained from the report on the 2016 National Senior Certificate indicate that Ilembe District schools have performed poorly in the matric examinations. Of the 10 107 students that enrolled to write matric, 47.58% or 4678 students failed. The results for the past three years were as follows:

59.20% pass in 2014, 51.93% pass in 2015 and 52.42% pass in 2016, making it the province's worst performing district. These findings indicate a steady decline in the pass rates (South Africa. Department of Education KwaZulu-Natal 2016: 15). In 2016, Ilembe achieved a pass rate of 21.89% for mathematics and 44.44% for physical science. These poor results led to the District Director being redeployed.

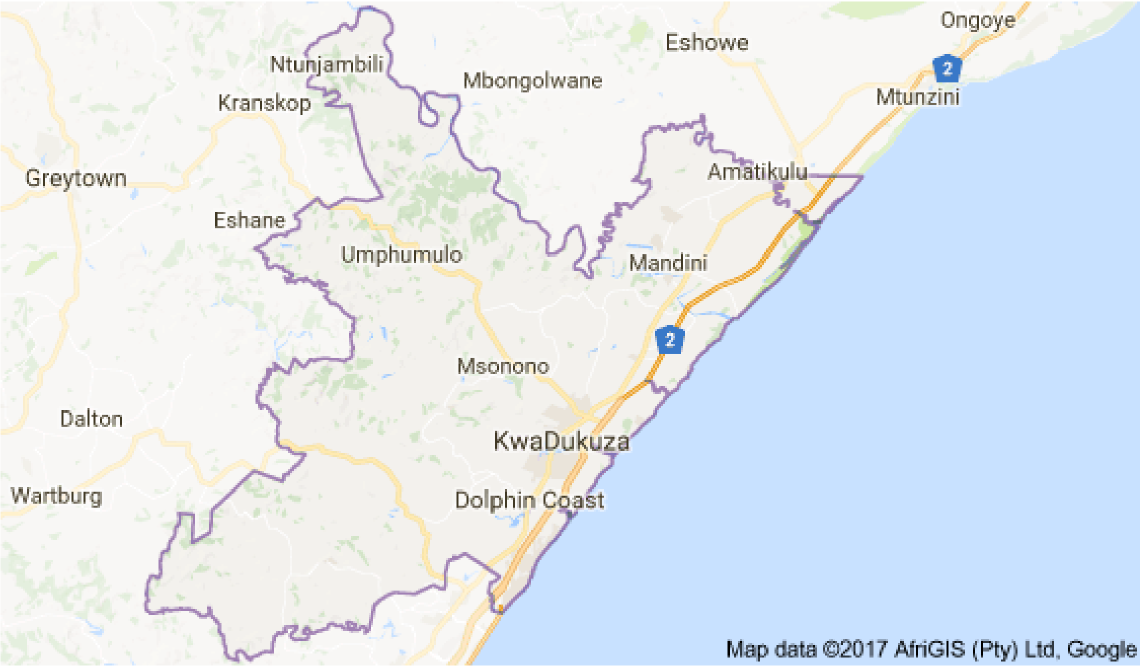

Figure 1.1 Map of Ilembe District in KwaZulu-Natal (Google Maps 2017)

According to the Education management information system (EMIS) statistics (South Africa. Department of Basic Education 2017c) there are no technical/vocational schools in the schools which were sampled in the Maphumulo circuit offering subjects in the mechanical, electrical or civil technology fields. Only one school, Ezithabeni Secondary, offers engineering graphic drawing. This limitation further contributes to the situation of Technology being excluded as a relevant subject due to a lack of continuity. The geographic location of this circuit in a deep rural area with no technical high schools is another barrier to the learners benefitting from an increased number of subjects at their schools, thereby inhibiting their selection of career choices.

1.2 Research problem to be investigated

This section first gives some background to the problems facing technology education. It then follows the research problem cycle in defining the real world problem to be solved (Waghid 2002: 472), thence narrowing it down to the research problem, the specific research questions formulated to guide the enquiry, and the anticipated research answers (Kapp 2000; Pratt 2011: 152-153).

The curriculum transformation process in South Africa was initiated in South Africa after the 1994 elections, and has been steadily implemented since then. The curriculum prior to the 1994 democratic elections was known as NATED 550, and learners were issued with the senior certificate at the end of standard 10 (Mahomed 2004). In 1997 outcomes-based education (C2005) was introduced and a review was prompted in 2000, which led to the Revised National Curriculum Statements, and in 2012 the National Curriculum Statement (CAPS) was introduced. The new certificate which was issued to learners who successfully completed grade 12 was (and still is) the National Senior Certificate (South Africa. Department of Basic Education 2014b: 3).

These changes were accompanied by the challenges of providing educators with the necessary skills to roll out the curriculum at the level of the school. This study will examine the role that teacher development plays in equipping teachers with the necessary skills to empower the learners with vocational skills to meet the challenges of the 21st Century. When a lesson is being planned, the teacher must also consider how the learner is to acquire and/or develop these skills. These skills can be learned through verbal instructions, demonstrations, videos and diagrams as well as through effective use of information and communication technologies (ICTs).

The Technology and Natural Science and Technology subject advisor renders a valuable service in upgrading and developing the knowledge and skills of the teacher.

There are currently four policies which synergise what needs to be done to make South Africa part of the global village and create vital industries and employment. These are:

- Curriculum and Assessment Policy Statements (CAPS) – for Grades 4-6 in Natural Science and Technology (NST) and Grades 7-9 in Technology Statements (South Africa. Department of Basic Education 2011d; South Africa. Department of Education 2011b);
- National Development Plan (Outcomes involve understanding concepts and skills) Plan (South Africa. National Planning Commission 2010);
- White Paper 7 (ICT in Education), deals with lack of skills: encourages use of digital technology to overcome this shortcoming (e.g., viewing technical processes on YouTube) (South Africa. Department of Education 2004); and
- The Norms and Standard document for educators (South Africa. Department of Education 2000).

1.3.1 Real world problem to be solved

The real world problem (Waghid 2002: 472) was how to re-skill the current South African teaching workforce in keeping with the needs of their 21st Century pupils. In particular, inadequate preparation for technology education at the time of this study meant that technology itself was poorly conceptualised by educators, which had implications for the way the subject Technology was taught. A critical aspect of technology education is its practical application, which constitute 70% of the assessment, and most of the teachers had no practical technological expertise. Therefore, they could not be expected to understand how to model, demonstrate or offer experiential learning in the practical applications of technological processes.

1.3.2 Research problem

The research problem was narrowed down to addressing the issues of:

1. How the current South African teaching workforce in rural schools (Ilembe) conceptualised the subject Technology;

2. How to assist teachers to conceptualise it in ways which might assist them to teach it with insight into how technology works in the world; and
3. How to provide the support needed to acquire and develop the knowledge, skills and training needed to teach the subject Technology.

1.3.3 Specific research questions

The following specific research question were used to guide the inquiry:

With reference to educators in the Ilembe district:

1. To what extent do teachers' current concepts of Technology inform effective teaching practice, with specific reference to their:
   a. knowledge;
   b. skills; and
   c. training?
2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?
3. What are the results of these interventions on the following:
   a. teachers' concepts of Technology; and
   b. their plans for future teaching practice?

1.3.4 Anticipated research answers

It was hoped that the proposed interventions might enable teachers to gain insights into conceptualising the subject Technology, including its various practical applications, in ways which might assist them to teach the subject more effectively.

1.4 Aim and objectives of the research

The general aim of the research was to provide a model of teacher education which assisted them to construct key concepts in technology education which might guide effective teaching practice in the subject Technology

The specific objectives were as follows: with reference to teachers in the Ilembe District:

1. To determine whether teachers' current concepts of Technology inform effective teaching practice in the subject;
2. To ascertain what measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice; and
3. To establish what the results of these interventions are on the following:

    (a) teachers' concepts of Technology; and
    (b) their plans for future teaching practice.

1.5 Definitions of key terms

Working definitions of the key terms "technology", "technology education", "teacher and learner preparedness", "conceptualisation of technology" and "practical application of technology" are given in this section.

1.5.1 The phenomenon of technology

Technology involves engaging with complex processes which involve knowledge, skills and resources available in various environmental contexts, in order to produce solutions to societal problems or to meet needs and/or wants. It is defined by the Department of Basic Education in South Africa as, "the use of knowledge, skills, values and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration" (South Africa. Department of Education 2011b: 8). The inclusion of "social" emphasizes the fact that, in South Africa, technology should not be viewed from a solely Eurocentric perspective, with a focus on industrial processes or advanced digital innovations. In indigenous cultural terms, technology can refer to material technology, such as bows and arrows and fishing nets; social technology, such as management methods, social institutions (e.g., patriarchy or matriarchy) and songs, jokes or ideas; and communication technology, including use of language and nonverbal signals (Gumbo 2016: 15). These cultural technologies have subsets which can be organized in terms of material, cultural and intellectual goods and services (Gumbo 2016: 15). It must be emphasized, however, that the population of Ilembe district, while predominantly rural, has technical knowledge not only of boreholes, tractors and crop rotation, but also exposure to more modern cultural technologies accessed through television "soapies" such as *Isidingo* and *Generations*, and not only traditional oral folklore. These widely popular television narratives were used in the educator training method which gathered data for this study.

1.5.2 Technology education

According to Makgato (2011: 119), technology education has generally been seen as being associated with the "acquisition of motor skills" or "computer related activities". Gumbo (2016) defines technology education as follows:

> Technology Education is a subject with its own content and methods, the intention of which is to prepare students to participate in the technological or engineering (job) environments. Technology Education is a unique theory-practice subject that presents opportunities for teachers to engage students in the learning activities that are informed by their (students') thinking, which is in turn shaped by their (students') environments or cultural backgrounds. The design concept - which drives the teaching of the subject (referred to as the backbone of Technology Education) through a problem-solving approach to investigate, design, make, evaluate and communicate, not followed linearly—should allow students room t*o express their design ideas from their cultural contexts* (Gumbo 2016: 16, my emphasis).

Initially technology education was referred to as the "Technology Learning Area" (South Africa. Department of Education 2002b). Later, it was referred to as the subject, "Technology" (South Africa. Department of Basic Education 2011a). Gumbo emphasises the point that research has neglected the topic of making the learning of technological processes relevant to local indigenous contexts, giving the reason for this as the almost entirely Eurocentric (i.e., western) approach to education, which "perpetrates the exclusion of indigenous knowledge and overemphasizes a 'modern' industrial concept of technology to the detriment of indigenous forms of technology" (2016: 17).

Whatever the elements involved in technology education, be they conceptual, social, material or process-based, it is the contention of this study that the emphasis must be on learners gaining practical experience (Kumar 2002: 125).

1.5.3 Teacher and learner preparedness

Teacher and learner preparedness includes not only the concepts of educational qualifications and deeper conceptual understanding of the technology process (Verbeek 2014; Magwedze and Nicolaides 2017), but also the ability of educators to acquire the pedagogical skills to teach both concepts and practice effectively (Shepherd 2013, 2015) in ways which learners will readily grasp in terms of their specific cultural and geographical local contexts (Gumbo 2016; Gwekwerere 2016) . Both teachers and learners must show evidence of knowledge of relevant practical applications and the ability to carry these out in locally relevant projects which are useful to the community in which they are set.

1.5.4 Conceptualisation of technology

Educators should show deeper knowledge of technology and its various applications in practice in ways which are relevant to the communities in which the technology is to be applied (South Africa. Department of Education 2011b: 8). Deeper knowledge should include that of not only industrial and ICT applications, but also knowledge of the forms of technology relevant to the communities, in terms of building on past traditions and community lore towards future development (De Vries 2010; Gumbo 2016; Gwekwerere 2016).

1.5.5 Practical application of technology

Practical application of technology is the most important aspect of technology education, not only in terms of its usefulness to the wellbeing and economic prosperity of the local and greater community, but also because of the emphasis on practical application in its assessment (South Africa. Department of Basic Education 2011a). It is, therefore, essential that curriculum delivery takes some form of experiential learning, based not necessarily on expensive laboratories and equipment, but also on local community activities and the perceptions of the community of the world around them (Gwekwerere 2016: 41).

1.6 Main themes of the research

The following main themes can be found in this study:

- The importance of technology education for economic development and employment;
- The importance of teacher and learner preparedness for technology education;
- The importance of concepts in informing practice and vice versa;
- The key role of practical application in technology education (for both teacher training and learner assessment); and
- The importance of using a pedagogy which enables learners to grasp key technology concepts and apply them in practice.

1.7 Value of the research and new contribution to knowledge

The research cuts to the key issue in technology education in terms of what to do to prepare teachers for technology education, and provides and tests out an intervention for teacher training. The focus of this study is on constructing key concepts in technology education for teachers as a prerequisite for effective teaching and learning. Thus far research in technology education has focused on teaching practice rather than on how conceptualising both informs, and is informed by, teaching practice. The new contribution to knowledge is thought to be in showing how the conceptualising and practice of the subject Technology are linked, and how important conceptualisation is to effective practical application and teaching/learning. The teaching methods associated with deeper conceptual knowledge of technology education were modelled in the training method used to gather data from participants. The study also contributes to the body of knowledge in the field of technology education by proposing a teacher developmental model comprising a District Based Professional Learning Community (DBPLC).

1.8 Conclusion

In this chapter, the outline, context, rationale, and significance of the study were presented. The chapter concludes with an overview of the rest of the chapters, as follows:

- Chapter 2 deals with technology education.

- Chapter 3 gives an account of constructivism as research orientation and pedagogy.
- Chapter 4 discusses the research design, methodology, sampling and data collecting instruments, as well as the methods used to analyse the data.
- Chapter 5 presents an analysis of the data generated by the results of the teacher survey, the interview and the pre-test questionnaire, showing the degree of teacher preparedness for the task of engaging in technology education, as well as the specific needs for which the intervention was designed. It then provides an analysis of the educator intervention, as well as participant feedback.
- Chapter 6 draws conclusions and makes recommendations as to the way forward in technology education, including a proposal for a teacher developmental model.

CHAPTER 2: TECHNOLOGY EDUCATION

2.1 Introduction

Chapter 2 gives an overview of technology education, looking first at its purpose and at the importance of earlier preparedness for technology education. Next, the nature of technology education is discussed, showing how it is a preparation for the world of work, and distinguishing between information and communication technology and wider forms of technology. Some key concepts in technology education are identified, before the chapter goes on to deal with the teaching of technology education, covering pedagogical aims, curriculum aims and principles, curriculum values, and methods used in teaching technology education. The latter include outcome-based education, an approach to teaching the design process, and the importance of recognising indigenous knowledge systems and technology. Assessment methods for technology education are then discussed. The hidden curriculum and its impact on of technology education, and, in particular, how it affects its status, is suggested at macro-, meso- and micro-levels. After summing up some of the key points in technology education, the chapter concludes with the specific research questions used to guide the enquiry.

2.2 Technology education

This section gives an overview of technology education, and looks at the purpose of offering Technology as a school subject, the importance of earlier learner preparedness for technology education, and the nature of technology education itself.

2.2.1 The purpose of offering technology education

South Africa has a serious skills shortage due to an inadequately educated workforce (Breier 2010). Of the 1 400 000 students currently registered in the various fields of study in 2016, only 100 000 were enrolled for Engineering and Technology (Papier *et al.* 2016). The technology education curriculum provides students with opportunities to develop the necessary skills for successful careers of the future. Technology has been described as is the driving force of the economy (Steinke and Putnam 2009), and more and more jobs require technological skills (Rausch 1998).

2.2.2 The importance of earlier preparedness for technology education

According to the Curriculum and Assessment Policy Statement (CAPS) NCS Grades 7-9 Technology Policy Document, the intention is to introduce learners to the basic needs in Civil Technology, Mechanical Technology, Electrical Technology and Engineering Graphics and Design (South Africa. Department of Education 2011b). Additionally, learners gain an idea of the way engineers apply scientific principles to practical problems. Moreover, evaluation skills will be fostered and the introduction of product design and production will be useful in other FET subjects that use these skills, such as Consumer Studies and Design. These skills provide a solid foundation for the world of work (South Africa. Department of Education 2011b: 8). Most importantly, they provide the learners with an insight into a career pathway with unlimited possibilities. Even if learners decide to exit in Grade 9 to follow a chosen field, they can still attend a technical college (known as a TVET) to pursue a career choice. The Technology curriculum is (i.e., at the time of writing the thesis) still organized within the General Education and Training (GET) Band of the National Qualifications Framework in South Africa (see Table 2.1), and is situated in level one of the National Qualifications Framework. It encompasses all learning that takes place within the GET Band, between Grades R and 9 (South Africa. Department of Basic Education 2018).

It is only individual technology subjects, for example, Mechanical Technology, which have been extended to include Grades 10-12 (South Africa. Department of Basic Education 2014a). Even with the newly introduced technology curricula, the problems caused by educators having received no formal education in technology stays the same (Sedio 2013: 2).

Table 2.1 The Technology curriculum (adapted from Lemmer 2003: 119)

<table>
<tr><td>SCHOOL GRADES</td><td>NQF LEVEL</td><td>BAND</td><td colspan="2">Types of qualifications and certificates</td></tr>
<tr><td></td><td>8</td><td>Higher</td><td colspan="2">Doctorates-Further research degrees</td></tr>
<tr><td></td><td>7</td><td>Education</td><td colspan="2">Degrees</td></tr>
<tr><td></td><td>6</td><td>and</td><td colspan="2">Diploma</td></tr>
<tr><td></td><td>5</td><td>Training</td><td colspan="2">and</td></tr>
<tr><td></td><td></td><td>Band</td><td colspan="2">Certificates</td></tr>
<tr><td colspan="5">Further Education and Training Certificates</td></tr>
<tr><td>12</td><td>4</td><td>Further</td><td colspan="2">School/College/NGOs Training certificates, Mix of units</td></tr>
<tr><td>11</td><td>3</td><td>Education and</td><td colspan="2">School/College/NGOs Training certificates, Mix of units</td></tr>
<tr><td>10</td><td>2</td><td>Training Band</td><td colspan="2">School/College/NGOs Training certificates, Mix of units</td></tr>
<tr><td colspan="5">General Education and Training Certificates</td></tr>
<tr><td rowspan="4">9
8
7
6
5
4
3
2
1
R</td><td rowspan="4">1</td><td rowspan="4">General Education And Training Band</td><td>Senior Phase</td><td>ABET 4</td></tr>
<tr><td>Intermediate Phase</td><td>ABET 3</td></tr>
<tr><td>Foundation Phase</td><td>ABET 2</td></tr>
<tr><td>Pre-school</td><td>ABET 1</td></tr>
</table>

The significance of technology education is to develop citizens who can display the competencies and values encapsulated in the CAPS "Unique Features and Scope", as follows:

- To solve problems in creative ways;
- To use authentic contexts rooted in real situations outside the classroom;
- To combine thinking and doing in a way that links abstract concepts to concrete understanding;
- To evaluate existing products and to evaluate their own products;
- To use and engage with knowledge in a purposeful way;
- To deal with inclusivity, human rights social and environmental issues in their tasks;
- To use a variety of life skills in authentic contexts (such as decision making, critical and creative thinking, cooperation, problems, solving and needs identification);

- While creating positive attitudes, perceptions and aspirations towards technology–based careers; and
- To work collaboratively with others (South Africa. Department of Education 2011b: 9).

The above are to be achieved through practical projects using a variety of technological skills (investigating, designing, making, evaluating and communicating), that suit different learning styles (South Africa. Department of Basic Education 2011d: 9-10)

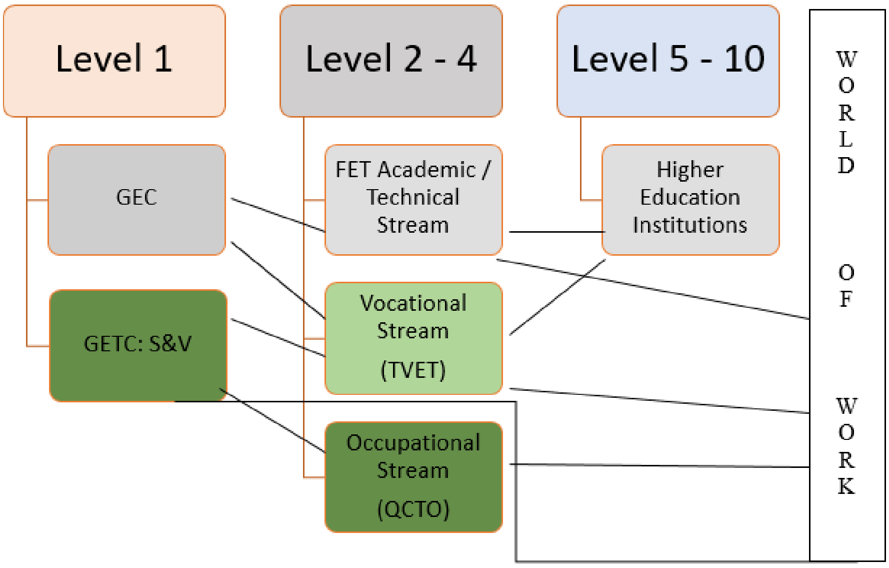

Figure 2.1 The intended flow of learners through NQF (from South Africa. Department of Basic Education 2016)

From 2017, a three stream curriculum model GEC/GETC (see Figure 2.1) is proposed for South African schools (Simkins 2017). The current system has two streams: the academic/technical, leading to the National Senior Certificate and technical vocational, leading to a qualification at the same level within the National Qualifications Framework (NQF). Both streams are built on a common school programme of general education up to the end of Grade 9, after which learners can either stay in schools or transfer to Technical and Vocational Education and Training (TVET) colleges, progressing through the N1/NC(V) Level 2 and N2/NC(V) level 3 to N3/NC(V) Level 4 and even studying beyond to the N6 level (Simkins 2017). The proposed third stream will have implications for the current uniform Grade 1 to 9 education. The intended flow of learners through the system is shown in Figure 2.1.

2.2.3 The nature of technology education

Technology education involves the use of any technology as preparation for the world of work (South Africa. Department of Basic Education 2011a: 8), but should not be confused with information and communication technology (ICT), which is one type of technology, admittedly an extremely important one, in terms of the increasing use of digital technology the workplace, education and social life (International Technology Education Association 2007: v, 9, 20). Technology education is often confused with educational technology, in spite of the fact that that "Technology" is a subject with a curriculum, whereas "educational technology" refers to a general educational tool (Brown and Brown 2010: 49)

2.2.3.1 Technology education as preparation for the world of work

Technology education was introduced into the South African curriculum in recognition of the need to produce the engineers, technicians and artisans needed in modern society, and the need to develop a technologically literate population for the modern world. The subject stimulates learners to be innovative, and develops their creative and critical thinking skills. It teaches them to manage time and material resources effectively, provides opportunities for collaborative learning and teamwork. These skills provide a solid foundation for several Further Education and Training (FET) subjects as well as for the world of work (South Africa. Department of Basic Education 2011a: 8). This knowledge and the skills developed in the GET band present the learners with a head start when choosing career choices even in rural and deep rural areas where there is a shortage of technical high schools.

Technology dominates in all spheres of life, and has become an integral part of teaching and learning in schools in many parts of the world. Sadly, South Africa is lagging behind, and the following observation by McCabe and Van Wyk applies in most of our schools:

> The chalkboard was invented in 1801. While many twenty-first Century learners have digital devices in their pockets, teachers are using technology developed more than two centuries ago as teaching aids. It is no wonder that many learners are bored (McCabe and Van Wyk 2012: 2).

It is no longer a question whether technology should be used in the classroom but rather how the process of making it part of the classroom experience can be fast tracked. However, it must be stressed that use of technology as a teaching aid is termed "educational technology", and is different from technology education, where the subject "Technology" has its own curriculum, as with other school subjects (Brown and Brown 2010: 49).

2.2.3.2 Information and communication technology

Technology education, while it cannot be equated with educational technology or ICT, does *include* use of ICT. This is because ICT is an extremely important type of technology in terms of the increasing digitization of the technologies used in industry, commerce and education. In the past, information was available almost exclusively in the form of books. Teachers used books to teach learners to read. Modern technology makes it possible for information to be stored and accessed in other ways. ICT can be defined as: "technologies for the processing, storage, and transmission of digital materials, comprising hardware and software systems for physical storage and logical representation of sets of data" (Bhorat 2014: v). Computers (desktops and laptops), mobile phones (including smartphones) and iPads (tablets) are common examples of such technologies. Other examples of communication technologies include the Internet, e-mail and social networking applications, such as Skype, Facebook, Twitter, WhatsApp and BlackBerry messenger.

Previously information and communication technologies involved separate tools. For example, a computer and a telephone were distinctly different tools and were used separately. Owing to the rapid convergence of once-separate technologies (Bhorat 2014: 17), one now finds many of these tools on a single device. For example, one can do the following on a mobile phone:

- make Skype calls;

- send and receive e-mails;
- view a video;
- download a Living Pages application using Android and IOS devices;
- access the World Wide Web; and
- send text messages via SMS or WhatsApp.

Teacher and learners using the "Living Pages" application will be able to watch experiments, explore destinations and see problems being solved (see https://vimeo.com/228773243). The amount of information is increasing all the time (Bialobrzeska and Cohen 2005: 12). So is the need to record it, process it, store it and share it with others, often over great distances. Computers, either alone or in combination with some other technology, enable us to do all these things quickly and efficiently.

According to Woodard (2003: 185), the growth of technology in the educational environment creates greater access to information, support for different kinds of learning, opportunities for participating in the creation of knowledge, equitable access, improved student motivation, sustained participation by less able students, increased achievement in project-based programmes, and changed communication patterns resulting from teaching with technology.

Currently in South Africa the National Curriculum Statements (NCS) in the Further Education and Training (FET) band from Grades 10-12 offer two computer related subjects, namely, Computer Applications Technology (CAT) and Information Technology (IT). In the GET band, these skills are incorporated into the technology curriculum and are situated within the design process. No official subjects are offered where skill and knowledge regarding computers can be studied. Computers and other information technology tools are used to enhance and improve the implementation of technology education.

According to the Policy on Minimum Requirements for Teacher Education Qualifications, the Department of Higher Education and Training (DHET) has included the ability to use information and communication technologies (ICTs) competently as one of the principles underpinning the design of programmes leading to teacher education qualifications (South Africa. Department of Higher Education and Training 2012: 10-12). In its problem statement (Towards the Realisation of Schooling 2025), the DBE acknowledges that most of South Africa's teachers did not receive all the training they needed with the curriculum changes that have taken place since 1994, and envisages the use of e-Education to meet the challenges faced (South Africa. Department of Education 2011a: 108-109).

However, Reeves (2001: 136) explains that technology education involves much more than the use of computers. Technology education is intended to introduce learners to the basics needed in Civil Technology, Mechanical Technology, Electrical Technology and Engineering Graphics and design. Learners should gain an idea of the way engineers apply scientific principles to practical problems. In addition, evaluation skills will be fostered and the introduction of product design and production will be useful in other FET subjects that use these skills, such as Consumer Studies and Design, Further Education and Training (FET) subjects, as well as for the world of work (South Africa. Department of Education 2011b: 8).

2.2.4 Key concepts in technology education

Most reports on South African education indicate that the majority of teachers have not yet been sufficiently equipped to meet the educational needs of a growing democracy in a 21st Century global environment. The President's Education Initiative research project (Taylor and Vinjevold 1999) concluded that the most critical challenge for teacher education in South Africa was the limited conceptual knowledge of many teachers. This includes poor grasp of their subjects as evident by a range of factual errors made in content and concepts during lessons; many teachers' conceptual and content knowledge contribute to low levels of learner achievement (South Africa. Department of Education 2007: 4-5). The Report of the Ministerial Committee on Rural Education (South Africa. Department of Education 2005) highlighted specific challengers in rural schools. It noted a shortage of qualified and competent teachers in these schools, problems of teaching multi-grade and large classes, under resourced school facilities, and limited access to professional development programmes for teachers' achievement (South Africa. Department of Education 2007: 5). An in-depth knowledge of the key concepts and skills that a Technology teacher would need prior to teaching the lesson is shown in Table 2.2. All of the key concepts are infused in the four content areas which form the basis of the four knowledge strands, namely, Structures, Processing of materials, Mechanical Systems and Control, Electrical systems and control (South Africa. Department of Basic Education 2011b: 10)

Table 2.2 Key concepts and skills needed by Technology teachers (adapted from Bull 2000: 11)

DESIGN PROCESS		
Design and make tasks	Sources of information	Brainstorming and concept-mapping
Proposals	Specifications	Design decisions
Evaluation	Costing	Design, past and present
GRAPHIC COMMUNICATION		
Sketching isometric projection	Orthographic projection	Presentation techniques
Producing a folio	Drawing using computers.	
MODELING		
Modelling materials	Scale	Kits
Two dimensional modelling	Three- dimensional modelling	
Marking skills		
Cutting away-materials	Joining by gluing	Permanently joining materials
Temporary joining of materials	Finishing techniques	Making one – off products
Making more than one product	Forming materials	Computer –aided manufacturing
MATERIALS AND COMPONENTS		
selection of materials	cutting and shaping tools	tools for drilling and cutting holes
tools for holding materials	tools for forming	
SYSTEMS AND CONTROL		
systems	control	input devices
processes	output devices	Feedback
MECHANICAL		
Gears	pulleys	Levers
cams	cranks	Movement
Linking mechanism		
STRUCTURES		
Recognising structures	compression	Tension
torsion	shear	Bending
Building model structures	loads	

ELECTRICAL		
Understanding circuit diagrams	Analogue and digital signals	Using electronic kits to make up circuits
capacitors	resistors	Switches
Logic gates	semiconductors	Integrated circuits
Printed circuit boards		
HYDRAULICS and PNEUMATICS		
Use of pneumatics	Pneumatic cylinders	Valves
Regulators and reservoirs	pistons	Pipes/tubes
FOOD		
Healthy eating	Food and nutrition	Labeling of food products
Food ingredients and their uses	Altering foods to suit us/ Preserving foods	Hygiene and food safety
TEXTILES		
Tools of textiles	Investigation textiles	Fibres used to make textiles
Properties of fabric	labelling	Manufacture of artefacts
New type of textiles/ natural/manufactured	Working with leather	
PAPER and CLAY		
Investigating paper	Chemicals and dyes	Machines and equipment
Properties of paper	Manufacturing process	Hand tools
Investigating clay	mining	
HEALTH and SAFETY		
Use of formulae and tables	Use of small hand tools and portable electrical machines	Symbols for pneumatic devices
Electronic components symbols	Isometric grids	waste disposal/recycling
INDIGENOUS KNOWLEDGE		
processing	structures	System and control

It must be emphasised that the concepts to be grasped in Table 2.2 involve more than mere abstract definitions to be “learned off by heart” and repeated verbally (i.e., superficially). Concepts learned from familiar community and cultural contexts rather than abstract diagrams in text-books would facilitate deep conceptual learning, and enable learners not only to understand the concepts but also to apply them effectively in different contexts (Gumbo 2016; Gwekwerere 2016).

2.3 The teaching of technology education

This section gives an overview of the teaching of technology education, dealing with pedagogical aims, curriculum aims and principles, curriculum values, teaching methods and the assessment method.

2.3.1 Pedagogical aims

Technology education is aimed at providing learners with some experiences to help them make career orientated choices at the end of Grade 9 and contributing towards the learners' technological literacy (South Africa. Department of Education 2011b: 8-9).

In technology education, there are three Specific Aims (South Africa. Department of Basic Education 2011a: 8):

- Specific Aim I

  Develops and apply specific design skills to solve technological problems addresses the technological processes and skills. The design Process (investigate, design, make, evaluate and communicate - IDMEC) forms the backbone of the subject and should be used to structure the delivery of all learning aims.

- Specific Aim 2

  Understand the concepts and knowledge used in technology education and use them responsibly and purposefully. It addresses the technological knowledge and understanding. There are four core content areas now called strands learning, i.e.,, structures, processing, mechanical systems and control and electrical systems and control.

- Specific Aim 3

  Appreciate the interaction between people's values and attitudes, technology, society and the environment. This specific aim is associated with the integration of coexisting knowledge systems, often referred to as indigenous knowledge system (IKS) (adapted from South Africa. Department of Basic Education 2011a: 8, expanded for clarification with excerpts from the whole policy document).

The Specific Aims for the GET Band builds on, and were inspired by, the seven Constitutional Principles underpinning the Curriculum (South Africa. Department of Education 2011c: 4). Specific Aims are the benchmark against which learners' work is assessed. They are the knowledge, skills and values that learners need to show to achieve the learning in each grade. For example, in Grade 7 the topic in the first term is Mechanical Systems and Control. The content to be taught/learnt is Levers, Linkages, Hydraulics, and Pneumatics. The context is Rescue System. The Scenario for the Mini-PAT (Practical Assessment Task) is the impact of technology, for example, emergency workers using the "jaws-of-life" system to rescue trapped accident victims. The learners must show evidence of investigating, designing and making a simple model of the "jaws-of-life" so that they can be assessed formally. The Mini-PAT allows the learner to demonstrate the level of technological literacy that he/she has achieved and to have shown understanding of the key concepts, that is, how Mechanical Systems and Control can improve people's lives. From the above model it is clear that, during the Overview stage, everything that is going to be taught is included across the grade. Areas where integration is going to occur with other learning areas are also included.

2.3.2 Curriculum aims and principles

When the curriculum is to be designed and implemented, it needs to be done within a framework which includes the aims, principles and procedures of an education system. These components are contained in the framework of most countries that have a common national curriculum. According to Dekker and Van Schalkwyk (1989: 10), educational aims and objectives are normally found in educational policy documents and education legislation. A national education system is a means or vehicle to attain a nation or community's educational objectives. Dekker and Van Schalkwyk maintain that, although each community has its own specific educational objectives, they are all related to one or more of five basic categories, namely:

- intellectual objectives;
- occupational, career and economic objectives;
- personal, human objectives;
- social objectives;
- political objectives (Dekker and Van Schalkwyk 1989: 10).

These five categories form the backbone of most of the aims and principles to be found in curriculum frameworks.

Fafunwa's (1992: 9) research confirms the existence of the above categories. During his comparative research of African education, he also found that African education systems contained five identical categories that formed the framework of traditional and indigenous educational systems that emphasised:

- social responsibility;
- job creation;
- political participation;
- spirituality; and
- moral values.

These five aims that Fafunwa mentions in his findings are directly related to the "Seven Constitutional Principles" underpinning the curriculum (South Africa. Department of Education 2011b: 4-5). Learners experience all these values on a first hand basis during their interaction with the technology learning area resource tasks.

Technology in the National Curriculum Statements (NCS) (CAPS) is defined as the use of knowledge, skills, values and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration (South Africa. Department of Education 2011b: 8).

The envisaged aims of the technology education curriculum are to build on the Seven Constitutional Principles underpinning the curriculum, namely:

- Active and critical learning.
- Social transformation
- High knowledge and high skills
- Progression on content from simple to complex in each grade
- Human rights, inclusivity and environmental and social justice
- Valuing indigenous knowledge systems
- Credibility, quality and efficiency (South Africa. Department of Education 2011b: 4).

In South Africa the vehicle designed to drive the curriculum is known as the Curriculum and Assessment Policy Statements (NCS). It strives to enable all learners to achieve to their maximum ability. It is therefore crucial for the school principal, as head of the institute, to ensure that these values are included in the management and implementation of the curriculum (South Africa. Department of Education 2011b: 13).

2.3.3 Curriculum values

Globalisation and the advent of new technologies have had a profound influence on the economic and educational systems of all countries (Lechner and Boli 2015). While globalisation is a process which has its origins in economics, it has spread to influence other aspects such as culture and education (Lechner and Boli 2015: 3-4). Some of the facets that have contributed to it are market forces and technology. Proficiency in Mathematics, Science and Technology have become prerequisites for economic success, and technology is a tool, not just a reward, for development that would affect developing countries and poor people (Fernando 2001: 8). This is because a lack of desirable knowledge and technological capacity could become a source of exclusion and conflict (Barber 2015: 38). The need for skills forced changes to the traditional, aristocratic, and elitist curriculum system: the curriculum now had to contribute towards improving employability (Pratt 1980: 45; Kelly 1989). Globalisation and the advent of new technologies require the education system to produce graduates with relevant knowledge, critical and higher-order skills and proper attitudes (Kelly 1989).

Thus the school curriculum which previously serviced certain values such as religion class or social status, would now have to service the nation’s economic needs by providing suitable qualified manpower. In order to survive the new era, people will need to function successfully within an economy in which identifying and filling niches are more important than mass production, according to the modern way. Technology education as part of the school curriculum will also contribute towards the attainment of the aims of education, that is, to develop the all-round intellectual, moral and physical capabilities of individual children and contribute to the improvement of society economically (Holmes 1987: 7). As part of the national curriculum in South Africa, technology education can contribute to equality in education by providing opportunities to all learners. In an inclusive education system, it caters for all types of learners irrespective of race, colour, gender and/or disability.

Technology education is unlike technical and vocational education, which prepares learners for specific careers. The technology education curriculum strives to improve technological literacy by giving learners the opportunity to:

- develop and apply specific skills to solve technological problems;
- understand the concepts and knowledge used in technology, and use them responsibly and purposefully; and
- appreciate the interaction between people's values and attitudes, technology, society and the environment (South Africa. Department of Education 2011b: 8).

In order for the principal to be able to implement the Technology syllabus in the school situation, s/he must firstly have some knowledge of the contents of the Technology curriculum, which sets out the key issues to be taught (i.e., problem solving using the design process, practical skills, knowledge and application of knowledge). This knowledge will enable the principal to determine the resources needed to implement Technology.

2.3.4 Methods used in teaching technology education

Methods used in teaching technology education include the outcome-based model, an **a**pproach to teaching the design process, use of indigenous knowledge systems and technology, and technological pedagogical content knowledge (TPACK).

2.3.4.1 The outcome-based model

The outcome-based model (Spady 1994), which is referred to as "outcomes-based education" (OBE) in South Africa (Mokhaba 2004: 29), is an approach to teaching and learning that requires a shift from teacher input through syllabuses to a focus on learner outcomes (Jacobs and Chalufu 2004). OBE is a system of education that consists of its own philosophy of education, which includes lifelong learning, accountability, participation by students and a constructivist approach to teaching/learning; it is learner-centred, and focuses on results (Makgato 2003: 51), which explains the name "*outcomes*-based".

Technological, social and individual change has resulted in the explosion of knowledge which has created a need for new educational principles and aims (Lemmer and Badenhorst 1997: 264; Jacobs and Chalufu 2004: 92). Important curricular issues in this regard are the principles of lifelong learning and open learning, as well as the aim of personal change assisted by education within and beyond the school situation. In this context, a person should be able to reflect on what he/she can do both intellectually and practically.

Human capability should be taken into account more especially when the learner should be assisted in:

- becoming a person through change on her/his own terms;
- establishing meaning through discourse and personal choice; and
- being creative, including exploring alternative ways of solving problems.

Outcomes-based education is based on the following premise about the role of the learner, the role of the teacher, and the aims and content of teaching (Lemmer and Badenhorst 1997: 265). As the learner grows and develops, the learners' participation in the educational and schooling activities increases along with the capacity to accept responsibility for his/her actions, investigations, beliefs and thoughts, and the learner moves towards becoming a student. Education and schooling are regarded as a process of dialogue and discourse. Classroom practice is based on the acceptance that both the teacher and the learner are striving towards the same aim. The role of the teacher shifts from one of transmitting information to that of a facilitator.

The outcomes-based model approach to curriculum design and development may include various approaches to help and guide the activities as long as they do not control the learning process. There is a need for knowledge (subjects, problem solving core knowledge, and personal interests), classification and organization in view of learner development, with emphasis on a holistic approach to curriculum development.

South Africa has a unique outcomes-based model using terminology not found in any other country (Jacobs and Chalufu 2004: 103). Although the word "outcome/s" is common in all models, each country creates its own supporting terms and definitions when they design outcomes-based programmes. The designers of the South African model believed that some of the old teaching terms should be replaced by new terms that are in line with outcomes-based education.

The following changes of terms have been made in South Africa:

- "aims and objectives" are replaced with "outcomes";
- "evaluation" is replaced with "assessment";
- "pupils" and "students" are replaced with "learners";
- school "standards" are replaced with "grades";
- "subjects" are replaced with "learning areas"; and
- "syllabus" is replaced with "learning programme" (adapted from Jacobs and Chalufu 2004: 103).

The outcomes-based model is concerned with the outcome of a curriculum from the learner's point of view. Such a result may either be observable or refer to internal change in the learner. This model represents a shift from a content based approach towards a learner based approach (Lemmer and Badenhorst 1997: 272).

The curriculum design approach generally begins by establishing what competencies are needed to enable the learner to be successful in life. In contrast to other models, which started by studying existing curriculum in order to determine objectives, this approach examines and defines various areas of learning (Lemmer and Badenhorst 1997: 272).

The types of high quality knowledge outcomes that Spady (1994) argues for are contained in the unique features and scope in Technology and the Technology learning area gives learners the opportunity to:

- learn by solving problems in creative ways;
- learn whilst using authentic contexts that are rooted in real situations outside the classroom;
- combine thinking and doing in a way that links abstract concepts to concrete understanding;
- carry out practical projects using a variety of technological skills- investigating, designing, making, evaluating, communicating - that suit different learning styles;
- use and engage with knowledge in a purposeful way;
- learn by dealing directly with inclusivity, human rights, social and environmental issues in their project work;
- use a variety of life skills in authentic context (e.g., decision-making, critical and creative thinking, co-operation, needs identification); and
- create more positive attitudes, perceptions and aspirations towards technology-based careers (South Africa. Department of Education 2002b: 5).

The approach recommended to teach Technology is to introduce the required knowledge followed by practical work in which the knowledge is applied. This process takes place in resource tasks (RTs), which are small practical activities that are taught to learners to empower them with skills, knowledge, attitude and values prior to the practical project been undertaken. RTs assist in identifying learners who experience problems/barriers to learning, thereby allowing the educator to assist those learners (Clitheroe, Dilley and Van der Westhuizen 2001: 10).

Lessons are structured using the design process as the methodology. They will be presented as scenarios where learners will be exposed to a problem, need or opportunity as a starting point. The activities in which the learners engage are is known as the capability tasks (CTs). Capability tasks are projects that involve designing and making a product that works. Learners have the opportunity to apply the knowledge and skills that they gained from doing resource tasks in the capability tasks, using the design process (Clitheroe, Dilley and Van der Westhuizen 2001: 10).

2.3.4.2 Approach to teaching the design process

The design process is a central aspect of the science and technology curricula of in terms of fulfilling teaching/learning and vocational needs, as a problem solving activity which develops solutions that cater for authentic needs and opportunities (De Jager 2012: 29). While the design process used in the NCS is very general, to encourage critical thinking educators can encourage learners to interact with the process in an unstructured way, using an "open model" (De Jager 2012: 47). The essence of the Technology learning area in the GET band involves the application of the technology design process. At the heart of this process is the identification of everyday problems, needs or wants of people, and the selection and application of appropriate resources, knowledge, skills and values to develop practical solutions. The design process encourages the development of critical and creative thinking skills. In South Africa the approach to teaching and learning of Technology is project–based, using group activities to drive the process and hands-on experience, with the end product being the Mini-PAT. The tool used to assess the Mini-PAT is an analytical rubric (South Africa. Department of Education 2002b: 43). Figure 2.2 shows a layout of the design process arranged as part of a systems diagram indicating the five components, namely, investigate, design make, evaluate and communicate.

Technology offers authentic, real-life opportunities for learners to interact with each other within teams when they develop the following technological solutions (Compiled from: South Africa. Department of Education 2002b: 4,7; 2002a: 15):

- Investigate: When studying Technology, our main aim is to investigate problems in the context in which they occur, and attempt to solve them by finding out more about the problems.
- Design: This process identifies and solves problems by applying knowledge, skills, values and attitudes. Once the product or system has been completed, it can be tested to determine whether in fact it serves its purpose.

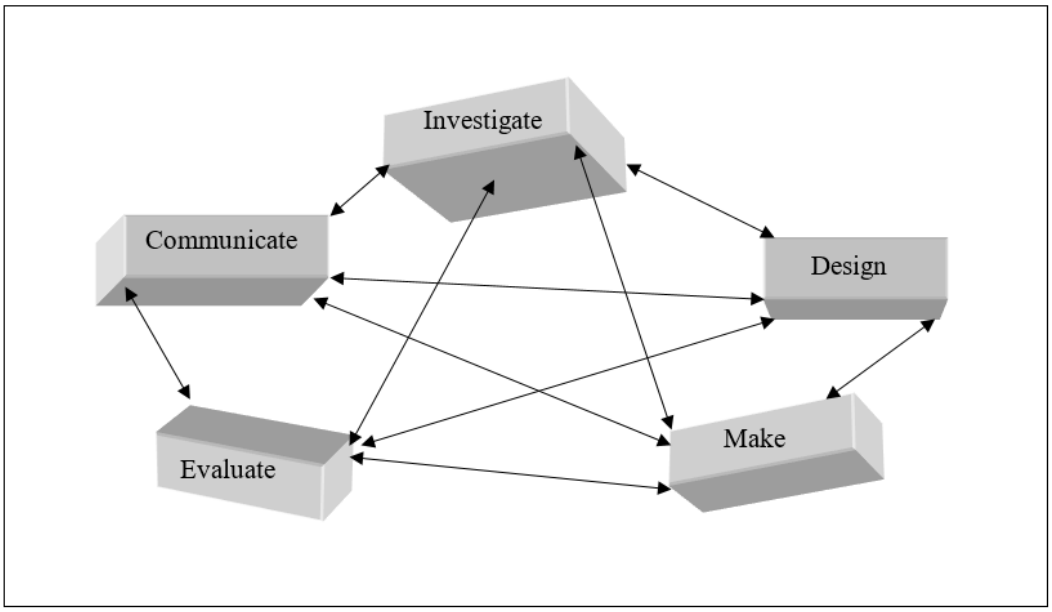

Figure 2.2 Systems diagram of the technology design process (adapted from Basset *et al.* 2005: 7).

- Make: In the making stage the planning and making of the product needs to be very carefully considered. Firstly, the planning in advance to get materials and equipment together, and second, a flow chart should be drawn up so that the learner can set a time frame for each component of the project.
- Evaluate: When a project is completed, it is necessary to evaluate or test the project. One needs to see whether it meets the requirements that were set to guide a person to build it. This stage requires the use of probing questions, fair testing, and analysis.
- Communicate: The assessment evidence of the processes followed in any project - that is the ability to analyse, investigate, plan, design, draw, evaluate and communicate - is presented. This could be done in oral, written, graphic or electronic form. A record of the design process from conception to realization is kept in the form of a project portfolio (South Africa. Department of Education 2002b: 7)
- Learners also interact with their communities when, for example, they test and market products that they made themselves.
- On a personal level, Technology learners become more and more aware of their responsibilities within their classrooms, families and society. They learn to manage the technological resources at their disposal when developing products, and they also learn to minimize the potentially negative impact that their solutions could have on the environment and on human rights.

- Learners in Technology classrooms work in groups to analyse the given information in order to create practical solutions. Learners co-operate and communicate with each other, often combining verbal and graphic modes of communication. Discussion and reporting techniques and use of appropriate terminology are encouraged during technological activities (South Africa. Department of Education 2002a: 15).
- Technology Education contributes to the intellectual and practical development of learners, to enable them to cope with challenges of a technological society. Through its open-ended, problem-solving approach, Technology links knowing with doing, it affords learners opportunities to apply and integrate their knowledge and skills from other learning areas in real and practical situations that can be further developed in various situations throughout their lives.
- Learners explore both positive and negative impacts of Technology on their political, social, economic and biophysical environment. This will be done when they evaluate the product they have made, using criteria like affordability, safety, fit for purpose, effect on the environment, and so on. This will enable learners to develop into critical consumers.
- Learners are provided with opportunities to interact with business and various industries that help them to understand and adapt to changing economic realities. They learn to generate creative and innovative ideas, and to co-operate in translating their ideas into action. Learners gain skills, knowledge, competencies and confidence that equip them to contribute to South Africa's social and economic development. This process also allows learners to explore various opportunities for further education and future careers (South Africa. Department of Education 2002b: 4).

2.3.4.3 Indigenous knowledge systems and technology education

The need to integrate IKSs in South Africa across the curricula of various learning areas has very definite implications for the socio-political and socio-historical context, particularly in the teaching of science and technology (Van Wyk 2002). The envisaged aims of the technology education curriculum are to build on the Seven Constitutional Principles underpinning the curriculum. Valuing indigenous knowledge systems is the sixth pillar, and is integrated into the specific aims, both in the intermediate phase and senior phase curriculum (South Africa. Department of Basic Education 2011b: 4).

As a result of the country's discriminatory socio-political history which has excluded oral and documented cultural heritages, the inclusion of IKS into the school curriculum was proposed (South Africa. Department of Education 2002b).

Since South Africa's transition into democracy in 1994, there have been a number of changes to the schooling system and the strengthening of the curriculum. Chisholm (2004) identifies these changes as attempts to overcome the legacy of apartheid, and they were introduced in order to improve educational access, equity and quality. In its policy documents the DBE argues that the National Curriculum has been designed this way so as to ensure that it is flexible, and has the ability to be adapted to local conditions and needs at school level. In turn, the DBE expects these curricula to be interpreted and implemented differently in diverse contexts. However, schools in co-called "rural" areas are often unable to take advantage of the opportunities created by the National Curriculum, owing to the limited resources available to the schools (Meyiwa, Letsekha and Wiebesiek 2013).

The disciplines involved in natural science and technology, in particular, have a cultural bias which has marginalised the majority of learners in the past (Van Wyk 2002: 305). IKS is a strategy designed to transform this view and is therefore of significance to educators in the learning areas of natural science and technology. IKS gives educators the opportunity to reflect on their learners' cultural identification. This raises critical questions about classroom and teacher-learner relationships. This is not to say that learners might construct and reconstruct their identity over a period of time. The point is that the present interactions in science and technology teaching/learning are conducted in codes (e.g., language, behaviour, knowledge construction) which are "other" to learners (Yon 2000: 12). (Yon, 02000:12). Educators need to realise the difficulties inherent in communicating with learners of different cultures.

The three specific aims in Technology makes allowances for the teaching and learning of IKS. The Technology curriculum provides the perfect platform for the educators to enhance the teaching and learning of IKS by integrating the learners' knowledge and experiences with that of local and global communities. In the Maphumulo circuit many of the schools are situated deeply in the rural area. Through the design process learners will be able to engage with the elders in the community and gather valuable information around the scenarios presented as real life problems and needs. For example, during the teaching of processing the learners can investigate how maize was stored, crushed and produced, as well as how pests were eliminated. The elders, through storytelling, will be able to provide very rich information which was not recorded due to the apartheid system in the country, as South Africa had then imposed a western system. Similarly, for the teaching of structures, learners can engage with the community and discuss the design of the rondavel, the fireplace and materials used in its construction. The teacher can invite a leading member of the community and ask him/her to narrate the story of the construction of the rondavel, the choice of materials and the location of the fire place. Learners, in groups, can also present their findings and solution via a similar process of storytelling.

2.3.4.4 Technological pedagogical content knowledge (TPACK)

Pedagogical content knowledge is a key issue in technology education, and the DBE acknowledges the deficiencies of teachers in this crucial area:

> While it must be recognised that a wide variety of factors interact to impact on the quality of the education system in South Africa, teachers' poor subject matter knowledge and pedagogical content knowledge are important contributors (South Africa. Department of Basic Education 2011c: 4).

Mishra and Koehler's (2006) framework for technological pedagogical content knowledge (TPACK) is one of the most well-received and widely researched theoretical frameworks for technology integration in the classroom, and has been followed up extensively in subsequent works (Koehler and Mishra 2009; Koehler 2012; Koehler, Shin and Mishra 2012; Koehler, Mishra and CaIn 2013; Koehler *et al.* 2014)

Building on Shulman's (1986) model for pedagogical content knowledge (PCK), Mishra and Koehler added the dimension of technology knowledge (2006: 1027) and demonstrated how various kinds of teacher knowledge could be derived from the integration of technology, pedagogical, and content knowledge (see Figure 2.3). These integrated forms of knowledge are pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPCK) (Mishra and Koehler 2006: 1027-1028).

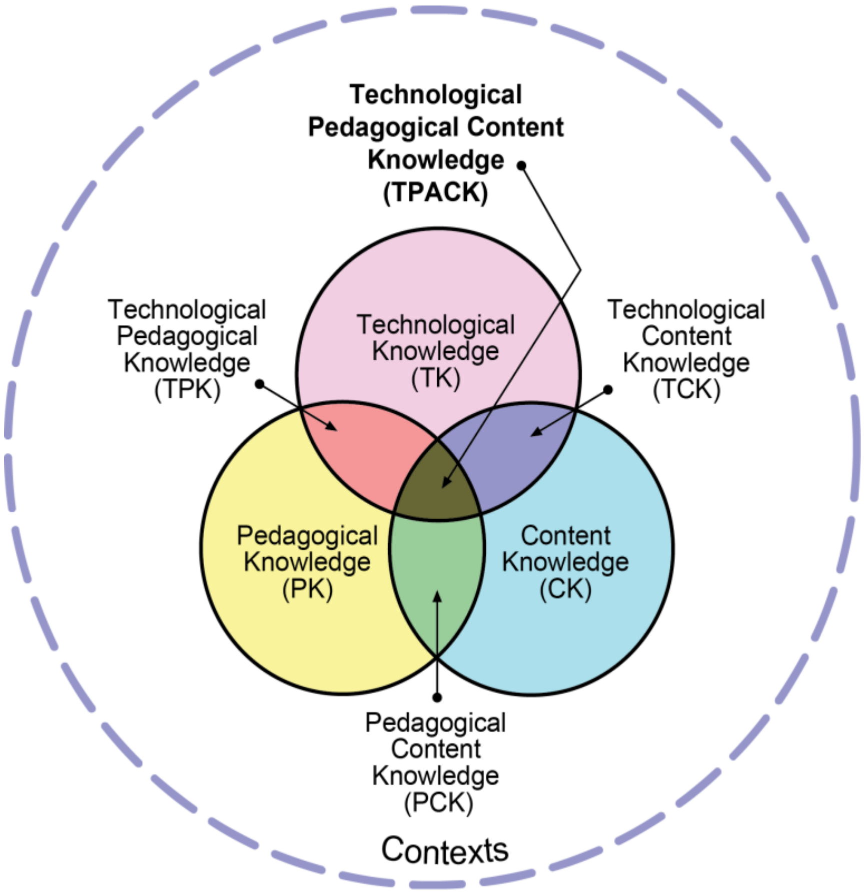

Figure 2.3 The technological pedagogical content knowledge (TPACK) conceptual framework (Koehler 2012; Koehler *et al.* 2014: 9).

Together with technology knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) (Mishra and Koehler 2006: 1026-1027), these seven kinds of knowledge make up the TPCK framework (TPCK was later termed "TPACK" for ease of pronunciation). According to Mishra and Koehler (2006: 1020), not only learning, but teaching itself is a highly complex activity drawing from many kinds of knowledge, the two main kinds of knowledge being knowledge of content and knowledge of pedagogy. Shulman (1986) contends that knowledge of content and knowledge of pedagogy cannot be separated when teaching, but must be integrated, as teachers are confronted with both issues while teaching. According to Mishra and Koelher, the benefits of the TPACK model are as follows:

> The TPCK framework, we argue, has given us a language to talk about the connections that are present (or absent) in conceptualizations of educational technology. In addition, our framework places this component, the relationship between content and technology, within a broader context of using technology for pedagogy (Mishra and Koehler 2006: 1044).

Yet, while TPACK provides a much-needed framework for technology educators, the model has been criticised for being imprecisely formulated and in need of further theoretical development (Graham 2011). Furthermore, it has been claimed that TPACK does not deal with evaluation consistently, has not been related to specific disciplinary areas, and has not been sufficiently researched in higher educational contexts (Papanikolaou, Makri and Roussos 2017). Robertshaw and Gillam (2010: 3927) comment on the difficulty of measuring educators' TPACK, although Koehler, Shin and Mishra (2012) offer a method of analysis, and suggest use of self-report measures, open-ended questionnaires, performance assessments, interviews and observation to measure TPACK. In her analysis of the literature on TPACK, Cox (2008: 116-131) noted thirteen different descriptions of TCK, ten of TPK, and eighty-nine of TPACK, showing that these concepts are conceptualised in many different ways by different researchers and practitioners.

The following problem areas regarding TPACK have been identified for further research and clarification (Graham 2011: 1959):

- unclear construct definitions;
- vagueness about how the constructs are related to each other;
- unclear demarcation and definition of the boundary areas distinguishing various elements from each other;
- no rationale for the inclusion of each construct; and
- no explanation as to how the constructs might contribute to a better understanding of the issues faced by educators

In spite of the above problem areas, Graham concedes that TPACK provides an integrated framework which can "provide theoretical guidance for how teacher education programs might approach training candidates who can use technology in content-specific as well as general ways" (Graham 2011: 1959). Research on teacher education has found the TPACK model to be a potentially effective framework for preparing and developing teacher competencies for school teaching (Srisawasdi 2012: 2327), and it has been used in this sense in this study.

In a deep rural district such as Ilembe, the educators lack content knowledge about the actual subject matter to be taught as well as the pedagogical content knowledge which deals with the teaching process. The transfer of specialised skills as required for the teaching of mechanical systems and control can become problematic should an educator also lack technological content knowledge, as this knowledge can create new representations for specific content. However, teachers with poor subject matter knowledge and pedagogical content knowledge can achieve the successful teaching of Technology if they are competent with sufficient TPACK knowledge and skills. This can be carried out on two levels. The first level involves the use of quality digital learning materials which can be used to bring real life situations into the classroom by using YouTube videos to teach concepts such as hydraulics and pneumatics (e.g., in Grade 7 classrooms). The second level involves teachers engaging in self-learning experiences by using multi-media devices to prepare and present relevant materials. By previewing and post-viewing the materials, teachers are able to attain a deeper understanding of the concepts to be taught. This process was modelled for teacher participants in the researcher's workshops, which form the basis of the empirical work presented in this study

2.3.5 Assessment method for technology education

The National Curriculum Statements Grades R-12 (NCS) stipulates policy on curriculum and assessment in the schooling sector (South Africa. Department of Basic Education 2017b). To improve implementation, the national Curriculum Statement was amended, with the amendments coming into effect in January 2012. A single comprehensive Curriculum and Assessment Policy document was developed for each subject to replace subject statements, learning programme guidelines and subject assessment guidelines in Grades R-12. Tables 2.3 and 2.4 show the changes between the "old" NCS (South Africa. Department of Education 2002b) and "new" NCS (CAPS) (South Africa.

Department of Education 2011b) (adapted from the CAPS policy documents and NCS curriculum statements).

Table 2.3 Changes in the amended CAPS document in GET phase

PLANNING in GET PHASE	
OLD NCS	NEW NCS (CAPS)
1.POLICY DOCUMENTS Subject Statement for every school subject Learning Programme Guidelines Subject Assessment Guidelines An addendum to the policy document regarding learners with special needs Gazette, No 29466 of 11/12/2006 An addendum to the policy document , the NCS regarding the National Protocol for Assessment GradesR-12, Gazette No 29467 of 11/12/2006	POLICY DOCUMENTS Curriculum Assessment Policy Statements for every school Subject listed in the policy document, National policy pertaining to the programme and promotion requirements of the National Curriculum Statements GR-12 National policy pertaining to the programme and promotion requirements of the National Curriculum Statements Grades R-12 The National Protocol for Assessment GradesR-12 (JANUARY 2012.)
2. NINE NCS Principles underpinning the Curriculum	Seven Constitutional Principles underpinning the Curriculum.
3. Learning Outcomes and Assessment Standards	Topics: concepts, knowledge and skills
4. Terminology:	Terminology:
5. Number of subjects in intermediate phase: 09 Number of subjects in Senior phase: 09	Number of subjects in intermediate phase: 06 Number of subjects in Senior phase:09
• Learning Programmes • Work Schedules • Programme of Assessment • Lesson Plans	• Overview • Annual Teaching Plan • Programme of Assessment

The main thrust of these changes is as follows. Firstly, there are changes in terminology from the earlier outcomes-based terms to the more traditional academic terms used in the FET band. Thus what in OBE were termed “learning areas” are now called “subjects” (e.g., by their subject names, such as Technology or Mathematics). Next, the number of assessments for Technology has been reduced to two PATS (no longer Mini-PATS) per year instead of four, thus reducing the opportunities for practical implementation of technology. Finally, Technology was a stand-alone subject at GET band and Intermediate phase, but is now combined with Natural Science, thus reducing the number of subjects offered. These changes can be viewed as constraints on the success of Technology as a subject in terms of it being downgraded as an academic subject, as it is no longer an equal partner with Science, which has a higher status. The reduction in numbers of assessments also downgrades the status of Technology for staff and learners. The reduction in compulsory practical work (from four to two PATS) means that technology concepts are learned as examination content and learners have less experience of implementing them in practice.

Table 2.4 Changes in the amended CAPS document in Intermediate and Senior phase

Natural Science and Technology in the Intermediate and Senior Phase		
	NCS	CAPS
Time: In OBE no time allocation was provided. In CAPS the time to teach the content knowledge and skills is stipulated in weeks	Notional time for teaching: • Natural Science= 3hours 30 minutes • Technology= 2hours per week	Natural Science and Technology Combined as one subject with combined teaching time of 3.5 hours. The time is allocated per topic. The topics are divided into 9 weeks with the tenth week for assessment. Two hours have been taken away and distributed to other subjects.
Knowledge strands: Previously called content areas for technology Technology has followed in line with science including the Senior Phase	Natural ScienceGr4-6 Life and Living Matter and materials Energy and change Earth and beyond --- Technology Gr.4-6 Structures Processing System and control	Combined knowledge strands Technology is infused with Natural Science Grade 4. Life and living and structures Matters and materials and structures Energy and change and Structures Earth and beyond and Mechanisms Grade 5 Matter and materials and structures Energy and change and mechanisms Life and living and mechanisms Life and living and earth and beyond Grade 6 Energy and change Earth and beyond and electrical mechanisms Matter and materials Life and living and mechanisms
The Learning Outcomes have changed to Specific aims in the strengthened NCS(CAPS)	Natural Science Learning Outcomes lo1- Scientific investigations LO2- Constructing science knowledge LO3- Science, society and the environment --- Technology Learning Outcomes LO1-Technological processes and skills LO2-Technology knowledge and understanding LO3- Technology, Society and the environment	The specific aims for Science and Technology are combined. It is now termed as; Specific Aim1 Knowing science and Technology Specific Aim2 Investigating phenomena in Natural Science AND designing and making solutions in technology Specific Aim3 Appreciating and understanding the history, importance and applications of science and technology in society.

Skills in (CAPS) has replaced Assessment Standards	Assessment Standards	Skills
Content (Theory)	In the NCS the learning outcomes were not clearly stated and organized as to the core knowledge and concepts to be taught	In the CAPS document the theory and practical work (Mini-PAT) is the core of the curriculum and is specific and prescribed. * In the previous NCS the core content areas could be taught in any term as long as it was taught during the course of the year.
Practical work	The practical tasks and the resources to be used were not prescribed	In the CAPS document the resources and the resources to be used are listed with minimum requirements.
Assessment Intermediate phase Senior phase	The number of formal tasks is suggested per term. six tasks were suggested per wear with no indication prescribed per term No marks for each assessment is given No weighting per cognitive level is given.	Specifies the number of formal assessment tasks per term and what these should be (practical, case study, project). Given mark allocation per formal assessment task. Gives weighing of topics per exam. Gives weighing of cognitive levels per exam. Time is specified for exam-60 minutes. In the senior phase time allocation and mark allocation is per grade Gr7- 60 minutes- marks 60 Gr8- 90 minutes- marks 100 Gr9 120 minutes- marks 1200

According to Stevens (2006), the largest constraint in the development of technology as a subject is the fact that there is no general technology subject at tertiary level in South African Institutions. The lack of technology (as a subject) in the FET band exacerbates the situation. Learners are expected to make choices for technology-related subjects at the end of Grade 9. However, in the Maphumulo circuit there are no technical high schools, and this further impacts on the implementation of technology, as teachers see it as a “dead end” subject.

All of the curriculum models have their constraints, and no one model or approach is perfect. The principal as head of the institute must take a leading role in the continuous development and improvement of the curriculum by using an integrated management approach. As the instructional leader of the school, the principal has the obligation of developing and promoting the school’s goals and objectives to enhance student achievement. With the “big picture” of the school in mind, the principal has the power and the authority to implement a curriculum management process that include all stakeholders. The NCS (CAPS) Grades 7-

9 Technology Policy (South Africa. Department of Education 2011b: 13,42) puts the development of teachers and the provision of resources as the responsibility of the school, and the school principal is the accounting officer on whom this responsibility falls.

2.4 The hidden curriculum

As this section relates to an aspect of technology education which is not formally curriculated, but has relevance to the researcher's ad hoc attempts to train technology education teachers, it has been dealt with in a new section. While every school has a planned or formal curriculum, that is, a stated and structured set of objectives, with related content and learning experiences and expected outcomes, there is also an unplanned and informal curriculum, which is referred to as the "hidden curriculum" (Ornstein and Hunkins 1993: 369-370; Sambell and McDowell 1998). The hidden curriculum behind the curriculum model includes the methods that principals and teachers can employ to make their curriculum planning more effective (Jacobs and Chalufu 2004: 107). It is a process not only for curriculum development but also for making teachers more skilful and more effective, of putting them more in control of the curriculum and the teaching and learning process. The hidden curriculum indicates a wide variety of planned as well as unplanned experiences which learners and teachers have at schools but which are not stipulated in departmental rules and regulations (Sambell and McDowell 1998: 391). The hidden curriculum is not consciously planned or intentionally taught, but it does influence the learners to a large extent in their development and outlook towards their way of life. It encompasses all school-related experiences that are not described in the curriculum statements, policies and directives that are issued by the department. The culture of the school influences the experiences of the learners and teachers who work in the school in unplanned ways, yet the hidden curriculum is not publicly acknowledged as its curricular intentions escape policy control within the school since it is taken for granted (Stenhouse 1987: 40). It exerts both positive and negative influences on learners, particularly in terms of the way it is revealed in its assessment policies (Sambell and McDowell 1998: 392), which may not match the "official" (i.e., stated) educational objectives. As with the official curriculum, the hidden curriculum operates at three levels, namely, the macro-, meso- and micro-level (Jacobs and Chalufu 2004: 94).

2.4.1 The macro-level hidden curriculum

Educationists interested in the hidden curriculum often focus their debate on the hidden macro-curriculum, which is based on covert school experiences that take place on a national level, often as a result of government and political influences (Jacobs and Chalufu 2004: 94). A government has complete control over the vast amount of state money available for education in a country, and it sometimes uses that economic power to create a hidden curriculum which helps it to achieve certain political goals. A case in point is the implementation of Curriculum 2005, and, more recently National Curriculum Statements (NCS) Curriculum and Assessment Policy Statement (CAPS). The hidden macro-curriculum, therefore tends to be related to politics. From the researcher's own experience as a Senior Specialist Subject Advisor for the DBE, the following are just a few examples of macro-level hidden curriculum influences affecting technology education, particularly in the implementation of policy:

- Circulars not being received by principals;
- Failure to cross-reference changes to include technology education in government documents;
- Principals not knowing where to access funding, even when available;
- Little or no formal teacher training for technology education;
- Teachers being expected to take responsibility for their own development (IQMS) when their initial grounding in the subject is lacking;
- The provincial moderation of school based assessment (SBA); and
- Technology which is part of the MST family not being included in official documents.

2.4.2 The meso-level hidden curriculum

The hidden meso-curriculum is operational at the level of the school. While the term "hidden curriculum" may suggest something sinister, learners' experiences are often positive and valuable (Naicker and Waddy 2003: 7). For example, in schools where there is respect for human rights, learners acquire social skills that are based on trust and respect through their interaction with other learners as well as with teachers. It is at the meso-level that the principal interacts with the hidden curriculum, and recognizes the hidden aspects of the formal curriculum which may lead to dysfunctional or negative learning experiences, and takes action to prevent such experiences. Meso-level issues may include which subjects are accorded high and low status, which is relevant to this study.

In spite of its importance to nation-building especially with regard to economic progress and employment, and the importance placed on it by the DBE, technology education is not valued by staff, pupils or parents, and is given low status. As staff, students and parents observe, technology education is taught only at Grades 8-9, and is not offered as a subject in Grades 10-12. It has therefore become a low status subject, and is often farmed out to teachers to make up a teaching load (Makgato 2012: 1400). Funding and resources are first allocated to further education and training subjects within the high school, as Grade 12 is a priority (another facet of the hidden curriculum is the focus on matriculation at all costs).

The following examples of meso-level issues affecting technology education are, again, drawn from the researcher's experience as a Senior Specialist Subject Advisor for the DBE. A factor mentioned above at macro level is the provincial moderation of school-based assessment (SBA), which works its way down into the meso-level in terms of implementation of assessment at school level, and affects the perceived status of Technology as a subject by school management. Five subjects are identified for provincial moderation, namely, Mathematics, Economics and Management Sciences (EMS), English, Natural Sciences and Social Sciences. Technology, which is part of the MST family, is not included (South Africa. KwaZulu-Natal Department of Education 2017a). This kind of omission invariably results in Technology being perceived as a low status subject, as it is seen as being less important than subjects which are included, and confirms Sambell and McDowell's (1998: 392) contention that a mismatch between official curriculum policy and actual assessment procedure can reveal features of the hidden curriculum.

2.4.3 The micro-level hidden curriculum

The teacher, who is a classroom-based manager, works at the micro level of curriculum development. It is at this level that the teacher, firstly, would have to have expert knowledge and skills to explain the key concepts to the learners in detail. The key concepts in technology education are:

- Problem solving using the design process (Specific Aim 1);
- Practical skills (Specific Aim 2); and
- Knowledge (including IKS) and application knowledge (Specific Aim 3) (South Africa. Department of Basic Education 2011a: 9).

The teacher of Technology would also have to make the learners aware of the interrelationship between technology, society, the environment and the different coexisting knowledge systems which are referred to as indigenous knowledge systems, or IKSs (South Africa. Department of Basic Education 2011a: 10). This may require some careful (and tactful) consultation with community members (Meyiwa, Letsekha and Wiebesiek 2013). Teachers cannot teach content or model it for learners if they are not "technology literate" - as well as indigenous-technology literate - themselves. Teachers need to be sensitive when implementing the curriculum; all factors both known and unknown must be considered prior to implementation (Ornstein and Hunkins 1993: 370). This refers to the subject Technology as well, which requires skills for the Mini-PAT to be learned.

A lack of knowledge and understanding of the content matter operates at the micro-level of the hidden curriculum. Not knowing how to conduct a demonstration or attempting to explain the intricate working of a hydraulics system can contribute to potentially dysfunctional or negative learning experiences when sections of the syllabus are left out by educators who have not been trained to handle such sections competently.

2.4.4 How the hidden curriculum impacts technology education

While extremely important intrinsically in terms of its potential for preparing learners for the world of work, building the economy and moving South Africa into the fourth industrial revolution, technology education is plagued by operational issues which have made it a subject fraught with problems. The main problem, from the researcher's point of view, is the lack of subject-specific teacher training (see Makgato 2012: 1399), which problem he has to address on a daily basis in an ad hoc fashion in his role of Senior Subject Specialist. While the job should more properly involve development of subject knowledge and pedagogical skills, the researcher has to start each training session at a basic level. The problem is even more marked at secondary school level, where teachers are expected to "fill in" teaching technology education with little or no training in subject content or pedagogy. Why this should be so, when the knowledge and skills involved are so important to social and economic development, is due to the double standards operating in technology education. How it might best be taught is not problematic: a detailed research account has been compiled of the type of curriculum for teachers of technology education which might lead to exemplary teaching and learning practices (Makgato 2003), but this (or a similar) curriculum has not been implemented, and is unlikely to be so in the near future.

In essence, an excellent subject, leading to employment and much needed industry skills, technology education has a problematic aspect which is apparent at the operational level. In its implementation, it is apparent that Technology is not really valued as a high-level school subject, and is viewed as a practical "vocational" subject for learners who cannot succeed at an academic level. Moreover, in South Africa, it does not go on to Grade 12, that is, it has no university entry option. For these reasons, it is not likely to be valued by teachers or learners. The education departments themselves send out ambivalent messages about its status and implementation, in terms of gaps in the circulars. For example, Technology is left out of the assessment circulars, with no explanation being given (South Africa. Department of Basic Education 2017a; South Africa. KwaZulu-Natal Department of Education 2017a). Funding is available for classroom resources needed for Technology, but very few school principals could know that, as neither technology education nor the procedure/s for obtaining resources for it are detailed in the relevant funding circular (South Africa. KwaZulu-Natal Department of Education 2017b), The suspicion that technical colleges (TVETs) are being funded by a government elite so as to relegate the majority of South African youths to labourer status is yet another barrier in acceptability of a technical vocation (Ngkaweni 2017). The reality is that the country needs skilled artisans more than university graduates, but if artisans are viewed as being "academically challenged" rather than "technically gifted", this is going to be a problem, and does not bode well for the status of technology education.

The worst problem, from the researcher's point of view, is the lack of formal teacher education in technology education. The researcher as Senior Subject Specialist is tasked with offering teacher training in an ad hoc fashion, and his workshops have to make up for the lack of teacher education in technology education by assisting them to:

- Construct concepts; as well as
- Understand the practical application of these concepts (as assessment is loaded towards practical application).

These two aspects go hand in hand: concepts and application (both necessary), and, at the same time, the researcher was modelling for teachers a constructivist teaching methodology, which is equally important (Shepherd 2013, 2015).

2.5 Summary of key points in technology education

Certain key points emerge in the general overview of technology education:

- The concept of technology itself is difficult to grasp, as it widely permeates all aspects of human life in adapting the natural universe to cater for people's needs, and as such, has relevance for so many disciplines and research fields.
- Technology is realised in its practice, which may involve, amongst other processes, the design process, production, actual use and/or maintenance of technical artefacts or systems.
- Understanding of technology and its actual application go hand in hand, and involve key processes such as design, problem-solving and creative thinking.

- Teachers cannot teach technology education unless they have a firm grasp of the concepts involved as well as their application in actual practice.
- The concepts and application of technology are socially constructed and affected by the context in which technology is found, which is why indigenous knowledge and practices are crucial elements of technology education.
- Both concepts and practice need to be learned and assessed experientially.
- As concepts of technology are constructed socially, and technological artefacts (or systems) are constructed in given social contexts, a social constructivist approach is particularly appropriate for technology education.

2.6 Conclusion

In view of what has been discussed in this chapter, the rationale for the research problem and research questions (pre-empted in Chapter 1) should have become clearer. Conceptualising technology (whether the teacher of technology education is qualified or not) and the ability to share this conceptualisation with learners, as well as demonstrate to them how to apply technological concepts in practical applications can be seen as key issues for teachers. The research problem, then, could be narrowed down to addressing the issues of how teachers conceptualised technology (research problem 1), how they could be assisted to conceptualise it so as to assist effective teaching (research problem 2), and how to provide support for teachers in acquiring the necessary knowledge and skills involved (research problem 3) (p.13). The inquiry was guided by the following specific research questions (p.13):

With reference to educators in the Ilembe district:

1. To what extent do teachers' current concepts of Technology inform effective teaching practice, with specific reference to their:

   a. knowledge;

b. skills; and

c. training?

2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?

3. What are the results of these interventions on the following:

   a. teachers' concepts of Technology; and

   b. their plans for future teaching practice?

The next chapter will discuss the constructivist orientation and pedagogy within which answers were sought to the above research questions.

CHAPTER 3: RESEARCH ORIENTATION AND PEDAGOGY

3.1 Introduction

This chapter deals with the social constructivist research orientation underpinning this study, as well as the related constructivist pedagogical approach informing the teacher interventions in which the data were generated. After the meaning of the term "paradigm" is clarified, the constructivist paradigm governing this study is discussed. The chapter then moves to a consideration of the constructivist pedagogy, showing its appropriateness for technology education, and how it is used in the construction of the specialist knowledge contained in the TPACK framework. The compatibility of constructivist pedagogy with TPACK as shown in various studies is then discussed, in terms of the importance of social context and individual experience, TPACK as a process of constructing knowledge, TPACK working with constructivist principles, how TPACK can operate by focusing on creating artefacts within a constructionist framework, and, finally, educators' perceptions of constructivist-oriented TPACK. The chapter concludes by acknowledging the potential of constructivist pedagogy to contribute to the development of key concepts in technology, which is the aim of this thesis.

3.2 The constructivist research orientation

This section will look at the constructivist research orientation, which is one of the paradigms governing inquiry, and the orientation used in this study.

3.2.1 The meaning of the term paradigm

Kuhn (1962) was the first to use the term "paradigm" in the sense of world view, to account for the revolutionary shifts in perspective which he saw as typical of progress in the natural sciences. In this sense, the definition of a paradigm is "the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community" (Kuhn 1962: 175).[1] Following Kuhn, Guba and Lincoln define a paradigm as "the basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways" (1994: 105). Creswell also refers to the term paradigm as a world view, or "general orientation about the world and the nature of the research that the researcher holds" (2009: 6).

According to Guba, research orientations can be characterised by questions about their ontological, epistemological and methodological assumptions:

> (1) *Ontological*: What is the nature of the knowable? Or, what is the nature of reality?
>
> (2) *Epistemological*: What is the nature of the relationship between the knower (the inquirer) and the known (or knowable)?
>
> (3) *Methodological*: How should the inquirer go about finding out knowledge? (Guba 1990: 18)

In the field of education, the notion of the paradigm has been used to explain different orientations in curriculum development and classroom practice (Popkewitz 1984; Carr and Kemmis 1986; Schubert 1986; Grundy 1987). In spite of the fact that its creator, Kuhn, was writing in the context of the natural sciences, the concept of the paradigm is highly applicable to the field of education:

> Again, following the discussion of Kuhn's account of science, it can be argued that the notion of 'paradigm' is very much applicable to a social institution like education. For just as a scientific paradigm provides a framework of assumptions which determine what is to constitute an approved scientific practice, so it is only against the background of a shared educational paradigm that educational practices can be made intelligible, not only to educational researchers, but also to educational practitioners as well (Carr and Kemmis 1986: 111).

Paradigms can act as the "conceptual lenses" through which curriculum issues are viewed (Schubert 1986: 2). They can also provide a useful guide in the practical, everyday lives of educators:

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[1] Kuhn, in reaction to the (then) dismissive response of the scientific community to this rather too revolutionary concept, later compromised by saying that perhaps the term paradigm should rather be used to describe a "disciplinary matrix" (1969: 184) or even "shared examples" (1969: 197) in a given field (i.e., of typical calculations, rubrics and formulae used).

> A paradigm is a worldview, a general perspective, a way of breaking down the complexity of the real world. As such, paradigms are deeply embedded in the socialization of adherents and practitioners telling them what is important, what is legitimate, what is reasonable. Paradigms are normative; they tell the practitioner what to do without the necessity of long existential or epistemological considerations (Patton 1975: 15).

However, educators are not necessarily consciously applying the beliefs, values and assumptions contained in paradigms (Carr and Kemmis 1986: 74), and perhaps should be seen as "authenticating" the existence of various paradigms in their actual teaching practice (Grundy 1987: 21).

3.2.2 The constructivist paradigm

If one uses Guba's suggestion that research orientations can be characterised by questions about their ontological, epistemological and methodological assumptions, the constructivist paradigm can be summarized as follows (Guba 1990: 27):

Ontology: *Relativist* - realities exist in the form of multiple mental con-structions, socially and experientially based, local and specific, dependent for their form and content on the persons who hold them.

Epistemology: *Subjectivist* - inquirer and inquired into are fused into a single (monistic) entity. Findings are literally the creation of the process of interaction between the two.

Methodology: *Hermeneutic, dialectic* - individual constructions are elicited and refined hermeneutically, and compared and contrasted dialectically, with the aim of generating one (or a few) constructions on which there is substantial consensus.

The nature of reality (i.e., ontology) is relative, as, "if there are always many interpretations that can be made in any inquiry… there is no alternative but to take a position of *relativism*" (Guba 1990: 26). The relationship between the knower and the known (i.e., epistemology) is subjective: "Subjectivity is not only forced on us by the human condition … but because it is the only means of unlocking the constructions held by individuals" (Guba 1990: 27). How the inquirer goes about finding out knowledge (i.e., methodology) occurs in two ways. The first is to describe individual constructions as faithfully as possible, in a process which is “hermeneutic” in the sense of interpreting meaning inter-subjectively (Schubert 1986: 181). The second is to compare and contrast these constructions using discussion and logical comparison (dialectic), so as to arrive at constructions on which there is general consensus.

The above description of the constructivist paradigm clarifies for researchers using a constructivist approach what reality is and how they can know reality; what approach they can use to acquire knowledge; and what procedures and tools they can use to acquire knowledge. It even suggests what data constructivist researchers should use, namely, data generated by individuals as they go about their everyday activities in given social contexts, as was done in this research. Also, if realities are “dependent for their form and content on the persons who hold them” (Guba 1990: 27), then data on the background of participants (in this case, educational) also need to be gathered so as to understand the factors constraining individual constructs.

The constructivist research orientation is highly appropriate to this study as it relates directly to the researcher’s professional work as a Senior Subject Advisor, technology education. His task is to ensure that educators construct the meaning of technology in ways which will enable them to inform and inspire their learners to be able to take up individually satisfying careers in technology, as well as to become part of the technology-skilled workforce needed to develop South Africa economically.

3.3 Constructivist pedagogy

According to Whitby (2007: 2), the “old pedagogies” are no longer relevant, and there is a need for a “21st Century pedagogy” to move into the future. The pedagogy used in the teacher training workshop used to gather data in this study was constructivist, as was the approach teachers were encouraged to use with their learners. The rationale for this was that understanding of the technological process, namely, “investigate, design, make, evaluate, and communicate” (South

Africa. Department of Education 2002a; South Africa. Department of Basic Education 2011a), involves a number of subjective aspects, and is greatly influenced by the social context (i.e., local environment) in which it is researched, as, in different communities the needs of the community will vary. In a teaching and learning environment the contributing social factors include the location of the school, transport, electricity, poverty, employment provision/non-provision of essential teaching and learning resources (South Africa. Department of Basic Education 2011a). Other social factors include the teacher's pedagogical content knowledge and skills, assessment practices, Mini-PAT requirements and the demographic profiles of learners and teachers.

Ilembe District is made up of part urban and mostly rural and deep rural schools. Over the past three years it has performed poorly in the national senior certificate examinations. In 2016, it was positioned last out of twelve districts. The low levels of performance over the years make this an important focus of attention in terms of influences (positive and negative) on the learning process. The constructivist pedagogy is considered appropriate for this study. As a subject specialist, the researcher believes that constructivism means that one has to understand the teachers and their learning beliefs or behaviours, and to be aware of their experience and culture (historical and cultural contexts), and recognise that they do not just only see the world differently from the way the researcher does, but also experience it differently too.

During the group work stages, personal elements, such as individual skill and knowledge, common understanding, acceptance of choice of decisions, and presentation and communication strategies, are contributing factors that make development of technology concepts a subjective matter. For these reasons, constructivist pedagogy is a highly suitable teaching and learning approach for this study. "Cooperative learning, hands-on activities, discovery learning, differentiated instruction, technology, distributed practice, critical thinking, and manipulatives are elements that embrace the constructivist educational philosophy" (White-Clark, DiCarlo and Gilchriest 2008: 41). This fits the multi-faceted process of technology as a creative subject in the 21st Century which is co-constructed in social interactions to solve human needs and wants.

The notion that social factors play an important role in the development of science is a tenet of constructivism, holding that scientific theories are social constructs rather than the result of reasoning based on observations (De Vries 2010: 238). According to De Vries (2010), the same principle applies to the field of technology, and therefore teachers and learners need to realise that "technological developments are very much influenced by the interaction between social actors and cannot be adequately represented by the work of engineers alone" (De Vries 2010: 247).

Key theorists in the history of constructivism as a theory of learning are Piaget (1969) and Vygotsky (1978, 1986). The former focussed on the construction of meaning in individual learning, while the latter viewed learning as occurring in, and influenced by, its social context. These two schools of thought are referred to as "*cognitive* constructivism" and "*social* constructivism" (Griffin 2011: 15). In either case, however, knowledge is constructed by the learner, and not transmitted from an outside source (Jonassen 1991). The constructivist position on learning is that it is a process of learners constructing meaning and making sense of their experiences (Caffarella and Merriam 1999: 260). This means that children are not passive recipients of knowledge, but rather active constructors of their own knowledge in interaction with the world and society around them. The main difference between Piaget's and Vygotsky's approaches was in their proposed method of providing for the construction of knowledge by the learner (Griffin 2011). In Piaget's approach, the learner is provided with a suitable setting for what needs to be learned, and takes an active role, while the teacher's role is more passive, facilitating, rather than directing, the action or discussion (Griffin 2011: 13). Vygotsky, however, believed in more active interventions in which learners were guided by "cultural tools" (e.g., images or mnemonics) to assist learning, thus mediating, rather than merely facilitating, learning (Griffin 2011: 21). Both approaches have merit for empowering learners in the classroom (Mensah and Somua 2014: 171).

According to Brooks and Brooks (1999), these five key principles underpin constructivist pedagogy:

- *Teachers seek and value their students' points of view.*
- *Classroom activities challenge students' suppositions.*
- *Teachers pose problems of emerging relevance.*
- *Teachers build lessons around primary concepts and "big" ideas.*
- *Teachers assess student learning in the context of daily teaching* (Brooks and Brooks 1999: ix-x, shortened).

Constructivist pedagogy is based on the premise that the individual creates meaning from his/her own experiences (Jonassen 1991: 10). Constructivist learning environments are based on the following elements (Jonassen *et al.* 1995: 13):

- *Context*, which must be a real-world setting;
- *Construction* of knowledge, that is, active meaning making, by learners;
- *Collaboration* between participants to assist and reflect on meaning-making; and
- *Conversation*, as meaning making is generated.

Thus constructivist learning environments "engage learners in knowledge construction through collaborative activities that embed learning in a meaningful context and through reflection on what has been learned through conversation with other learners" (Jonassen *et al.* 1995: 13). Knowledge is constructed by "an individual or group of individuals who interact among themselves and with their surroundings in the process of acquiring knowledge" (Rockmore 2005: 79). The context in which learning takes place must be an "authentic learning environment" (Herrington and Herrington 2006), which includes not only the classroom but also the sociocultural setting. For this reason, Gwekwerere (2016) suggests that African students should be given learning tasks with meaningful examples fitting their home environment and cultural background, and Gumbo (2016: 17) recommends "place-based pedagogies" which are relevant to the learners' social setting. These views concur with Vygotsky's socio-cultural learning theory, namely, that one cannot understand the development of cognitive abilities involved in learning without considering the culture in which learning takes place (McCormick and Pressley 2007: 153).

To sum up its key features, constructivist pedagogy:

- is socially based and learner-focused;
- uses experiential, hands-on learning;
- views theory and experience as interconnected and complementing each other;
- encourages creative thinking and problem-solving;
- uses collaborative group work and group problem solving; and
- is pitched at gradual small changes at the proximal area of development (i.e., just above the level of the learner, Vygotsky 1978: 79-81).

The notion that social factors play an important role in the development of science is a tenet of constructivism, holding that scientific theories are social constructs rather than the result of reasoning based on observations (De Vries 2010: 238). According to De Vries (2010), the same principle applies to the field of technology, and therefore educators and learners need to realise that "technological developments are very much influenced by the interaction between social actors and cannot be adequately represented by the work of engineers alone" (De Vries 2010: 247). This means that there is a need for a pedagogy for technology education which recognises the importance of social context and social actors in understanding the nature and role of technology.

3.4 The appropriateness of constructivist pedagogy for technology education

As mentioned in Chapter 2 (pp. 21-22), the significance of technology education is its potential to develop citizens who can display the competencies and values encapsulated in the CAPS "Unique Features and Scope" (South Africa. Department of Education 2011b: 9). The (current) outcomes-based education (OBE) model stresses the following:

- problem-solving in creative ways in authentic, real-world contexts;
- linking abstract concepts to concrete understanding;
- carrying out practical projects using a variety of technological skills;
- using and engaging with knowledge in a purposeful way;

- learning by dealing directly with social (including environmental) issues in practical project work;
- using a variety of life skills (e.g., decision-making, critical and creative thinking, co-operation, needs identification); and
- creating more positive attitudes towards technology-based careers (summary of points on pp. 35-36).

Practical problem-solving of real-world problems in authentic social contexts are all features of not only OBE, but also constructivist pedagogy, as described above, as is collaborative group work. As mentioned in Chapter 2 (p. 54) constructivism encourages social interaction to develop citizens who can display the competencies and values encapsulated in the unique features and scope of Technology, and one of them is to solve problems in creative ways.

Makgato (2012) sums up four principles of constructivist pedagogy which are highly relevant to technology education:

1. Teaching should begin with content and experiences familiar to the students, so they can make connections to their existing knowledge structures (i.e., real-life contexts should be used rather than abstractions).
2. Knowledge should be presented in a manner that does not change students' cognitive models drastically (i.e., so as to remain within the "zone of proximal development" described by Vygotsky, see Derry 2013: 48)
3. Teaching should enable students to fill the gaps and extrapolate information and materials presented by the teacher (i.e., encouraging them to become independent learners).
4. Teaching should involve students working in small groups dialoging and arguing to find solutions to the learning activities (e.g., cooperative learning) (Makgato 2012: 1399, slightly adapted).

Constructivist (Vygotskian) techniques such as using scaffolding, small groups, cooperative learning, group problem-solving, across-age tutoring, assisted learning, and/or alternative assessment (Mensah and Somua 2014: 168), are all enshrined in the activities of the Mini-PAT. The use of social constructivist pedagogy by teachers will encourage the learning of the design process to develop basic and integrated skills, this pedagogy supports group work and discussions. In Term 1 of the Grade 7 seven Mini-PAT, the learners are expected to work in groups to develop working models of their “Jaws-of-life”, and this must be presented as a group project (South Africa. Department of Education 2011b: 15).

3.5 TPACK and constructivist pedagogy

This section will discuss the connection between the TPACK framework and the constructivist pedagogy, identifying affinities between the two and motivating the use of this pedagogy for teaching/learning of TPACK. It will be shown that constructivist pedagogy to some extent solves the problems noted with TPACK in Chapter 2 (p. 43), particularly the problem of precisely defining the nature of the various types of knowledge contained in the framework.

It is not thought to be an issue whether educators adopt radical constructivism, which posits that scientific knowledge cannot be tested against an external reality, or social constructivism, which views reality itself as a product of social negotiation (Mintzes, Wandersee and Novak 2005: xviii). A constructivist approach views the “knowledge” in TPACK as being socially constructed in accordance with individual propensities and/or social context. For this reason, the knowledge contained in TPACK will obviously not lend itself to precise or discipline-specific definitions. Moreover, TPACK knowledge will be assessed in the context of what passes for knowledge in that social setting or in the opinion of individual assessors, the result being further complicated by the dictates of the “hidden curriculum” in different social contexts (it must be remembered that both the “official” and hidden curricula are social constructs). It is in fact the diversity of definitions of technological knowledge and how the various elements in TPACK are integrated which makes it a problem for educators. There is no easy solution: TPACK reflects a reality which is complex, layered and dynamic.

3.5.1 Knowledge contained in the TPACK framework

The TPACK framework described in Chapter 2 indicates that teaching is a highly complex activity drawing from many kinds of knowledge (Mishra and Koehler 2006: 1020). The two main kinds of knowledge teachers use are knowledge of content and knowledge of pedagogy, which, according to Shulman (1986), must be integrated during teaching. This view fits with Zungu's (2015: 37) contention that the emphasis of the TVET curriculum should be on integration rather than modularisation of content.

As mentioned in Chapter 2 (p.42) seven kinds of knowledge make up the TPACK framework:

1. Content knowledge (CK);
2. Pedagogical knowledge (PK);
3. Pedagogical content knowledge (PCK);
4. Technology knowledge (TK);
5. Technological content knowledge (TCK);
6. Technological pedagogical knowledge (TPK);
7. Technological pedagogical content knowledge (TPACK).

According to Mishra and Koehler (2009), content knowledge (CK) is the knowledge teachers possess about the subject matter to be taught/learned. Pedagogical knowledge (PK) refers to teachers' knowledge about teaching/learning methods, processes and practices. Pedagogical content knowledge (PCK) refers to knowledge of the pedagogy appropriate to the teaching of specific subject content. Technology knowledge (TK) is "always in a state of flux" as technology changes and develops exponentially, and, therefore is more difficult to explain. As for technological content knowledge (TCK), technology and content knowledge have a "historical relationship" as progress in diverse fields has occurred hand in hand with developments in technology. Technological pedagogical knowledge (TPK) "is an understanding of how teaching and learning can change when particular technologies are used in particular ways" (definitions from Koehler and Mishra 2009: 63-65).

Technological pedagogical content knowledge (TPACK), however, according to Mishra and Koehler (2009), is a very different form of knowledge and constitutes more than the sum of its component parts:

> Technological pedagogical content knowledge is an understanding that emerges from interactions among content, pedagogy, and

> technology knowledge. Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. Instead, *TPACK is the basis of effective teaching with technology*, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler and Mishra 2009: 66, my emphasis).

3.5.2 The compatibility of constructivist pedagogy with TPACK

The compatibility of constructivist pedagogy with TPACK is illustrated by the following examples in this section.

3.5.2.1 The importance of social context and individual experience

According to Angeli and Valanides (2009: 159), development in TPACK needs a constructivist approach (both social and individual), "because the most effective content transformations are those that create cognitive or socio-cognitive conflict and encourage dialogue and negotiation of meaning among students whose initial conceptions are different". They adopt a transformative view of TPACK, that it is "a unique body of knowledge that is constructed from the interaction of its individual contributing knowledge bases" (Angeli and Valanides 2009: 154) rather than an integrative view, that is, constructed by the teacher in the actual process of teaching. They stress the role of the teachers' social context (including institutional constraints) and individual experience in "constructing" their TPACK concepts, and comment on the absence of contextual factors in research on the TPACK framework. They also point out that an objective view of TPACK as discrete knowledge content (i.e., a positivist view) hinders the use of the framework by focusing on content rather than process (Angeli and Valanides 2009: 191), which leads us to the next sub-section.

3.5.2.2 TPACK as a process of constructing knowledge

Olofson, Swallow and Neumann (2016) incorporated ideas from radical constructivism to interpret TPACK as a process rather than a body of knowledge, focusing on the way in which teachers construct their knowledge. They thus refer to “TPACKing: an active process carried out by the teacher in which s/he constructs knowledge for teaching in the technology-rich setting”. They describe the process as follows:

> When engaging in the process of TPACKing, teachers bring together their technological, pedagogical, and content knowledge and interact them with each other. They pull in contextual influences, past experiences, and their knowledge of students in the process of building their TPACK. Teachers then enact this TPACK with students and their environment, and these interactions mediate their further TPACK constructions. The resulting changes in turn influence their understandings and beliefs about technology, pedagogy, and their content area. When TPACKing, a teacher's knowledge is continuously being constructed and interacted. Therefore the content of a teacher's TPACK changes (Olofson, Swallow and Neumann 2016: 189).

The focus on social interaction, experience and context, as well as the sense that knowledge is an emergent process rather than a static body of knowledge to be transmitted, are typical features of constructivist pedagogy. According to Harris *et al.* (2017: 5): “Their work forefronts the importance of constructivist pedagogy in particular as a core component in the ongoing development of teachers' TPACK.”

3.5.2.3 TPACK working with constructivist principles

In developing a pedagogy that would motivate and inspire students, Maor (2013) used the following constructivist principles:

> Interaction: Students engage in frequent, focused discussions with peers and the teacher.
>
> Peer learning: Students contribute reflective comments to peer conversations, on- and offline.
>
> Discussion leader: Students take a rotational leadership role as online facilitators.
>
> Facilitation: The teacher stimulates the discussion, presents core questions and topics, and challenges the students.
>
> Reflective practice: Students create reflective online journals in which they use technology to demonstrate their understanding and transformation of thinking over time (Maor 2013: 532).

She comments that this changed the focus from technology and skills to "a different way of working in a digital world" (Maor 2013: 532). While the learners found the course "challenging", the results revealed that learners took part in advanced collaborative learning using digital technologies, and showed that it was important for the teacher to challenge learners' thinking.

Hunter (2015: 41) cites a classroom case study where six constructivist principles of learning were used for TPACK integration:

- raising questions;
- challenging ideas and experiences by generating inner cognitive conflict or disequilibrium;
- reflection through journal writing, drawing, modelling and discussion;
- opportunities for dialogue;
- learners communicating their ideas, defending and justifying them; and
- learners working with big ideas, which are the central organizing principles that have the power to generalize across experiences and disciplines.

The teacher who used this approach commented that it took time: "To really know the subject matter well fits with the idea of inquiry-based constructivist teaching around a focus question and big ideas in a subject, and this approach takes time" (Hunter 2015: 80).

3.5.2.4 TPACK within a constructionist framework

The term "constructionism" refers to a type of constructivism developed by Seymour Papert which focuses on the construction of meaning through the making of artefacts, that is, "learning by making":

> Constructionism ... shares constructivism's view of learning as "building knowledge structures" through progressive internalization of action. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe (Papert 1991: 1).

Papert developed constructionism from Piaget's version of constructivism, but focused rather on learning and pedagogy than the cognitive aspects on which

Piaget concentrated (Ackermann 2001). As designing and creating artefacts is a key aspect of TPACK, the constructionist version of constructivism offers a highly compatible pedagogical approach. According to Ackermann (2004):

> Papert's "constructionism" sheds light on *how people's ideas get formed and transformed when expressed through different media, when actualized in particular contexts, when worked out by individual minds.* The emphasis has shifted from general laws of development to individuals' conversation with their own representations, artifacts, or objects-to-think with (Ackermann 2004: 20-21).

Hosseini (2015) describes a study exploring how teachers developed TPACK using a constructionist pedagogy and what activities influenced the development of TPACK. She found that teachers' knowledge improved on three levels as a result of engaging in constructivist activities; the levels involved using technology for (1) exhibiting curriculum information (2) presenting content and materials and (3) enhancing teaching and learning. Her findings thus suggest that constructionism could help to facilitate the development of TPACK. However, Hosseini (2015: 102) recommends that further research is needed to see how teachers transfer TPACK into practice in the actual classroom using constructionist pedagogy.

3.5.2.5 Educators' perceptions of constructivist-oriented TPACK

A study by Koh, Chai and Tsai (2014) examined the perceptions of three hundred and fifty-four teachers using constructivist methodology for TPACK. They termed "teachers' knowledge for implementing constructivist instruction with technology" as their "constructivist-oriented technological pedagogical content knowledge" (Koh, Chai and Tsai 2014: 185). The rationale for the study was that there were no available surveys for understanding teachers' perceptions of this pedagogy, and that, therefore, possible gaps in teachers' knowledge of constructivist-oriented technology integration were not well understood. Using the Technological Pedagogical Content Knowledge for Meaningful Learning Survey, this study examined the constructivist-oriented technological pedagogical content knowledge perceptions of the teachers, who were in active practice. Koh, Chai and Tsai (2014) validated the survey through exploratory and confirmatory factor analyses. Using regression analysis, they found that teachers' perceptions of

TPK, TCK and TK had the largest positive relationships with their constructivist-oriented TPACK. The role of teacher demographics is emphasised here, as age and gender were not found to be such significant factors as experience and teaching level. The results showed that the development of intermediate forms of TPACK contributed to teachers' confidence with using constructivist pedagogy. They concluded that it was important to understand the specific challenges faced by experienced teachers and primary school teachers (the groups showing the least confidence), and that this needed to be considered when one was designing professional development for Technology teachers.

3.6 Conclusion

In the course of his duties as Senior Subject Specialist: Technology in the Ilembe District, the researcher observed that the educators lacked content knowledge about the subject matter to be taught and the pedagogical content knowledge which deals with the teaching process. This state of affairs is borne out by many other studies on technology education in Africa (Zuga 2004; Nkwana 2010; Makgato 2012; Mpotse 2012; Ndlovu 2012; Sedio 2013; Fikeni 2014; Mabaso 2014; Ohemeng-Appiah 2014). The constructivist pedagogy has the potential to contribute enormously to the development of key concepts in technology. It has implications for how teachers interact with learners and how learners interact with teachers. Results from the post-test in this study suggested a marked increase in the understanding of knowledge of key concepts by teachers' teaching Technology when compared with the pre-test results. There was also an improvement in the marks obtained by learners in the groups taught by the teachers who attended the researcher's training workshop. The next chapter focuses on the methodology used for this study.

CHAPTER 4: METHODOLOGY

4.1 Introduction

Chapter 4 starts with an overview of the research design, which involves application of case study methodology within a social constructivist research orientation in order to assess the potential of using training workshops to transform pedagogy in technology education in selected schools in a rural district in KwaZulu-Natal. The constructivist pedagogy which Chapter 3 identified as complementing the TPACK framework is included in the research design, as it was the pedagogy to be modelled for teachers in the workshop. The chapter then goes on to discuss the case study methodology as well as the rationale for its use, and the specific case which was selected for the empirical work, namely, a DBE workshop run for technology teachers. The sampling method is then described, as well as the pre-test/post-test procedure used to gauge the effects of the workshop experience on teachers. An account is given of the construction and use of the research tools, namely, questionnaires and one-on-one interviews. The dual role of the training workshop is then discussed, in terms of its use as an intervention to develop technology knowledge and pedagogy as well as a data-generating mechanism for the pre-test and post-test interviews. It is shown that the workshop was designed to provide an exemplar for teachers of constructivist pedagogy used within the TPACK framework. After a review of the ethical considerations and the limitations of the study, the methods used for data analysis are described. The chapter concludes by showing how the various elements of the research design were used to provide answers for the specific research questions which guided this inquiry.

4.2 Overview of the research design

The elements of the research design (shown in Table 4.1) are as follows. Working within a social constructivist research orientation (as described in Chapter 3), the researcher used case study methodology to assess the potential of Department of Basic Education (DBE) training workshops to transform pedagogy in technology education in schools in a rural district in KwaZulu-Natal.

Constructivist pedagogy (as described in Chapter 3) is included in the research design as it was the teaching/learning approach used to generate the data gathered to assess the impact of the technology education workshops.

Table 4.1 Research design

RESEARCH DESIGN				
ORIENTATION	Social constructivism			
[PEDAGOGY]	[Constructivist]			
METHODOLOGY	Case study approach based on technology education workshop			
RESEARCH TOOLS	Educator survey		Pre-test/post-test questionnaire and interviews	
	Mixed methods in question types and instruments used			
Methods	*quantitative questions*	*qualitative questions*	*open-ended questions*	*open-ended questions*
Purpose	to establish factors showing educator pre-paredness for teaching Technology	to gain insight into reasons for educator pre-paredness for teaching Technology	to establish educator grasp of Technology concepts and pedagogy pre-workshop	to establish any changes in grasp of Technology concepts and pedagogy post-workshop
Products of the research	degree of preparedness for teaching Technology identified	rationale provided for degree of preparedness	specifics of educators' problems in teaching Technology as shown by interviews and questionnaire	evidence of post-workshop change/s (if any) in educators' conceptual grasp and future plans for Technology pedagogy

The research tools consisted of an educator survey, one-on-one interviews, and pre- and post-test questionnaires, comprising a mixed method approach as to research instruments and question types. The survey was used to establish factors indicating teacher preparedness (or not) for teaching technology education, and the one-on-one interviews probed in more depth to establish in what specific areas teachers thought they were unprepared or unsupported. The pre- and post-test questionnaires were used to indicate the teachers' grasp of technology education concepts and pedagogy before and after a DBE technology education workshop designed and run by the researcher. The anticipated products of the research were evidence of the degree of preparedness of teachers for technology education and the rationale for this as shown by the survey. Further products of the interviews and pre-test questionnaire were anticipated as being the specific areas in which teachers faced problems in teaching technology education. Finally, the results of the post-test questionnaire would provide evidence of any change/s in teachers' conceptual grasp and future plans for pedagogy as a result of what they had learned in the workshop.

4.3 Case study methodology

This section will deal with the case study methodology use in this study and the specific case selected for the study, as well as the method of sampling and the pre-test/post-test procedure used.

4.3.1 Rationale for using a case study

According to Stake (2010: 65), the purpose of qualitative research is to arrive at an understanding of certain situations, which enables researchers to "contribute to setting policy and professional practice"; he names the case study as one of the methods which can be used "to probe the meanings of situations". The term "case study" can be defined as follows:

> 'Case study' is a generic term for the investigation of an individual, group or phenomenon. While the techniques used in the investigation may be varied, and may include both qualitative and quantitative approaches, the distinguishing feature of case study is the belief that human systems develop a characteristic wholeness or integrity and are not simply a loose collection of traits (Bassey 1999: 26).

The case study approach is used to investigate a chosen real-world case, whether it be an activity, process, individual, group or phenomenon, to answer specific research questions (Bassey 1999: 26; Gillham 2000: 1-2; Creswell 2009: 13). While the case study can be referred to as a "methodology" (Yin 2002), as in Table 4.1, it is a choice of the subject of the investigation rather than a methodological choice (Stake 2005: 443). In this study a case study was used to describe an intervention and the real-world context in which it occurred, with the focus being on understanding the educational action (and results) involved (Bassey 1999: 15, 28). This is congruent with the social constructivist emphasis on the perceptions of participants in real-life contexts. Case studies are better suited than large-number studies for exploring these perceptions because they can use in-depth interviews or discourse analysis as well as quantitative evidence (Blatter 2008: 68). The thesis argument is then built on the empirical evidence thus obtained:

> The quality of a case study, thus, does not depend on providing detailed evidence for every step of a causal chain; rather, it depends on a skilful use of empirical evidence for making a convincing argument within a scholarly discourse that consists of competing or complementary theories (Blatter 2008: 71).

Some of the advantages of case studies are as follows:

> (a) Case study data, paradoxically, is 'strong in reality'… in contrast other research data is often 'weak in reality';
>
> (b) Case studies allow generalisations either about an instance or from an instance to a class;
>
> (c) Case studies recognise the complexity and 'embeddedness' of social truths;
>
> (d) Case studies, considered as products, may form an archive of descriptive material sufficiently rich to admit subsequent reinterpretation;
>
> (e) Case studies are 'a step to action'. They begin in a world of action and contribute to it;
>
> (f) Case studies present research or evaluation data in a more publicly accessible form than other kinds of research report (Bassey 1999: 23, shortened).

As teachers' lack of preparedness to teach technology education is an urgent, complex, real-life problem in a specific social context, requiring understanding and action from stakeholders, most of whom are not conversant with formal research terminology, the above advantages motivate the use of case study methodology for this study.

Some criticisms are that case studies lack rigour, provide little basis for scientific generalisation, take too long to accomplish and generate "massive unreadable documents" (Yin 2002: 10). Therefore, attempts have been made to add rigour by use of triangulation, generalise on the basis of not only the specific data gathered, but also on what the literature suggests about the teaching of technology education (e.g., using the TPACK framework), and to make this thesis as brief and "readable" as possible, without skimping on the results. The use of "before and after" measurement of the results of a specific educational intervention helped to cut down on the time taken to accomplish the empirical work.

4.3.2 The case selected for this study

The empirical work in this study was carried out in the course of the researcher's duties as Senior Subject Specialist in technology education in the Ilembe district. The case study approach was used to investigate the potential of DOE training workshops to transform pedagogy in technology education by looking at the results of one such intervention. The DOE workshop on technology education featuring in this study was designed and facilitated by the researcher as part of his duties as Senior Subject Specialist (see Appendix B for workshop materials). It was thus a real-life situation but "contextually bound", in this case, by the frame of the event itself and a limited time-span (Baxter and Jack 2008: 545; Creswell 2009: 73; Gondo, Amis and Vardaman 2009: 136).

The study was limited to sixty public schools as defined by the South African Schools Act, Act 84 of 1996 (South Africa. Department of Education 1996). Ilembe district is made up of three circuits, Ndwedwe, lower Tugela and Maphumulo, which serve deep rural schools. The study was conducted in the Ilembe District, Maphumulo circuit, Untunjambili ward, in which there are thirty-one schools. Access to these schools is on unpaved, corrugated roads, filled with potholes and boulders, and in many instances, require traversing low-lying bridges and streams. Public transport is almost non-existent in these areas, and most teachers either rent rooms near the school, or in some instances live in cottages on the school property.

The Maphumulo circuit, Untunjambili ward was chosen for the following reasons:

- Schools in this district are in a deep rural area.
- All of the schools in Maphumulo circuit fall into quintile 1, the lowest-ranked quintile of four, and requiring the most amount of government support.

- The area is ravaged by HIV/AIDS and high levels of unemployment and poverty.
- Schools in this area are unable to function without state funding.
- Vandalism of the buildings is rife in most schools (which impacts on equipment).

These schools thus represent the most under-resourced rural schools not only in KwaZulu-Natal, but also in South Africa, and those which serve the rural communities whose populations are most in need of employment and economic advancement. The researcher's contention is that it is not an issue of "pumping money" into schools to improve teaching and results, and ultimately, improve the quality of life for the communities, but that effective interventions in teacher training have the potential to transform the teachers' grasp of technological pedagogical content knowledge (TPACK) and, ultimately, learner performance. As most schools in this area are drawn from the former KwaZulu-Natal Department of Education and Training (DET), the research might also provide some insight as to how these schools are managing Technology as a learning area under a single education department.

4.3.3 Sampling method used

The researcher focused on teachers because they were perceived to be the prime initiators in managing and implementing the school curriculum. Classroom-based teachers were chosen as the population of the survey because they are the people who have to manage Technology as a learning area within the General Education and Training Band, more especially in the Intermediate Phase, which is targeted for national implementation. More learners would also be engaged in Technology activities, and it would require greater planning on the part of the teacher to ensure that knowledge was transferred to the learners in an effective manner. Thus sampling was to some extent purposive, as a specialist target group was sought (Ary *et al.* 2009: 156), although sampling *within* this group was random (see below), eliminating researcher bias.

The Ilembe district stretches for more than two hundred square kilometres (see map on p. 10), and has four-hundred-and-thirty schools, most of which are deep rural and rural, with only a few peri-urban schools. It would not have been feasible to include all the schools as part of the sample. For this reason, the researcher used a simple random sampling procedure within the purposively targeted group of technology education teachers: this meant that any teacher within that group might have participated without specifically being selected by the researcher. “The basic characteristic of simple random sampling is that all members of the population have an equal and independent chance of being included in the random sample” (Ary *et al.* 2009: 150).

Simple random sampling falls within the ambit of probability sampling, and is a method which researchers use so as to select a sample in a way which will not allow researcher bias to be a factor (Ary *et al.* 2009: 150-151). In this way, researchers avoid the possibility that they might select participants who will produce results which confirm the research proposition which they are trying to prove. Simple random sampling means that the members of the population who are selected for the study will be determined by chance, which also gives every member an equal opportunity to be selected. In this way, any researcher bias in terms of skewing the results can be avoided, although a simple random sample does not guarantee that the selection is representative of the total population (Ary *et al.* 2009: 151-152). The steps are as follows (Ary *et al.* 2009: 150): “1. Define the population. 2. List all members of the population. 3. Select the sample by employing a procedure where sheer chance determines which members on the list are drawn for the sample.”

4.3.4 Pre-test/post-test procedure

Pre-test and post-test procedures are methods commonly used to evaluate learner outcomes of educational programmes (Dugard and Todman 1995: 181). This procedure provided feedback to the subject specialist by measuring the initial knowledge level of the teachers and the knowledge gained by the teachers from the workshop and the presentation. It also provided important feedback for the organization of future workshops and the areas of development requested. The workshop which was the subject of the case study was based on the findings from the pre-test questionnaire, which indicated the areas where teachers’ conceptual knowledge needed to be developed, and dealt with pneumatics and hydraulics, safety systems and the Jaws of Life mechanism (Appendix D shows some rural learner achievers demonstrating artefacts associated with some of these areas at the *Eskom EXPO for Young Scientists - International Science Fair*, 4-5 October 2017).

4.4 Research tools

As shown in Table 4.1, the research tools consisted of an educator survey, one-on-one interviews, and pre- test and post-test questionnaires, comprising a mixed method approach for the research instrument and question types. However, all three instruments made use of a questionnaire, with different delivery methods (i.e., self-administered, researcher administered, and as the basis for the interview).

4.4.1 Survey questionnaire

The educator survey was carried out by means of a self-administered questionnaire, as this method helps to eliminate interviewer bias, and also works well with specialised target groups (as here), who are likely to have high response rates (Singleton, Straits and Straits 1993: 265). The aim of the survey was to identify aspects that might have an influence on the successful implementation of technology education in the Maphumulo circuit. Fifty-five schools from two circuits, namely, Imati and Untunjambali, were chosen as a random sample.

The questionnaire was divided into two sections. Section one pertained to biographical, educational and logistical information about the respondents. Section two addressed the implementation of technology education and teaching of the subject Technology as part of the curriculum (see Appendix C for a copy of the questionnaire).

The self-administered questionnaire was used, as this method helps to eliminate interviewer bias (Singleton, Straits and Straits 1993: 265). In order to add more value to the study and elicit more information from the respondents, the researcher decided to include both closed and open-ended questions (Roulston 2008b, 2008a) This was done to enable these types of questions to complement each other as well as to establish whether the respondent (i.e., teacher) had an understanding of the concept in question. Both open-ended and closed questions are widely used in research, as excellent results can be obtained from them (Oppenheim 1996: 141).

The aim of questionnaire design is to construct an instrument that will not only avoid putting people off from responding, but will also ensure that the data collected are complete, valid, and reliable (Bailey 1994: 146). The required data must be obtained without risk of bias, with the proviso that the respondents must be able to understand the questions (Oppenheim 1996: 121). The researcher included the topic and aim of the research on the questionnaire and accompanying letter, so that respondents could better understand the significance of the topic (Wolhuter *et al.* 2003: 15). According to Oppenheim (1996: 122), the questions must be adequate for the sampling process, must not be too one sided, and it must make it easy for the respondent to answer fully. It is important that:

- the focus and contents of the questions must be right;
- the wording must be suitable;
- the context, sequence and response categories (if any) must help the respondent without unintentionally biasing the answers; and that
- the questions should seek only that information that cannot be obtained from other sources (Oppenheim 1996: 122, slightly adapted).

4.4.1.1 Questionnaire construction

The questionnaire contained a series of statements which were geared towards providing partial answers to the first specific research question, namely:

1. To what extent do teachers' current concepts of Technology inform effective teaching practice, with specific reference to their:
    a. knowledge;
    b. skills; and
    c. training?

The answers provided by the data generated by the survey would be further strengthened by the interviews and pre- and post-test questionnaires.

The questionnaire was redrafted a number of times before being finalized. The researcher attempted to avoid any ambiguity, vagueness, prejudice or jargon so as to reduce the risk of misinterpretation of the statements and to encourage frank responses. As mentioned above, the questionnaire was divided into two sections, one comprising questions requesting the biographical information of the respondents as well as the educational and logistical information about their schools. This section contained thirteen closed-ended questions. Section two was made up of questions requesting information about the implementation and management of Technology as part of the curriculum, as well as respondents' perceptions of the subject. The information requested was divided into five themes, with each theme containing a mixture of closed and open-ended questions, as follows:

- Theme 1 contained nine questions: five closed and four open-ended.
- Theme 2 contained five questions: three closed and two open-ended.
- Theme 3 contained eight questions: three closed and five open-ended.
- Theme 4 contained five questions: two closed and three open-ended.
- Theme 5 contained six questions: three closed and two open-ended.
- Theme 6 contained questions based on the teachers' preparedness to teach Technology.

Bailey (1994: 140-143) lists some of the advantages and disadvantages of closed and open-ended questions, which are summarised below:

The advantages of closed questions are that they result in standard answers, making comparison easy; the answers are easier to code and analyse; the meanings of the questions are clearer; the answers are complete and include fewer irrelevant responses; closed questions are more likely to be answered when the issues are sensitive; and are easier to answer as the respondent just has to choose a category. The disadvantages are that they encourage guessing; frustrate respondents by not providing a sufficiently accurate option; may need too many categories for feasible inclusion or short-term memory; give no indication of whether the question was misunderstood; may conceal important variations in participant responses; and transcription errors may go undetected.

Open-ended questions have an advantage in that they can be used without the researcher having to know all of the possible answer categories or when diverse respondents' views are sought; allow the respondent to answer in as much detail as is needed; can be used when there are too many possible options to include on the questionnaire; can be used with complex issues; and allow the respondent more opportunity for creative self-expression. The disadvantages are that they can produce worthless or irrelevant information; make comparisons and statistical analysis difficult; lead to subjective coding; may be too vague to understand; require a higher level of education to answer than closed questions; require more time and effort to complete; and make the questionnaire look more lengthy. The latter two factors may lead to discouragement and/or refusal to take part. The fact that the questions may be too vague or general to be understood means that a self-administered questionnaire should not contain only open-ended questions, which are more suited to a one-on-one interview.

To ensure that the balance of closed and open-ended questions in the questionnaire would provide the answers sought, the questionnaire was piloted and the questions adjusted where necessary.

4.4.1.2 Piloting the questionnaire

It is important to test the questionnaire to make sure that the questions are interpreted as intended (Bailey 1994: 165; Wolhuter *et al.* 2003: 16; Babbie 2012: 242). While each questionnaire is a special case, in general, piloting is recommended to anticipate and avoid any shortcomings (Bailey 1994: 168). Piloting the survey questionnaire had to be done in two batches. Initially twenty-five copies of the questionnaire were e-mailed to my colleagues, some of whom were teachers, and others, members of the Technology Association of KwaZulu-Natal. This type of trial respondents concurs with the suggestion by Bailey (1994: 165). The e-mail contained instructions of how to complete the questionnaire and the due date for its return. After two weeks a reminder (e-mail) was sent out to query the progress of the questionnaire and its due date for return. Two responses were received saying that they were unable to view the file, so the questionnaire was re-mailed to them. After another week, a second e- mail was sent out requesting for the returns, this was also followed up with telephone calls.

No completed questionnaires were received via e-mail, so it was then decided to try a second group, but to approach them personally with a copy of the questionnaire and instructions.

A new group of pilot respondents was identified and the questionnaires were taken to them by the researcher to complete. The group was made up of three Technology teachers and four technology subject advisors. After a week the researcher called them telephonically and was told to collect the forms. Seven questionnaires were given out for piloting, and all seven were completed. From the comments and suggestions received some changes had to be made to the questionnaire (Singleton, Straits and Straits 1993: 309). The four subject advisors felt that a few more probing questions needed to be added. After interviewing them on an informal basis, the researcher decided that these new questions would be added to the questionnaire. As a result of new questions being added, a second pilot study had to be conducted with two new respondents (teachers). The researcher also scanned the pilot questionnaires for any unanswered questions. This was done to refine question wording and response categories for the final questionnaire (Wolhuter *et al.* 2003: 16).

The respondents were familiar with the language and terminology used in formulating the questions. The respondents were also satisfied that the questionnaire covered all aspects of the subject Technology that was necessary for successful teaching and learning to occur. They were also satisfied that the questionnaire did not impede on their privacy in any way, as they believed that it did not request any personal details. During the second pilot test the two respondents were timed, and the questionnaire was completed within forty minutes.

4.4.1.3 Reliability and validity of the questionnaire

Validity and reliability are two issues that are critical for the effectiveness of the data collecting procedure (Best and Kahn 1993: 208; Oppenheim 1996: 144). Reliability means that one would obtain the same results if the measurement were to be duplicated under similar conditions (Oppenheim 1996: 122). Reliability is important in detecting the effect of one variable against another, as well as for establishing validity (Black and Champion 1976: 234). Validity relates, not to the actual measurement itself, but to "the *interpretation and meaning* of the scores derived from the instrument" (Ary *et al.* 2009: 225, my emphasis). According to Ary *et al*. (2009: 225), "validity deals with how well the operational definition [i.e., of the task performed] fits with the conceptual definition". In this study, the results are validated strictly in terms of participants' changed perceptions after the training intervention, and not actual teacher (or learner) performance. The results may establish that participants *think* that their conceptual grasp of technology pedagogy has improved, and, in fact, their answers may well give evidence of conceptual development, but this does not mean that either their teaching or their learners' performance will improve. Establishing this lies outside the scope of this study, as it would involve a detailed analysis of other causal factors impacting on actual teacher and learner performance, as suggested by the survey.

4.4.1.4 Administering the survey questionnaire

In preparation for the survey, a letter was forwarded to the Chief Director of the KwaZulu-Natal (KZN) Department of Education to request permission to visit schools in the Ilembe district, Untunjambili ward circuit with a view to administering the questionnaires. A letter confirming the status of the researcher was enclosed. Permission to conduct research in the relevant schools was granted (see Appendix A).

A time frame of three weeks was set to collect the data. The teachers of schools in the ward were telephonically informed and a suitable time to meet with them was arranged. The questionnaires were hand delivered to the school with a letter explaining the purpose of the research and assurance to the participants that their confidentiality would be maintained. Where this was not possible, alternative arrangements were made to leave the questionnaire with the deputy principals or the school secretary. Two days were set aside to drop off questionnaires for each circuit, and five days were allowed for teachers to go over the questionnaire and complete it. After five days the schools were telephoned to inquire about the completion of the questionnaire. Where the response was positive the questionnaires were collected. In the instances where the questionnaire was not completed, an appeal was made to the principals on encouraging staff to complete it, and an extension of time was arranged. Of the fifty-six questionnaires distributed to the primary schools, fifty-three responses were returned.

4.4.2 Individual interviews

Individual interviews were used before the training workshop to probe in more depth the teachers' understanding of technology and its importance within the General Education and Training (GET) band, and were held in a personal setting and on an individual basis. Fifteen participants were interviewed, selected by simple random sampling.

4.4.2.1 Interview construction

Semi-structured interviews were used, containing open-ended and closed questions as well as prompts to elicit more in-depth responses (Stake 1995: 65). The questions used in the interview were related directly to the objectives of the study (i.e., to probe in what areas educators were unprepared for technology education) and followed a given sequence that was adhered to in each interview. They focused on the areas in which the survey had shown teachers to be under-prepared for technology education, and focused directly on the teachers' perceived ability to teach Technology as a subject, as well as the support systems available (if any). The use of the questions in the interview in a sense served as a pilot study of the (same) questions for the pre- and post-test administered before and after the training workshop (apart from those added to the post-test questionnaire asking them of any changes in perceptions and attitude after experiencing the workshop). However, as the survey had revealed the specific problem areas involved in technology education, this, as well as the researcher's experience as Senior Subject Advisor in Technology, meant that the questions were well-formulated at the outset. By this time the study had narrowed down to the key issues involved, and the researcher had gained experience in formulating a combination of pertinent, easily-understood questions on the topic.

The questions to be asked were prepared in written form, and were exactly what was to be asked orally, along with prompts probing further responses (McMillan and Schumacher 2006: 205). All fifteen respondents interviewed provided a 100% response to the interview questions.

The interview and pre-test questionnaire (see Appendix C) were based around two basic questions:

1. What do you understand by “Technology”? OR: how do you see “Technology”?
2. How do you teach it?

The following questions were added to the post-test questionnaire:

3. Has the way you see “Technology” changed in any way since this training?
4. If so, in what way has it changed, and why?
5. Is there any change in the way you would teach it, and why?

It was hoped that comparing pre-test and post-test questionnaire answers would provide answers to specific research question 3:

3. What are the results of these interventions [i.e., training workshops] on the following:

   a. teachers’ concepts of Technology; and

   b. their plans for future teaching practice?

4.4.2.2 Interview procedure

Prior to the interview taking place, all of the respondents were contacted and arrangements made about the most convenient time to visit their school to conduct the interview. A schedule was drawn up to visit the respondents, with two available dates on which to conduct interviews. This was done to overcome any challenges that might have arisen due to unforeseen circumstances. The majority of the schools located in the Ilembe district were in rural and deep rural areas, and arrangements had to be made to overcome these challenges.

Three days prior to the date of the interview, schools and the respondents were telephonically contacted and SMS messages sent as a courtesy reminder. This was done to encourage as many respondents as possible to participate in the interview. Arrangements were also made with the principals of schools to secure a room for the interview. These arrangements had to be done in advance so that there would be very little disruption to the teaching and learning programme. In total fifteen respondents were interviewed and a tape recorder was used to record the interviews, which were transcribed as soon as possible after the interviews. This was done so as to include observations noted by the researcher about any unrecorded events or utterances which might be prove to be pertinent in retrospect (Bailey 1994: 274).

During the "small talk", which was carried out to establish a relationship with the participants, an ice breaker was used (McMillan and Schumacher 2006: 205). The ice breaker was based on South African soap operas aired on SABC TV and eTV. It also contributed to social cohesion, indicating to the respondents that interviewer watched South African "soapies" and also enjoyed the social satire contained in them. In Zulu culture it is a prerequisite to begin negotiations with light-hearted discussions. After the small talk and the necessary introductions were done, the respondents were briefed on the requirements, and the letter granting permission to conduct the research was produced together with the declarations of confidentiality and a copy of the questionnaire (Stake 1995: 65).

4.4.3 The training workshop

After explaining the dual role of the training workshop, the content and procedure of the workshop will be described.

4.4.3.1 The dual role of the workshop

The training workshop was designed and run to provide an exemplar of the kind of intervention which, it was hoped, might assist to transform technology education in rural areas where teachers had no adequate qualification, experience or prior training in this educational area, which is vital to both economic progress and improved employment opportunities. It was intended to answer specific research question 2, namely:

2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?

However, the workshop served a dual purpose in that it was also used as the basis for gathering the pre- and post-test questionnaire data. The data were collected at two venues, Umphumulo Primary school and Nyamazane Full Service School. A total of eighty-five respondents attended the content workshops, twenty-five more than expected. To add value to the workshop, two publishing companies and a technology kits supplier were invited to display their books and kits. These companies generously provided light refreshments for the workshop, and the attendees were supplied with muffins, cool drink, chips and fruit. All of the teachers who participated in the pre- and post-test questions provided a 100% response.

4.4.3.2 Content and procedure of the workshop

The workshop consisted of a full one-day programme which exposed the teachers to the requirements of teaching the key concepts of mechanical systems and control, hydraulics and pneumatics. The technological, pedagogical, content knowledge (TPACK) pedagogical framework described in Chapter 3 was used (see workshop programme in Appendix B). The use of the TPACK framework is an effective way of augmenting the technological pedagogical content knowledge of developing teachers as they learn to become effective teachers. The use of charts, PowerPoint presentations, YouTube videos, newspaper articles, working models and worksheets assists teachers to enhance their skills and knowledge. One of the strengths of using this model is that it supports the teacher's own conceptual development when using videos, as both the teacher and the learner are engaged in meaningful learning by using the forward, rewind and pause process. When this is done in a group, the interaction contributes to a social constructivist environment, modelling the constructivist pedagogy which the literature in Chapter 3 showed to be effective when used with the TPACK framework.

This workshop formed part of the planning workshops of teachers in the Ilembe district and is included as part of the district operational year plan in keeping with the goals of the National Development Plan (NDP) (South Africa. National Planning Commission 2010). The information for conducting the workshop was obtained from the National Curriculum Statement's (NCS) Curriculum and

Assessment Policy Statement (South Africa. Department of Education 2011b: 14-15). The document stipulates the time frames required to teach the content, concepts and skill for the grade. The focus is on mechanical systems and control and the context is on the Jaws of Life: rescue systems. The scenario is based on specific aim 3, the impact of technology, integrates specific aims 1 and 2, and contributes to seventy per cent of the assessments marks per term.

The workshop programme began with registration, a prayer, welcome, apologies and purpose of the workshop and house rules (see Appendix B), and participants were issued with workshop materials. Next, the pre-test was written. At the end of the test, the participants were introduced to the three social partners, the publishing companies and the technology kit supplier. The social partners were each given ten minutes to speak. This was done strategically to allow the researcher to peruse the pre-test answers briefly and use his impression of the results as a baseline introduction to the content workshop. This appeared to work extremely well, possibly because participants felt that their input was seen to be important and contributing to the workshop, rather than their just being "talked at" about departmental policies. Rather than being treated as passive subjects, teachers were being treated as collaborators with ideas to contribute, so that an important feature of constructivist pedagogy was being modelled for them at the workshop, one which they could use later with their own learners.

The researcher then used electronic media, newspaper articles, YouTube videos and artefact models to demonstrate how hydraulics and pneumatics work. The use of electronic technology was used to create a virtual classroom, resulting in bringing a vehicle accident scene into the classroom. Large speakers were used to amplify the sound of the "Jaws of Life" prising crushed vehicles open at the accident scene. The respondents appeared to be overcome by the vividness of the experience which related use of technology to real-world functioning and not just pages of text. They then participated in group activities such as experimenting with syringes and assembling a hydraulic system to demonstrate the concept of how hydraulics and pneumatics work. This contributed to improved collaboration, as they were fully engaged, and it also made learning fun. It must be noted that collaboration and hands-on engagement are key aspects of constructivist pedagogy, as applied to technology education, and that younger learners would be motivated by the "fun" factor. In this sense, using constructivist pedagogy for technology education was being modelled at the workshop in ways which had not been done for educators before, at least, not in large-group DBE workshops in rural areas.

Finally, the post-test questionnaire was administered, and all eighty-five respondents completed the post-test. The post-test results indicate that all respondents saw themselves as benefiting immensely from the workshop, with sixty-six percent indicating that they needed further development. The pre- and post-test results show a hundred per cent response. It might be argued that workshop attendees represented not only a convenient but also a "captive" population (Moreno 1998; Vandebosch 2008), accounting for the hundred percent response. However, the enthusiastic response to the workshop activities and the teachers' future plans for technology education pedagogy (as shown in the written responses) suggest that the workshop experience itself motivated them to respond, and not just the fact that they were there.

4.5 Ethical considerations

While is it generally agreed that ethical principles are important in research, according to Bailey (1994: 476), there is no agreed-on format for the wording of codes of ethics. In any case, apart from the general principles, one would expect the wording of codes of ethics and associated documents to be context-specific in terms of culture, language and current conditions, such as the HIV/AIDS pandemic, which might exploit populations, particularly uneducated, illiterate and/or economically disadvantaged groups. As well as following educator ethics and the provisions of the DBE, the researcher adhered to the DUT ethical requirements of the faculty in which he was registered (see Appendix A). The Faculty of Arts and Design (FAD) "Ethics Statement" required higher degree students to complete and sign an attached ethics questionnaire. The questionnaire dealt with issues such as use of deception, confidentiality, recruitment and informed consent, as well as the possible vulnerability of the intended target populations and avoidance of any physical and/or psychological harm to respondents.

A letter of informed consent, which is one of the most common practices in research ethics (Bailey 1994: 480), was required not only in English, but also in isiZulu, the majority language of the rurally-based educator group targeted. In the letter (see Appendix A), the researcher undertook the following:

- to maintain the participants' confidentiality;
- to protect participants' rights and welfare, i.e., to ensure that no harm came to them as a result of their participation in this research;
- no manipulation or withholding of information would be involved in the study;
- to present information and transcripts used in this research in such a way as to maintain the participants' dignity, and, if in doubt, to first consult with them;
- to make available to them the final copy of this research publication; and
- the participant was free to withdraw from this research process at any time, if the need should so arise.

The researcher ensured strict adherence to these ethical considerations. The procedure described in the various data collection methods, as shown in the above sections, followed these considerations as closely as possible.

4.6 Limitations of the study

The study was limited to groups of teachers in schools in certain districts in rural areas, and may not be representative of the participants, situation or results which might be obtained with other teacher or school populations. This is why a case study approach was used, to show what could be achieved in one specific, highly fraught and problematic case, but, nevertheless, an exemplar of what could be achieved in a "worst-case scenario". The numbers of participants (except in the interviews), geographical distance, time and resource constraints admittedly limited the depth and continuity of the study, as well as the quality of the intervention. There were also additional institutional and departmental constraints, which had to be worked within (or around).

The collection of three types of data was time consuming and costly, and had to be done in the course of the researcher's duties as Senior Subject Advisor. The data were collected over two terms, that is, the third and the first term of the following year. This was because the fourth school term is a busy term and no data collection for private research is allowed. On account of the timing of the distribution of questionnaires (i.e., the middle of the third term of the school year), many teachers were engaged in attending to departmental returns and submitting promotion documents and other school activities. This meant that a great deal of extra time had to be allowed for completion of the questionnaires. The following factors might have impacted on the investigation:

- Many teachers had to be encouraged to complete the questionnaire. The researcher made many telephone calls to check on the progress, and some schools had to be visited many times before the questionnaire could be collected.
- Setting up of dates and times for the interviews was very time consuming. Some of the interviews had to be re scheduled.
- Using the self-administered questionnaire as a survey research instrument may have limited the outcome of the research, in terms of participants not being frank in their responses.

The latter limitation was, however, compensated for by in-depth interviews, and the researcher-administered pre- and post-test questionnaires, which made greater depth and control possible. Attempts to persuade respondents to complete and return the questionnaires might be viewed as coercive, no matter how accommodating the researcher attempted to be. However, it is difficult to see how respondents might be influenced to supply researcher-biased answers, when all that was asked were (mostly verifiable) demographic and situational factors, not opinions or biases.

4.7 Data analysis

The Statistical Package for Social Sciences (SPSS) program was used to analyse and interpret the data from the survey questionnaire, the interview and the pre- and post-test questionnaires.

The analysis of the responses on the survey questionnaire involved coding the fifty-six questionnaires which were completed and returned. The coded data were then transferred onto a computer spreadsheet from the SPSS program, before being statistically analysed in order to test the relationship between the specific variables in section 4.2 statistically. For analysis, the coded data on the SPSS spreadsheet from the SPSS program were submitted to a data analyst from the University of KwaZulu-Natal, where the data were analysed using the SPSS computer program. The results were interpreted by means of descriptive and statistics.

Descriptive statistics involve organising and summarising quantitative data to make it more comprehensible and manageable (Mouton 2003: 163; Babbie 2012: 432). Data can then be displayed in the form of frequency tables, histograms and/or polygons: this assists in forming impressions about the distribution of data. Frequency tables were used to display the descriptive statistics generated in this study, and provided the following information:

- the number of times a particular response appears on the completed questionnaires; and
- percentages reflecting the number of responses to a certain question in relation to the total number of responses.

It also enabled the calculation of the arithmetic mean or average by finding the sum of all the scores and dividing this by the number of scores. Descriptive statistics differ from inferential statistics, which deal with the kinds of inferences that can be drawn when generalising from data (i.e., from the data of the sample to the whole target population) (Mouton 2003: 163).

After processing, the information was then analysed and interpreted in terms of apparent patterns and trends. This was followed by an examination of the written verbal responses on the questionnaires. Descriptive statistics were used to describe the core skills and knowledge that teachers would require to implement the Technology curriculum effectively. A qualitative analysis was carried out of responses to the "open ended" questions used to gain understanding of how teachers managed to teach Technology without the necessary conceptual skills and knowledge. The results were used as the basis for constructing the interview questionnaire, as well as the pre- and post-test questionnaires. The same method of analysis was used for the interview data and for pre- and post-test data.

4.8 Conclusion

The conclusion to this chapter sums up the ways in which elements of the research design were applied to answer the specific research questions guiding the inquiry. The data gathered in the educator survey (via the self-administered questionnaire), the interviews and the pre-test questionnaire were all used to provide answers to specific research question 1:

1. To what extent do teachers' current concepts of Technology inform effective teaching practice, with specific reference to their:
   a. knowledge;
   b. skills; and
   c. training?

The account of the training workshop and its reception by teachers in rural schools as shown by data gathered in the post-test interviews were used to provide answers to specific research question 2:

2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?

The data gathered in the post-test questionnaire were used to provide answers to specific research question 3:

3. What are the results of these interventions on the following:
   a. teachers' concepts of Technology; and,
   b. their plans for future teaching practice?

The next chapter deals with analysis of the results obtained by the methods described in Chapter 4.

CHAPTER 5: DATA PRESENTATION AND RESULTS

5.1 Introduction

Chapter 5 deals with analysis of the results, using the case study data gathered by means of the methodology described in Chapter 4. The raw data are presented in Appendix D, in the order in which they were gathered. However, in Chapter 5, items are selected and re-ordered to provide answers to the specific research questions used to guide the inquiry (p.13). Moreover, in order to follow the thesis argument, data from the survey, interviews and questionnaire are presented in the order of the research questions, and not in the chronological order in which they were gathered. Chapter 5 firstly shows which data were used to provide answers to which specific research questions, and, next, deals with the teachers' conceptual preparedness for technology education. It then looks at teachers' concerns when teaching technical processes, and, thence, goes on to the issues of subject-specific training, specialisation and support, the lack of school support, and operational problems experienced by teachers. The chapter then describes key features of the intervention involved in the technology education training workshop, identifying features which, it is suggested, account for the effectiveness of the intervention. It next looks at post-intervention changes in teachers' concepts of Technology and their proposed ideas for future pedagogy. The chapter then concludes by summing up the key points of the findings.

5.2 How results were used to answer the specific research questions

The data gathered in the educator survey (via the self-administered questionnaire), the interviews and the pre-test questionnaire were analysed to provide answers to specific research question 1:

1. To what extent do teachers' current concepts of Technology inform effective teaching practice, with specific reference to their

   a. knowledge;

b. skills; and
c. training?

A description of the DBE technology education training workshop designed and run by the researcher is given to provide an option which might provide an effective intervention for educators, thus (partly) answering specific research question 2:

2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?

It is not claimed that this is necessarily the only - or best - intervention amongst the many possible options available, but that this intervention was well suited to its audience, purpose and context (including constraints), as will be discussed further in the thesis conclusions drawn in Chapter 6. Feedback from the teachers involved in the training will be given to support this assertion.

The data gathered in the post-test questionnaire were analysed to provide answers to specific research question 3:

3. What are the results of these interventions on the following:
    a. teachers' concepts of Technology; and
    b. their plans for future teaching practice?

It must be emphasized that this chapter does not just look at three sets of data as a means of triangulating findings in a positivist fashion. As shown in Figure 5.1, the survey, interview and pre-test questionnaire were part of a "funnel" process used to narrow down Technology teacher needs from more general concerns to specifics which directly reflected the needs of attendees at the actual workshop run by the researcher. It is thought that this *process* is more important than the specific findings, which may be - in fact should be - seen to be context-specific to the needs of that group in that context, whether in the Ilembe district or the actual workshop. Analysis shows that, the results do, however, attest to the effectiveness of the particular intervention made in the form of a one-day training workshop for technology educators.

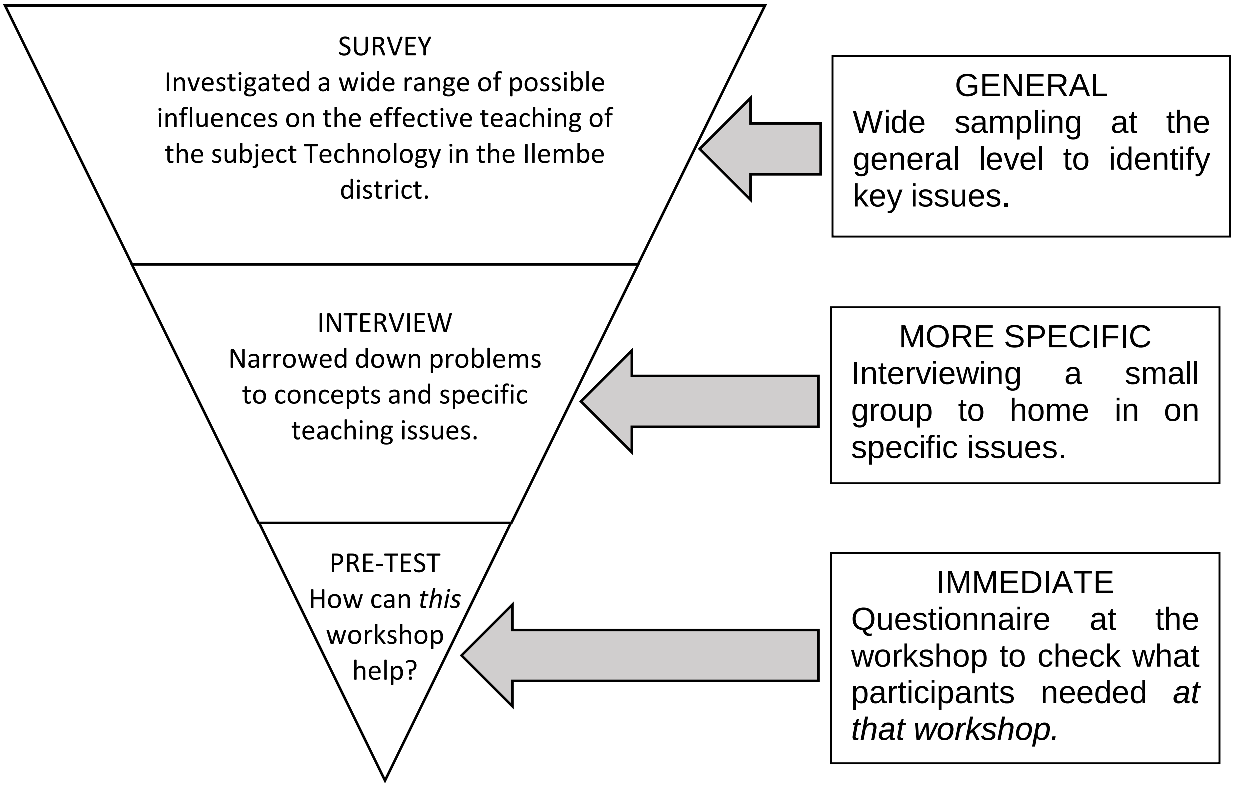

Figure 5.1 Narrowing down the specifics to inform an effective intervention

5.3 Educators' conceptual preparedness for technology education

To answer research question 1, the educator survey results will be dealt with first, then the results of the interview and pre-test, which narrowed down the most urgent teacher needs in preparation for the training workshop, so that it could be tailored to those specific needs. In view of the fact that TPACK is a complex integration of knowledge and skills, it was inevitable that certain categories would blend and integrate, and it would be difficult (if not impossible) to separate these into discrete categories. "Skills" and "knowledge" tend to be a composite in TPACK, so that there was a blending of these categories in the results. "Training" is easier to separate, but then inability to teach certain aspects of Technology may arise from lack of hands-on training rather than conceptual or pedagogical shortcomings, or vice versa.

5.3.1 Subject and pedagogical knowledge

This section attempts to provide answers to specific research question 1a, in terms of whether teachers' concepts of Technology informed effective teaching practice with specific reference to their knowledge. The results analysed here thus offer insights into teachers' subject and pedagogical knowledge in technology education.

5.3.1.1 Survey results on subject and pedagogical knowledge

Table 5.1 indicates what the survey revealed about teachers' perceptions of their lack of Technology subject knowledge. This knowledge can be seen to involve technical processes and pedagogical skills, ranging from technology-specific graphic communication to knowledge of general pedagogical skills, such as lesson planning and work schedules. However, these general skills need to be adapted specifically to the teaching of Technology, which has implications for the form of these pedagogical routines.

Table 5.1 Assistance needed with subject knowledge and pedagogy

Specific assistance needed with subject knowledge and pedagogy	**Survey Q No**
81.1% of the respondents indicated that they needed assistance with graphic communication.	S3.48.1
66% of the respondents needed assistance with processing.	S3.48.2
57.4% of the respondents indicated that they needed assistance with structures.	S3.48.3
82.7% of the respondents indicated that they needed assistance with skills to teach mechanical systems and control.	S3.48.4
77.4% of the respondents needed assistance with skills to teach electrical systems and control.	S3.48.5
72.9% of the respondents needed assistance with skills for lesson planning.	S3.48.6
73.5% of the respondents needed assistance with skills for developing work schedules.	S3.48.7.

5.3.1.2 Interview results on subject and pedagogical knowledge

The interview results were useful in clarifying in which areas teachers had strengths or experienced challenges in subject and pedagogical knowledge. Table 5.2 indicates that more than 93.34% of the respondents had a clear understanding of Technology and its importance in society. Only one (6.66%) of the respondents (who taught it as a “filler” subject) did not have an idea of Technology and if it was relevant in the school curriculum.

Table 5.2 Perception of Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	93.34	93.34	93.34
	No	1	6.66	6.66	6.66
Missing	System	0	0	0	0
Total		15	100	100	100

A qualitative analysis of responses to an “open-ended” question was used to arrive at an understanding of how respondents understood or saw technology.

Some responses showing understanding were as follows:

- I see technology as everything around [us]. As I used to explain to the children in my classroom, everything that we see around us has gone through the technological process, it has undergone planning processes, designing processes and a testing process and as a result we have these things in front of us.
- It is the subject that deals with equipping learners with knowledge on how to create solutions to problem. It gives learner information to make their lives easier.
- I see the combination of the knowledge, skills and resources that people can use to build things and can use as resourceful opportunities for them to prosper in life.

When asked to explain further, more than 93.34% of the respondents said that they had been influenced by the changes taking place around them and also how technology/ICT was influencing the changes, so that they had a clear understanding of technology and its importance in society. Only 6.66% of the respondents did not have an idea of the subject and if it was relevant in the school curriculum.

Table 5.3 Influences on the way participants perceived Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	93.34	93.34	93.34
	No	1	6.66	6.66	6.66
Missing	System	0	0	0	0
Total		15	100	100	100

Some of the responses were as follows:

- Well in the modern age when we think about technology we think of telephones, computer, and gadgets. I see technology in modern era as more technologically inclined as in being electronics and things that used to make our lives easier.
- Our lives revolve around technology so we can't do a thing without it. That why Government is also supporting some schools with facilities like laptops.
- When I'm teaching in the class I turn to see things that I didn't know assisted in the modern world.
- With regards to that we are living in a technological literate society and some of the devices around us influences the way I see technology and in terms of a classroom content the way learners develop and construct various projects.

Table 5.4 Technology and critical skills shortage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	93.33	93.33	93.3
	No	1	6.67	6.67	6.7
Missing	System	0	0	0	0
Total		15	100	100	100

Table 5.4 indicates that the majority of the respondents (93.3%) were positive about Technology playing a meaningful role in contributing to the critical skills

shortage in South Africa. When asked to explain further, participants responded by stating that Technology plays a pivotal role in promoting the skill required to be an electrical, mechanical or civil engineer; it further contributes to job creation and for people to cope in a changing country.

Some of the responses were as follows:

- Yes, technology forms a basis of everything; in Technology you are taught basics skills. If you want to be an engineer (electrical, mechanical or civil engineer) the basis that we taught in Technology plays a vital role, it forms the foundation to all these skills.
- Yes, it also needs to be done even at tertiary level. We are running out of the learners with the skills.
- It can create jobs for learners.
- Yes, it is one of the subjects where learners learn to be practical, where they put their theory into practice. We need some support so we can teach them to be creative.
- Yes, because in Technology we are working with designing processes and other technological steps, training the learners to be critical thinkers and innovative thinkers.
- Yes, as the world is changing, things are done electronically. Learners have to be developed technologically so they can cope in the changing country.

5.3.1.3 Questionnaire results on subject and pedagogical knowledge

The questionnaire responses confirmed the interview results in that the majority of respondents had a clear understanding of Technology and its importance in society.

Some of the responses were as follows:

- Technology is the use of knowledge skills, values and resources to meet people's needs.

- To equip the learners with technological practical and creativity skills that could be used to solve problems taking place in our communities.
- It is vitally important as learners are taught skills that they can use in many different career paths.
- Technology helps to produce people like engineers, technicians and artisans who help people with their daily needs.
- It is about improving our world and making it a better place to live in.
- It is showing the learners how technology changes the society. It also teaches them that technology varies from one generation to the other.

From the above responses, it is evident that the respondents had a basic understanding of Technology and its importance. This basic knowledge is important as the information gathered is used to plan further activities to develop the conceptual knowledge and skill of the teachers teaching Technology.

Teachers attending the workshop were asked whether they had the necessary conceptual knowledge and theoretical skills to teach Technology. Their responses are shown in Table 5.5. These responses indicate that only 57.65% of the respondents had the necessary conceptual knowledge and theoretical skills to teach Technology, and that 42.35% of the respondents did not. This must have impacted negatively on the implementation of Technology and might also have contributed to students not selecting technical subjects at Grades 10-12 levels.

Table 5.5 Pre-workshop conceptual knowledge and theoretical skills to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	57.65	57.65	57.65
	No	36	42.35	42.35	42.35
Missing	System	0	0	0	0
Total		85	100	100	100

Some of the responses were as follows:

- No, I need to research and find more information and find out from subject advisors.
- We use the information from the text books and visit libraries to get knowledge before we do our practical task Mini-PAT.
- No, it will be the first year to teach it this year.
- No, but we try to use our policy documents as our guide throughout the lesson
- No, I find difficulties in doing practical work myself but I use books and rubric to help me guide learners.
- No, I follow the information on the policy document and ATP.
- No, I ask other educators to assist in allocating marks.
- No, it's my first time teaching Technology and I'm hoping to get more relevant and vital knowledge and teaching skills.
- No, I am a novice at the subject but I try by all means to equip myself through different learning materials and seek for assistant from senior educators.
- No, I have to because of the shortage of Technology educators in our school.

From the above responses, it is evident that the respondents were experiencing challenges in implementing Technology successfully in their classrooms since they did not have the necessary conceptual knowledge and theoretical skills. Some of the reasons could be attributed to the following: teachers teaching Technology as a filler subject for the first time and not being orientated; change in post provisioning norms at schools; a drop in learner enrolment; or transfer of Technology teachers. These challenge often result in the Mini-PAT not being done by the learners.

5.3.2 Teaching technical processes

This section attempts to provide answers to specific research question 1b, in terms of whether teachers' concepts of Technology informed effective teaching practice with specific reference to their skills (technological or pedagogical, in terms of the gestalt described in TPACK).

5.3.2.1 Survey results on teaching technical processes

As mentioned above, inability to teach certain aspects of Technology may stem from lack of hands-on training rather than conceptual or pedagogical shortcomings. Table 5.6 is a good example of this inablity, as it suggests pedagogical skills are needed, but the deficits shown here also involve subject knowledge of a practical nature which is part and parcel of teaching the processes identified. The TPACK framework discussed in Chapter 3 has shown that a complex integration of knowledge and skills is involved in technology education, elements which cannot be easily separated and should, perhaps, be seen as a gestalt. Table 5.6 shows specifics of educators' admitted inability to engage in TPACKing, to the learners' detriment, thereby answering research question 1b. As the TPACK framework suggests, pedagogical skills cannot be separated from knowledge *about* technical processes and knowledge *how to* engage in them.

Table 5.6 Technical processes educators were unable to teach

Technical processes educators were unable to teach	**Survey Q No**
43.6% were not able to teach Mechanical systems: cams, gears, leavers and pulleys.	S3.8.3
67.3% were not able to teach Hydraulics and pneumatics.	S3.8.4
43.6% were not able to teach Electrical systems and control, logic gates, circuit diagrams.	S3.8.5

Before leaving the survey responses, there is one statement in Table 5.14 below, Factors impacting on delivery, which is highly relevant to the preparedness of teachers to teach Technology:

> 45.3% of the respondents believed that the l*ack of cognitive knowledge and skill* had impacted on the positive implementation of the curriculum. (S3.37) (my emphasis).

Whether one views these as combined or separated, knowledge and skills are clearly seen by educators as key issues in the effective teaching of Technology.

5.3.2.2 Interview results on teaching technical processes

Table 5.7 indicates that only 53.33% of the respondents were able to incorporate the specific aims [of the subject] into their lesson plans, while 46.67% of the respondents were grappling to include these aims. This is not a healthy situation, as Technology, as a subject, contributes towards learners' technological literacy by giving them opportunities to develop and apply specific design skills to solve technological problems, understand the concepts and knowledge used in technology education, and use them responsibly and purposefully. They would also be learning to appreciate the interaction between peoples' values and attitudes, technology, society and the environment.

Table 5.7 Ability to incorporate the specific aims into lesson plan

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	53.33	53.33	53.33
	No	7	46.67	46.67	46.67
Missing	System	0	0	0	0
Total		15	100	100	100

Table 5.8 indicates that only 53.33% of the respondents had the necessary knowledge to teach the four content areas, while 46.67% of the respondents did not. Teachers of Technology are expected to have high levels of knowledge and skills so as to scaffold the specified concepts to the learners. These concepts are mechanical systems, electrical systems, structures and processing. This lack of practical knowledge impacts on the delivery of quality teaching and learning.

Table 5.8 Possession/lack of practical knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	53.33	53.33	53.33
	No	7	46.67	46.67	46.67
Missing	System	0	0	0	0
Total		15	100	100	100

Some answers to the question: “Do you have the practical knowledge of the four content areas to be taught during the year?” were as follows, which shows that abilities were mixed:

- I’m able to - well, when teaching the children technological skills we always have a project. During the teaching process of the project, all these technological skills I taught them: investigation (how they go about researching on the Internet using books, magazine and going to the library), the designing process (children involved in the designing process: I asked them to sketch out their ideas), the making process (children are all involved in the groups to make the project), evaluating process (test if the model works), and in communicating with every child and every group: [this] is communicating their findings in the form of a portfolio.
- I use the policy document as a supporting document and other resources like text books and charts so I can go to class well prepared.
- I am not sure if I do it accordingly, technology was not my area of speciality; sometimes I learn as I prepare for the lesson.
- Yes, always try to incorporate all three.
- Yes, learners will make use of case studies, technological design processes and the various skills. We focus on different stances and the aims linked to different stances.

Responses to the question: “Can you explain further how you cope with the sections you do not have the necessary practical experience and pre-knowledge?” were also mixed, as these examples show:

- Yes, I do attend workshops to keep updated. I think my knowledge is relevant to communicate with Grade 7 that I teach. I do ask for help: my subject advisor helps a lot, and in cases when I’m stuck I use the Internet and research online, I ask other educators. I also attend workshops and seminars that are held by the department to keep updated.
- Yes, these are the tools that I’m using to make the learners to understand levers. Technology is a hands-on subject - that is why I always allow my

learners to do practical work. Practical is basic foundation of the technology.

- No, I ask the learner to carry some of the things that can be used to demonstrate.
- No, but I am trying. With that am failing to do well on I consult other educators for assistance.
- Not exactly. First time teaching technology. The subject is easy if you are willing to learn.

5.3.3 Subject-specific training, specialisation and support

This section attempts to provide answers to specific research question 1c, in terms of whether teachers' concepts of Technology informed effective teaching practice with specific reference to their training.

5.3.3.1 Survey results on subject-specific training, specialisation and support

As Table 5.9 shows, there was a lack of specialist Technology qualifications and training amongst the technology educators sampled.

Table 5.9 Subject-specific training and specialisation

Training and specialisation	**Survey Q No**
9.8% had qualifications that were offered by the Universities of Technology.	S1.3.9
Only 46.2% of the educators had a qualification leaning towards Technology.	S1.3.10
Only 37% of educators attended training offered by Engen/Technology for all.	S1.4
Only 13% of educators belonged to a professional body, Technology association or forum.	S1.4.1
Fewer than 25% of the educators were specialised to teach Technology.	S1.5.1

Table 5.10 shows the lack of subject development and specialist support for Technology teachers. 61.8% had to teach themselves how to teach Technology. This section is in a sense a transition between educator skills, knowledge and training and the support offered to them (dealt with in the next section), because

it is really the school's responsibility to develop teachers, no matter what deficit they arrive with, such as lack of specialist qualifications.

Table 5.10 Subject development and specialist support

Subject development and specialist support	**Survey Q No**
42.6% had not attended workshops to empower themselves.	S3.8.6A
Only 24.1% of the respondents had attended in service training of any type.	S3.8.6B
61.8% had to teach themselves how to teach Technology.	S3.8.6C
Only 25.5% of the respondents were specialized to teach Technology.	S3.8.6D
74.5% of the respondents did not have a subject head for Technology.	S3.9
Only 29.1% of the respondents' schools had a specialist Technology educator.	S3.10
38.9% of the educators had not attended any workshops, seminars, training to empower themselves.	S3.13
41.8% of the respondents had indicated that their SMTs did not have knowledge about the requirements for Technology.	S3.14

5.3.3.2 Interview results on subject-specific training, specialisation and support

Table 5.11 indicates that over half (53.33%) of the respondents needed support in mechanical systems, and a third (33.33%) of the respondents needed support in electrical systems; 13.33% needed support in all sections. The fact that two content areas, structures and processing, were understood by 86.66% of the respondents provides some consolation, as this showed that the teachers did have some limited content knowledge.

Table 5.11 Sections in which educators need support/assistance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mechanical	8	53.33	53.33	53.33
	Electrical	5	33.33	33.33	33.33
	Structures	0	0	0	0
	Processing	0	0	0	0
	All sections	2	13.33	13.33	13.33
Missing	System	0	0	0	0
Total		15	100	100	100

Responses on sections in which support/assistance were needed were as follows:

- Levers and linkages.
- Electrical systems and controls.
- Mechanical systems and control
- In terms of practical tasks, I feel the time allocation sometimes is time consuming for the learners to complete it in class, [as] they constantly have to link the knowledge to the practical. Hydraulics and designs.
- Electrical systems because of the shortage of the resources.
- Drawings (measure sizes), Mini-PAT… and electric systems.

5.4 Lack of school support and operational problems

Moving on from the skills, knowledge and training deficits apparent in the teachers surveyed, it was evident from the survey, interview and questionnaire results that “hidden curriculum” issues played a large part in the successful (or unsuccessful) implementation of technology education. As suggested in Chapter 3, a subject’s status, as well as operational problems in implementing it, can have an effect on how well it is taught.

5.4.1 Survey results on lack of school support and operational problems

Table 5.12 Support and operational problems

Support and operational problems	**Survey Q No**
57.4% of the respondents’ schools did not have piped water.	S2.8.2
40.7% of the respondents’ schools did not have a fixed line telephone.	S2.8.3
86.8% of the respondents’ school did not have the Internet, an essential tool to access information to improve teaching and learning.	S2.8.4
79.6% of the schools did not have libraries.	S2.8.5
The majority of educators surveyed (87.3%) did not have access to computers for their daily preparations.	S2.8.6
48.1% of the respondents taught Technology to multi-grade classes.	S2.10
50% of the respondents were not computer literate.	S2.14
82.7% of the respondents’ schools did not have a budget to support Technology.	S2.15
72.7% of the respondents’ schools did not have professional development to develop and orientate educators.	S3.5
Only 25.9% of the respondents’ schools had a professional development programme in a formalized policy.	S3.6

The results shown in Table 5.12 suggest that Technology was not valued as a subject, nor was much attempt made to see that it was taught well. Understandably, the deficits highlighted affect other subjects as well as Technology, but these are subjects which (regrettably) can be passed by learners resorting to rote learning if all else fails. Technology, by its very nature, which involves practical application, does not lend itself to rote learning. If the learner cannot demonstrate application of the required technological processes, the learner fails.

Table 5.13 Professional monitoring and school support

Professional monitoring and school support	**Survey Q No**
46.2% of the respondents had not had a supervision report done on them by members of their management.	S3.20
Only 39.2% of the respondents had supervision reports in their files as part of their monitoring.	S3.21
60.8% of the respondents were not monitored as there was no evidence of supervision.	S3.21
55.8% were not satisfied with the level of in-service training.	S3.22
68.5% of the respondents did not have learning area committee meetings.	S3.26
81.8% of the schools did not have a co-ordinator for Technology.	S3.28
79.6% of the schools did not allocate a budget for Technology.	S3.30
76.5% of the schools did not have a learning area policy in place to manage Technology.	S3.31

The survey results also showed a lack of professional monitoring and support by the school, as shown in Table 5.13.

Table 5.14 Factors impacting on delivery

Factors impacting on delivery	**Survey Q No**
73.6% of the respondents believed that the lack of in service/ pre-service training had impacted on the delivery of Technology	S3.36
45.3% of the respondents believed that the lack of cognitive knowledge and skill had impacted on the positive implementation of the curriculum.	S3.37
30.8% of the respondents did not use working models to enhance the quality of teaching and learning.	S3.40
50% of the educators stated that the learners did not write on typed exam papers.	S3.43
47.2% of the learners at the respondents' school wrote down the questions from the board during exams.	S3.44

Factors identified as impacting on delivery (Table 5.14) show a composite of deficits in skills, knowledge and training, pedagogy and assessment practices, all of which were identified by participants as impacting on delivery.

5.4.2 Interview results on lack of school support and operational problems

Table 5.15 indicates that only 33.33% of the respondents had technology kits/resources, while the vast majority of respondents did not have the necessary technology kits/resources to implement Technology successfully.

Table 5.15 Resources to implement Technology successfully

		Frequency	Percent	Valid Percent
Valid	Yes	5	33.33	33.33
	No	10	66.66	66.66
Missing	System	0	0	0
Total		15	100	100

When asked to explain how they managed, teachers responded by stating that they improvised and asked the learners to bring resources from home. The CAPS document clearly states that it is the responsibility of the school to provide all the requirements for Technology (South Africa. Department of Education 2011b: 13). Without these basic requirements, the teachers would not be able to scaffold the key concepts of the four content areas effectively. Essentially, the teachers would not be able to demonstrate concepts without working models to the learners, the omission of which would impact negatively on the quality of teaching and learning.

Responses show how most of the teachers have to “make do”, improvising or using their own resources:

- I do have resources and technology kit that were supplied and we did buy item from our stock. The resources that we have, I do have electrical kit, mechanical instruments like gears, levers to teach them mechanics, we have batteries and wires.

- No, but I have technology kit. As a teacher we have to improvise. I used to make some models for them and allow them to draw.
- No, I don't have technology kit, it's hard to manage without enough resources.
- No, I just look at the area we are in and ask the learners to bring what we can use to create what needs to be created.
- Yes we do have a technological kit but we don't have a room for our practicals. I try to network with other teachers to give me what we don't have to teach the learners.
- Yes, we have the essentials but we don't have electrical appliances. I collaborate with other educators and bring my own resources.

5.5 The intervention involved in the training workshop

This section attempts to answer specific research question 2, namely:

2. What measures could be set in place so that teachers' concepts of Technology might guide effective teaching practice?

It does so by eliciting key features of the DBE technology education training workshop which are thought to have contributed to its effectiveness as an intervention.

5.5.1 Needs analysis focusing the workshop

The specific immediate pedagogical needs of the workshop attendees to teach Technology effectively had been established by the series of research tools (survey, interview and questionnaire) so as to focus on specific activities addressing the knowledge, skills and training deficits revealed. This gave the facilitator and participants "quality time" to address fewer issue thoroughly, rather than a host of issues in passing.

5.5.2 Educator participation in choosing workshop content and process

Apart from making it possible to address the most urgent educator needs, the pre-test questionnaire included participants in deciding on the workshop content and process, so that they had some personal ownership of and engagement in the workshop. The fact that the facilitator had briefly looked at the questionnaire responses in the interlude between pre-test and engaging with participants, made them feel included, and their opinions valued. In the researcher's opinion, this inclusive technique, rather than any one other feature, accounted for the enthusiastic response to the workshop, as shown in the post-test questionnaire.

5.5.3 Use of sponsored resources

To ensure not only mental stimulation but also hospitality for workshop attendees, the researcher made use of sponsors to arrange displays of books and technology kits, as well as refreshments. Participants who are mentally stimulated (with various displays), as well as being provided with something to eat and drink, are generally more responsive to training than those who are bored and uncomfortable.

5.5.4 Engagement of target audience

The facilitator engaged the target audience, first by consulting them in terms of their needs (to some extent pre-empted), and then by involving them in actual group activities, not just "talking at them", or just showing a film. A film *was* shown, but was directed towards teachers learning a specific technological process (one requested by participants) and was high-tech in terms of the sound effects of the Jaws of Life tearing open a crumpled vehicle, which, the researcher observed, particularly impressed participants.

5.5.5 Multi-media approach

A multi-media approach (not just notes or talk and chalk) was used at the workshop. The facilitator also personally demonstrated easily available teaching and learning resources for technology education by using his own cell phone.

5.5.6 Multiple learning methods

Multiple learning methods were used at the workshop, as well as formal lecturing, such as:

- learning by observing processes being demonstrated;
- learning by doing;

- learning by making (artefacts); and
- learning by collaborating with peers in small group interactions.

5.5.7 Socially contextualised learning in a cognitively rich setting

Learning at the workshop was socially contextualised and facilitated (as in Vygotsky's social constructivism), and not just expected to happen when participants were offered various learning resources (as in Piaget's cognitive constructivism). Yet both Piaget's and Vygotsky's approaches are relevant here: the facilitator encouraged conceptual development by placing participants in a cognitively rich environment (i.e., with TPACK theory, demonstrations, films, activities, technology kits and books), but he also actively facilitated and guided participants in a specific social context and set up small groups to facilitate learning interactions amongst participants.

5.5.8 Constructivist pedagogy congruent with technology education

For the workshop, the researcher used a constructivist pedagogy congruent with technology education. This meant that key features of technology education, as in the departmental guidelines, gazettes and policies (see pp. 37-39), were modelled for teachers, as well as key features of the constructivist pedagogical approach. The workshop was teaching teachers to learn at the same time as they were learning to teach.

5.5.9 TPACK theoretical framework

There is a place for formal lecturing in training, which is why the TPACK theoretical framework was shared with teachers so that they would have a theoretical underpinning for all of the practical activities in which they were engaged.

5.5.10 Overcoming time, cost and number constraints

It must be remembered that the intervention took place in a specific district which was mainly economically-disadvantaged, and was limited by time, cost and number (i.e., of attendees) constraints. By pre-empting teacher needs, and using multimedia and small group interactions, a large number of teachers could be exposed to intense training on a few key topics and processes. This overcame time and number constraints, while engaging sponsors dealt with the cost constraints, as no funding was available to run the workshop.

5.6 Results of the workshop intervention

This section indicates the results of the workshop intervention, in an attempt to answer specific research question 3:

3. What are the results of these interventions on the following:
    a. teachers' concepts of Technology; and
    b. their plans for future teaching practice?

Data gathered in the post-test questionnaire were used to answer this question.

5.6.1 Post-workshop concepts of Technology and its significance

When asked what they understood by the purpose of Technology and how they saw its importance, educators gave clearer, more focused answers, as in the following examples:

- Its purpose is to improve our standard of living upgrading and developing our country with modernized and advanced knowledge of technical objects such as gadgets and buildings.
- To equip learners with various skills such as design skills, communication skills, critical thinking and innovative skills and problem solving skills.
- It introduces learners to the basic skills, knowledge and values they need in civil, mechanical, electrical and EGD in the FET phase.
- It has an impact on everyone's lives. It teaches us the skills for designing, making evaluating and communicating on ideas and models.
- To instil the basic knowledge and passion of different types of engineering career path.
- It stimulates learner to be innovative and develops their creative and critical thinking skills.
- It helps to produce engineers and artisan who works hard solve problems and make product to satisfy people's needs and wants.

- It is how we can use available material/resources to solve our daily problems and meet our needs and wants however taking into consideration the environmental and societal effect.

From the above responses, it is evident that the respondents had a more in-depth conceptual understanding of Technology and its importance after the workshop was conducted. Also, any possible misconceptions held by the respondents had, to some extent, been corrected.

Responses relating to whether the way teachers saw Technology had changed in any way since the workshop are shown in Table 5.16, which indicates that 98.83% of the respondents had benefitted from the workshop content.

Table 5.16 Post-workshop changes in the perception of Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	84	98.83	98.83	98.83
	No	1	1.176	1.17	1.17
Missing	System	0	0	0	0
Total		85	100	100	100

It is evident that, through continuous professional development, the goal of providing quality teaching and learning can be achieved. The fact that only one respondent said that s/he had not benefitted is not necessarily a reflection on the workshop, and this could have been one of the few teachers who had understood Technology before the workshop.

Some key responses were as follows:

Overall changes

- Yes, it has changed tremendously.
- Yes, children are more likely to show interest in the lesson.
- Yes, I am a new Technology teacher and fortunately now I understand my role as an educator.

- Yes, Technology is vital in educating youth.
- Yes, Technology is everything around us and I see the importance of teaching the children properly, the skills they need to become engineer, etc.
- Yes, I didn't [previously] understand the importance of Technology in our learners' lives.
- Yes, I have developed some new ideas and skills to solve some of the problems I had.
- Yes, I have realized that nothing is impossible to learn and understand.
- Yes, this makes our understanding more advanced than the previous knowledge.
- Yes, I learned a lot from the workshop and I enjoy the subject.
- Yes, it changed from unknown to known, there was some things I didn't understand but with this workshop I have even better understanding.
- Yes, the various ways and methods where you can bring reality to the classroom.
- Yes, I enjoyed the practical aspect of the workshop as it promoted the understanding.

Changes in understanding and teaching technical processes

- Yes, I can now differentiate between input and output processes and I am clear about lot of things.
- Yes, I have developed deeper appreciation for processes and have learned how to effectively demonstrate models.
- Yes, [previously] I was little bit confused about Mini-PAT for Jaws of Life. I've gained a lot from this workshop.
- Yes, I understand pneumatics and hydraulics, how they work, output, process input.
- Yes, I was lazy to create equipment to be utilized in the classroom as a

demonstration but now I will be creative and be passionate about my work.

- Yes, I was unable to use the jaw of life tool and I was a little bit confused about the use of technology in other things.

Changes in pedagogical knowledge and skills

- Yes, the role of ICT is important in the teaching of Technology education.
- Yes, before I used to teach them theory to help them do practicals, but now I can be able to show them so they can understand more. S
- Yes, [I] was developed in various ways of this subject e.g., lesson plan, how to do a mini.
- Yes, I've come to realize that I need to make use of as many as visual resources as possible.
- Yes, I can now see that as for resources we not have to worry, we just need to use the available material.
- Now I know what and how to teach Grade 7 class.
- Yes, because now I know how to do demonstration, drawing, the ways of assessing the learners.
- Yes, it was hard for me to draw but after the workshop I can easily demonstrate through drawing.
- Yes, I actual thought it hard to do some practical work but now I've got clarity in most of the things.
- Yes, on how to work with learners in Technology classes and the material that you can use to make project.
- Yes, I have realized that even though our school faces challenges as a Technology educator we can still make it an existing subject and must strive to make it interactive.

From the above responses it is evident that the respondents had benefitted from the training workshop and would be able to scaffold their new-found knowledge and skills to the learners, thereby positively contributing to the quality of teaching and learning.

When asked in what aspects their perceptions had changed, and why, educators responded as follows:

Understanding of Technology pedagogy

- I have seen that the problem I have of less resources is not an issue. I can use what I have to make learners understand.
- It has changed in a way that in Technology is more about hands on work more than written.
- More clear understanding of how to teach Technology, how to handle LTSM, how to formulate works and how to fully involve learners all through your lessons.
- Focus should be on creative/innovative ways of using various resources for projects.
- It equips learners with necessary skills and knowledge to communicate on a global scale and create innovative design. More ICT.
- That the usage of ICT in classrooms will attract learners' attention.
- It stressed the importance of training artisans for the S.A. Market, as we have a huge shortage of skilled labourers.
- It enabled and empowered me with skills and more tactics of how to teach my learners and make them more involved in any activity.
- Understand that practical work leads to better understanding. Promote active participation.
- I've come to realize that it is a very visual and practical subject.
- It has increased my level of understanding and confidence.
- I will now do more research for demonstration purposes, by always bringing models to class and have videos wherever necessary.
- I know now that I must be creative and innovative before I am going to class.
- Technology is something that is best understood practically.

Pedagogical skills enhanced

- I have been empowered to teach the subject better.
- Yes, I know what exactly I'm going do with my learners.
- It has changed my own teaching style into multiple possibilities to ensure learners have understood all concepts and aspects of the lesson.
- Teach and show for better understanding and better knowledge.
- I've gained more understanding of the subject and the ways to teach learners.

Understanding of concepts and processes

- I understand many things now, how pneumatics and hydraulics works, how to make a model and how to distribute the marks on Mini-PAT
- The explanation and demonstration with videos has made it easier for me to understand the various concepts.

Teaching/learning methods

- It enlightened me with new ways of cascading information to learners.
- Teachers need to be proactive.
- Keep the subject interesting by utilizing models and other media.
- The ability to demonstrate certain processes has become better.
- I have also learned to plan effectively.
- I will teach with more clarity and more demonstration.
- I should teach learners to see Technology as a skill that they should have to make life easy.
- It is not about teaching theory we as educators need to show demonstration, videos etc. in order for learner to fully understand the concept.
- We found that learners' attention is greater when they are exposed to visual activities.

- Reduce the time spent explaining verbally to learners and use more models and visual aids.

Insight into teaching resources

- Acknowledgement from various text books and videos clips made the lesson more meaningful and understanding.
- I've seen projects which are the product of the thing that we all have, e.g., cardboard.
- Now we can incorporate ICT within our Technology lesson so that learners come out with a better understanding.

From the above responses it is evident that, after the training workshop, the respondents were more knowledgeable, confident and empowered with the relevant skills to implement Technology, and, most importantly, had gained new knowledge in keeping with the goals of lifelong learning.

5.6.2 Post-workshop changes in proposed Technology pedagogy

Table 5.17 shows changes in the way participants said they would teach Technology after the workshop intervention. The results indicate that all 100% of the respondents had responded positively towards the idea of making changes in the way they would teach Technology. It is important to note that the quality of the workshop had contributed to the respondents becoming motivated to make changes it the way they would teach Technology.

Table 5.17 Post-workshop changes in proposed Technology pedagogy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	100	100	100
	No	0	0	0	0
Missing	System	0	0	0	0
Total		85	100	100	100

The following responses show that not only had the workshop modelled an effective pedagogy for technology education, but also that workshop delegates could see how they could implement these strategies themselves:

- Use more models when explaining concepts.
- Use more ICT in lessons.
- Include more videos as these are more informative and helpful in teaching learners about how Technology works.
- I am going to be more practical and make sure that I bring models to the class and use the Internet and videos.
- This time I will not just refer to notes but also demonstrate and engage learners in a lesson.
- Now I am clear about things that used to give me problems.
- I changed my way of teaching because now I know methods of teaching Technology.
- I can use my cell phone in the classroom to demonstrate, use waste materials, team work so that they can be 21st Century learners.

From the above responses, it is evident that after the workshop, the respondents were motivated and excited to embrace the changes they foresaw in their teaching styles. This is a positive step towards improving the quality of teaching, given the fact that 42.35% of the respondents did not have the necessary conceptual knowledge and theoretical skills to teach Technology prior to the training workshop taking place. Table 5.5 (above), from the pre-test Q2, supports the statement that workshop attendees did not have the necessary conceptual knowledge and theoretical skills to teach Technology before the workshop:

Table 5.5 Pre-workshop conceptual knowledge and theoretical skills to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	57.65	57.65	57.65
	No	36	42.35	42.35	42.35
Missing	System	0	0	0	0
Total		85	100	100	100

5.7 Conclusion

As far as educators' conceptual preparedness for technology education was concerned, it appeared that the majority of the respondents interviewed had a clear understanding of Technology and its importance in society. It is in the area of subject and pedagogical knowledge that, as the survey shows, the majority fell short and needed assistance, particularly in teaching technical processes. There was a clear lack of technical knowledge in nearly half of the teachers interviewed. This had consequences for lesson planning, as teachers did not understand exactly what it was that they were planning to teach.

The survey results on subject-specific training, specialisation and support explained why teachers suffered these deficits, which they, however, tried to rectify with many creative individual solutions. It was found that only half of the teachers surveyed had been allocated to technology education with subject-specific training, and that neither the schools nor the Education Department offered adequate (if any) support or further subject-specific professional development and/or training. The fact that 61.8% of educators surveyed reported that they "had to teach themselves how to teach Technology" (p.108) is an indictment of an education system that appears to pay lip service only to the importance of technology education. As pre-empted in Chapter 2 (pp. 51-52), it was also operational issues, revealed in all three levels of the "hidden curriculum", which led to poor implementation of technology education.

The intervention provided by the researcher, while in the nature of an emergency "bandage" applied to stem the immediate leakage of lifeblood from effective implementation of technology education, can be seen to have "done the job" of equipping teachers with urgently-needed subject knowledge and skills (pedagogical, as well as technical). It can also be seen to have modelled features of an effective teacher intervention, by showing how specific needs must be established with reference to context, audience and purpose, rather than by applying a "one best solution fits all cases" scenario.

The apparent success of the one-day intervention does not, however, remove the need for a more permanent departmental solution for the general problems identified. The next chapter will provide conclusions and recommendations for the study, based on the deficits in teacher preparedness, training and support as identified in the analysis of results.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter arrives at general conclusions by discussing the results given in the last chapter with regards to the preparedness of educators for technology education and the effectiveness of the teacher training intervention. Relevant linkages between this study's findings and those in the literature are also established in this chapter. Thereafter, recommendations are offered on how the problems dogging technology education might be addressed, as well as a proposed teacher developmental model for technology education. The chapter ends with some concluding thoughts.

6.2 Preparedness of educators for technology education

Chapter 5 analysed the results in terms of how they provided answers (or partial answers) to the research questions. The results presented here are related to the following issues that were raised in Chapter 1 (see p1):

- the need for technology-skilled citizens in South Africa;
- the need for teacher development programmes;
- the problems facing provision of skilled educators; and
- the crisis indicated by matric results.

The results indicate that the teachers participating in this study were well aware of the importance of the subject Technology and the need for technology-skilled citizens in South Africa. Teachers saw the subject as relating to real life, modern life, "everything around [us]", as giving learners information "to make their lives easier", and "knowledge, skills and resources that people can use to build things and can use as resourceful opportunities for them to prosper in life". Teachers realised that: "Technology helps to produce people like engineers, technicians and artisans who help people with their daily needs," and that it might help with quality of life in communities: "To equip the learners with technological practical and creativity skills that could be used to solve problems taking place in our communities." These results relate back to section 1.2.1, that is, "The need for technology-skilled citizens in South Africa", and teachers were well aware of this need.

The results confirmed that there was indeed a lack of properly trained technology teachers, as reported by Makgato and Khoza (2015) and the Council on Higher Education (CHE) (Council on Higher Education 2010: 10). It was mentioned in Chapter 1 that teachers were blamed for failing to equip their learners with the necessary knowledge and skills to keep up with the changing technological world (Reddy, Ankiewicz and De Swardt 2005: 32; Makgato 2014: 3689). The results of the survey, interview and questionnaire showed that teachers were well aware of their shortcomings, and confirm the admission of the Department of Higher Education and Training (DHET) that poor subject matter knowledge and pedagogical content knowledge are important contributors impacting on quality. The results also showed the need for teacher development programmes, as pre-empted in section 1.2.3, "The need for teacher development programmes". The problems facing provision of skilled teachers, in particular, the problems with assessment, were also confirmed by the results of this study. The fact (mentioned earlier, on p.9) that the Education Department was placing special attention on schools in Ilembe, in particular, is not surprising, either, in view of the results.

These findings about the state of Technology are in keeping with the earlier findings of the President's Education Initiative Research Project, as reported in the Government Gazette No 29832 (South Africa. Department of Education 2007: 4-5). The Report of the Ministerial Committee on Rural Education (South Africa. Department of Education 2005) highlighted specific challenges in rural schools. These included poor grasp of their subjects, as evidenced by a range of factual errors made in content and concepts during lessons. The teachers' low levels of conceptual and content knowledge were seen as contributing to low levels of learner achievement. The report noted a shortage of qualified and competent teachers in these schools, the problem of multi-grade and large classes, under resourced school facilities, and limited access to professional development programmes for teachers.

However, analysing the results in an attempt to provide answers to the specific research questions made it possible to pinpoint particulars of the real world problem in such a way as to elicit aspects which could be dealt with in the intervention provided by the researcher. While the literature identified poor subject matter knowledge and pedagogical content knowledge as being the main problems, as well as the pedagogical skills required to teach concepts and practice effectively (Shepherd 2013, 2015), the following two aspects emerged as paramount:

- Teachers' understanding of the technical processes used in practical applications of technological principles (i.e., those in the actual DBE Technology curriculum); and
- The need for a pedagogy to teach these practical applications in ways which learners would not only understand but relate to their own real-world socio-cultural contexts.

These findings clarified the key difference between the subject Technology and other academic subjects: teachers are not just expected to generate exercises based on applying a theory, and learners are not just expected to apply theoretical concepts in the completion of exercises, as with most academic subjects.

The subject Technology basically involves learning how to design and construct artefacts which will work in the same way - or along the same lines - as real world artefacts. Both teacher and learners need to assume the role of mechanics and engineers, in groups such as one finds in laboratories, various industries or community-based production, demonstrating and producing products that people can actually *use*, and that actually *work*. The pedagogical methods described in social (and cognitive) constructivism (small group collaboration, hands-on, student-centred learning) and construction*ism* (learning by making artefacts) have been around for some time, as described in Chapter 3. They are also congruent with features of outcomes-based education (OBE), which is still the pedagogy approved by the Education Department, in spite of it being downplayed because of rejection by teachers who still "swear by" traditional transmission methods. However, the application of design principles in the creation of artefacts which work on the basis of technical processes cannot be taught or tested by means of traditional transmission methods.

The teachers involved in the research actually understood this. What they did not understand was the specific technical processes which they were required to teach in the subject Technology, as they were not actually artisans, engineers or scientists, but academic types more skilled in literary-type verbal (or numerical) learning, as this is how they (or most of them) had been educated. They were literate, but not *technology literate*, as defined in the passage below:

> Broadly speaking, technology is how people modify the natural world to suit their own purposes. From the Greek word *techne*, meaning art or artifice of craft, technology literally means the act of making or crafting, but more generally it refers to the diverse collection of process and knowledge people use to extent human abilities and to satisfy human needs and wants (International Technology Education Association 2007: 1)

They were teachers, not engineers, architects, computer scientists or technicians. They did not know "the act of making or crafting" in terms of knowledge "how to", and did not understand technical processes or how they could be harnessed to drive various artefacts. This is because, in the 21st Century, society is diversified, and most individuals are no longer acquainted directly with the manufacture of machines and products in the way that the villagers of old were involved, for example in "home industries" (see Aunger 2010: 772). Moreover, their teacher training had not addressed this lack of subject-specific knowledge and skill. This meant that teachers were lacking in "a. knowledge b. skills, and c. training" particularly with regard to technical processes and the pedagogy needed to teach these aspects.

Although educators must take some responsibility for their own professional development, the results clearly highlighted the lack of training and further development which should have been carried out by the schools, the district centres and the Education Department, leaving teachers to "teach themselves how to teach Technology". It is also clear that the "hidden curriculum" factors pre-empted in Chapter 3, to some extent, devalued the subject and left teachers without the necessary resources. The results indicate that there is an urgent need to capacitate Technology teachers so that they are able to transfer and scaffold the necessary skills and knowledge to the learners, who then can contribute meaningfully to the skills development pool that this country so desperately needs. However, barriers that prevent the goals of the National Developmental Plan from being attained must firstly be addressed. These include the provision of Technology kits, text books and access to computers without further delay. The retraining and retention of Technology teachers must be implemented over a three-year cycle so that, when teachers are trained, they are not moved the following year to teach other subjects. This is because Technology needs teachers to possess high levels of knowledge and skill accompanied by hands-on experience so that the learners are able to benefit from the process and become employable in the 21st Century.

6.3 The effectiveness of the educator training intervention

Based on the post-test results, the intervention provided by the researcher can be seen to have been effective in equipping teachers with urgently-needed subject knowledge and skills (pedagogical, as well as technical). The effectiveness of the intervention is thought to lie in the winnowing down of the problems experienced by teachers to a few specific urgent needs which had to be addressed. These were identified as needs which typified the specific areas giving problems, that is, understanding of technical processes and how to teach them. The teacher training session thus modelled features of an effective training intervention by showing how specific needs must be established with reference to context, audience and purpose, rather than by applying a "one best solution fits all cases" approach. The nature of an effective educator intervention can also be seen to depend on its overall context, audience and purpose: the context in which teachers are teaching, and the context of the intervention (e.g., timing of intervention, time and funding available); the audience (e.g., teachers, including preparedness and numbers); and the purpose (e.g., in this case, to address specific problems identified). The intervention described here is shaped by the "real" as opposed to the "ideal". There are currently other very laudable options, but these are not always feasible. Makgato's (2003) "development of a curriculum for technology teacher education and training" provides an exemplary model for technology education, which, with time and funding, would accommodate future generations of technology teachers. Mpotse's (2012) "each one, teach one" buddy-system is also an excellent strategy for addressing the types of problems revealed in this study, but needs funding and time to accomplish. The intervention described in this thesis took place in one day and was not funded.

This intervention not only addressed specific needs expressed by teachers and fitted the workshop into the time and resources available, but also modelled a constructivist teaching approach, giving teachers a working example of how they could teach aspects they had formerly not understood. This is why participants said it was successful, because, as teachers, they became involved in the workshop design; they had been "engaged" in co-constructing knowledge, not just "about" but "how to". Pedagogy cannot be separated from subject content, particularly in an applied subject like Technology. This is what TPACK (Koehler and Mishra 2009; Koehler 2012) suggests, but an effective pedagogy for Technology can more realistically be seen to involve "TPACKing" (Olofson, Swallow and Neumann 2016), a complex, integrated process, not intellectual content on its own which is then applied practically. The requisite pedagogy for technology education is more like Papert's constructionism, where theory emerges in, and is refined by, constructing an artefact. The precise nature of TPACK's unfolding in practice can be seen to depend on context, audience and purpose. The success of this intervention suggests that TPACK should be seen primarily as a pedagogy and a process, that is, TPACKing, and not only as a theoretical framework or content.

In spite of the apparent effectiveness of this intervention, it is not recommended that the Education Department always has recourse to ad hoc measures in the nature of the training intervention described here. It is rather recommended as a suitable model for any intervention urgently needed to assist teachers who somehow "fell between the cracks", missing out on past and future training initiatives through no fault of their own. The intervention modelled the concepts for teachers, explained the nature of key technical processes, and modelled the pedagogy which might prove most effective for teaching the subject Technology. That the participants professed enthusiasm and excitement at the training suggests that it also built up their confidence and professional self-image as Technology teachers. This is an important factor when one considers the low value accorded to technology education by the hidden curriculum.

The responses of the educators who attended the training workshop support claims made about the efficacy of the intervention in terms of assisting educator preparedness. However, there is the need for a more permanent departmental solution to solve the general problems identified, as will be discussed below in the section on recommendations.

6.4 Recommendations

The National Development Plan Education 2014 addresses the role of education in promoting radical economic transformation (South Africa. National Planning Commission 2010). In order for these goals to be achieved the following challenges, which are directly linked to the results of this study, need to be addressed.

6.4.1 Provision of LTSM materials

A contributing factor to the poor quality of technology education is the lack of essential resources. This is a failure on part of the schools to adhere to the requirements of the National Curriculum Statements (CAPS) Technology policy document (South Africa. Department of Basic Education 2011a: 13-14), which stipulates that the school must take the responsibility for developing develop the teachers' appropriate knowledge and skills, and provide necessary teaching and learning resources (e.g., technology kits, budgets for acquiring resources, and access to computers, amongst others).

6.4.2 Establishment of School Based Professional Learning Communities

The scenario is the critical lack of teachers possessing the necessary levels of conceptual skills and using traditional teaching methods to provide the learners with 21st Century learning opportunities. It is again the responsibility of the school to set up, support and monitor the establishment of School Based Professional Learning Communities. These communities provide the first level of intervention and support to the teachers by providing orientation to newly appointed teachers, and hosting regular meetings, workshops and talks, where teachers are informed about current policies such as the National Development Plan (South Africa. National Planning Commission 2010), the role of education in transforming the education landscape, and the requirements of the norms and the standard document which stipulates the seven roles the teacher must adopt (South Africa. Department of Education 2000).

6.4.3 Supervision of teachers' work as a form of monitoring and support

Many schools fail in fulfilling their mandate to provide the necessary on-site support, that is, moderation of teachers' work, the writing of supervision reports and the setting up of subject committees (i.e., professional learning communities within schools). Such failure often results in the school being partly dysfunctional, as it negates its monitoring and evaluation function. Monitoring also provides positive feedback on the quality of teaching and learning.

6.4.4 Addressing the critical lack of teachers with the necessary conceptual skills

It is necessary to address the critical lack of teachers possessing the necessary levels of conceptual skills and using traditional teaching methods to provide the learners with 21st Century learning opportunities. The National Development Plan targets education, especially in rural areas, to transform the landscape by providing quality education and training. Therefore, it is the responsibility of teachers to improve service delivery by providing the learners with quality teaching and learning. The school management team must take a leading role in mentoring teachers on the need for continuous professional development as a means of upgrading their content and pedagogical knowledge and skill as well as technological knowledge necessary for 21centuary learning.

6.4.5 The integrated quality management system (IQMS) as a monitoring tool

Teachers are not taking a leading role in developing themselves and becoming lifelong learners, as stated in the norms and standards document for educators. The norms and standards document stipulates that teachers must be lifelong learners in order to be relevant in an ever changing landscape that requires high levels of knowledge and skills. Teachers need to become members of subject communities both within and outside of the school environment. The sharing and networking of ideas and developing skill of other teachers within a group situation are within the norms of *Ubuntu* (bring what you have to the table and share it).

6.4.6 Addressing the lack of in-service and pre-service training of educators

Technology as a new subject in the curriculum package lacks support from the education social partners, unlike maths and natural science, which are supported by organizations such as Jika Mfundo. This organization provides pre service training to teachers while technology has to rely on the subject advisor for limited support. The Ilembe District Teaching and Learning Services conduct content workshops on a quarterly basis in the first two terms of the year. At the workshops, assessment and Mini–PAT requirements are discussed and policy requirements outlined. The TPACK framework is also used to familiarize teachers with methodology and development of conceptual skills. However, it is also the teachers' responsibility to engage in professional development activities by actively engaging with professional organizations such as SAASTE, the *Eskom Young Scientists Expo*, the Technology Association, district-based professional learning communities and school-based professional learning communities.

6.4.7 Addressing the lack of electricity supply, fixed line telephones and Internet access

The lack of consistent electricity supply, fixed line telephones and Internet access impact negatively on effective service delivery as the teachers have to revert to traditional teaching methods, which practice goes against the values of the NDP. The other relevant role players who can support the development of the key concepts of the teachers are the KwaZulu-Natal Department of Education, the District Teacher Development Centre and full service schools.

6.4.8 Provision of all schools with technology kits and hand tools

There is a need for the Provincial Department of Education to include the General Education band as part of the re-capitalization programme by providing all school with technology kits and the relevant hand tools so that learners can engage in meaningful learning. This would also support the Further Education and Training Band, as learners would have exposure, by way of practical work, to the skills and knowledge necessary to make informed choices. Currently the programme supports only technical high schools, and the Maphumulo district does not have any technical high schools. The provision of all school with technology kits and the relevant hand tools would also curtail the use of inappropriate traditional content teaching methods.

6.4.9 Use of district teacher development centres to provide resources

The active inclusion of a district teacher development centre can play an instrumental role in providing access to schools lacking the necessary resources. The Maphumulo resource centre can support the implementation of technology by developing the teachers' knowledge by providing xsupport both on site and through a selected school.

Teachers can become ICT literate, as the centre has trained ICT personnel and a fully-fledged ICT centre with network capabilities. The centre can also train teachers in the use of the pre-loaded tablets that have been supplied to school as part of the MST/ICT rollout programme. It can also provide a service to schools that do not have electricity with printing and scanning facilities and the loaning of electronic mobile equipment.

District teacher development centres should provide a venue for the operation of a professional learning community for ICT, in view of the fact that 62.67% of the teachers surveyed had no access to computers, and could also train teachers in the use of multimedia devices.

6.4.10 Use of full service schools to provide resources

Full service schools cater for the needs of the broader community by providing a service for learners with special needs, such as counselling services and social worker visits, as well as having computer equipment with network connectivity. These venues are suitable for the professional development of technology teachers, as they have the necessary ICT materials. It is recommended that the district initiate the use of these venues by providing the necessary technology resources, so that schools are able to function by borrowing the tools and equipment for teaching and learning purposes. This would partly solve the problem of resources and also provide an important networking venue.

6.5 A teacher developmental model for technology education

As well as the specific measures recommended above, this study contributes to the existing body of knowledge by proposing the following teacher developmental model for teacher education (Figure 6.1).

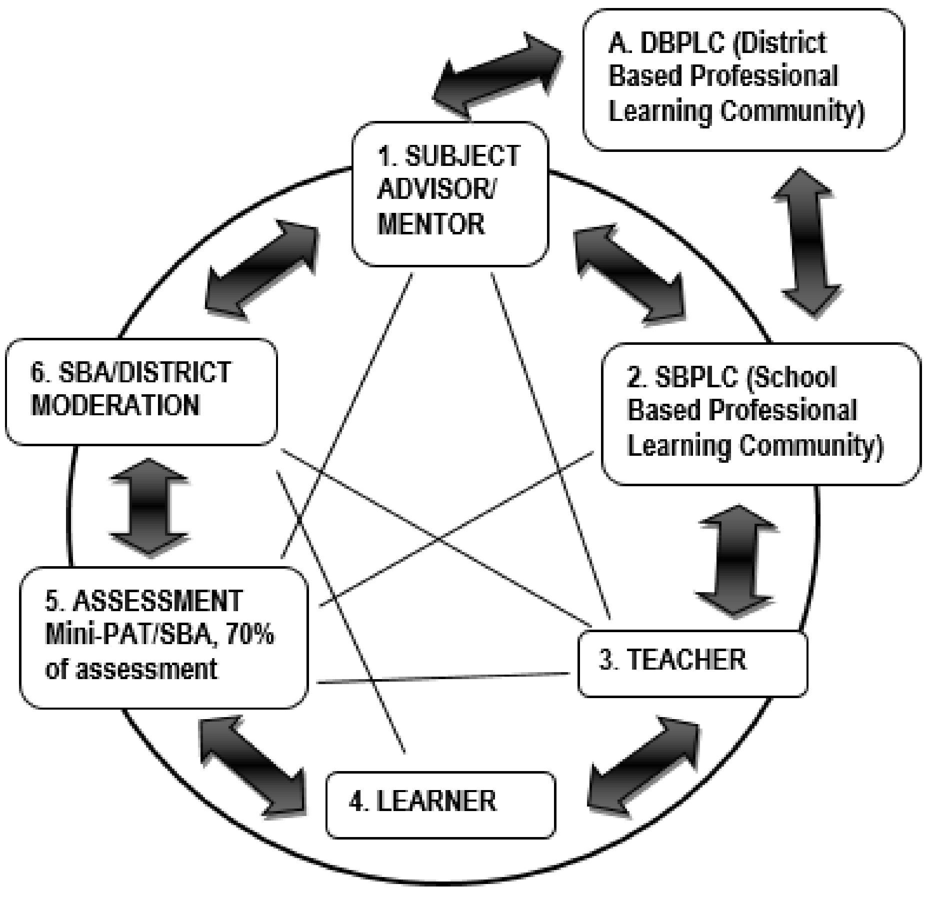

Figure 6.1 Teacher developmental model for technology education

6.5.1 The District Based Professional Learning Community

This model is based around a District Based Professional Learning Community (DBPLC) (A. in Figure 6.1), which would be supported by subject advisors, and would function as a cluster. Teachers could then form mini-clusters to support one another within the district cluster. The DBPLC would bring all Technology teachers together to inform, appraise, distribute and share common materials on district and provincial requirements. Teachers would then have an opportunity to interact, network and share information on best practice and form professional relationships. They could also establish communication channels to support one another as a cluster, and share equipment and/or resources, as well as ideas. The various elements of the DBPLC are envisaged as operating as follows:

6.5.1.1 The subject advisor

- The subject advisor mentors and supports all teachers teaching Technology, using a variety of strategies to clarify their existing beliefs and knowledge about the subject content, technical processes and pedagogy. Teachers mentored may include newly-appointed, untrained and/or under-qualified staff, as well as qualified teachers teaching the subject for the first time.
- Teachers are thus inspired to use Innovative strategies to empower and develop their own knowledge and skills, and those of the learners. This may be done through hands on for practical activities and the creative use of resources.
- Teachers are also empowered to construct new knowledge of policy requirements (e.g., school based assessments, content to be covered and skill required for the Mini-PAT).

6.5.1.2 The School Based Professional Learning Community

- Subject advisor interventions assist teachers to return to school with new found confidence. The teacher would then have a better understanding of subject content, pedagogy, conceptual skills, requirements for assessment and integrating the use of technology
- Knowledge and skills are cascaded via the subject committee of the School Based Professional Learning Community (SBPLC) to colleges, which can

then use this knowledge to support learners at schools to construct new meaning via Q&A, demonstrations, field trips and group activities.

- The teacher can also support other teachers within the cluster who require further support by assuming the role of a mentor, or seek assistance from other lead teachers within the cluster.
- This model contributes to the existing body of knowledge by facilitating teacher support, teaching, learning and effective assessment.

6.5.1.3 The teacher

- The teacher promotes constructivist pedagogy, asks questions, prepares and collects resources and gives demonstrations.
- The teacher thus inspires learners to be active participants.
- As a result, learners conduct research and apply these skills to real life situations via a Mini-PAT. This includes working in groups, collecting information and resources, drawing, preparing spread sheets and collaborating to present completed tasks in specified time frames

6.5.1.4 The learner

- The learner participates in all the pre–Mini-PAT activities such as demonstrations, investigations, collecting relevant materials, interacting with the community elders about the indigenous knowledge systems and providing feedback to the class.
- The Mini-PAT constitutes70% of school based marks (National Curriculum Statements Technology (South Africa. Department of Education 2011b: 40).
- This real life situation is a demonstration of the learner's understanding of the key concepts that were demonstrated to the learner at the beginning of the term via discussion, demonstrations and research. This Mini-PAT is presented in a portfolio of the work done as a collective group to address the challenges presented as a scenario.
- Presentations are made using a variety of communication methods, including flow charts, oral presentations to the whole class and other groups also contribute. Other learners provide constructive input on ways to improve the

project.

6.5.1.5 Assessment

- The Mini-PAT/SBA is assessed according to pre-arranged criteria using an analytical rubric.
- School level moderation should ensure that the quality and standards of the internal assessment are in keeping with the Curriculum and Assessment Policy Statements (CAPS) and are met.
- At the school level, assessment takes the form of the following stages: pre-moderation, moderation and post moderation.
- The Mini-PAT is assessed and moderated internally as part of the schools' management plan, and marks are recorded on the South African School Administration and Management System (SA-SAMS).

6.5.1.6 SBA/District moderation

- The District conducts moderation of sampled schools using a process of random sampling.
- Schools are informed via a circular of the dates of moderation, which is conducted on site.
- This sampling allows the district to evaluate the project, the quality of the teachers' assessment and the learners work. Learners have to show understanding of the conceptual skills.
- This further allows the district to identify potential caps in the teaching and learning process and to put in place remedial measures to improve the quality of teaching, learning and assessment.
- Feedback is provide to the school management teams so that the necessary support can be provided to the relevant teachers
- The district's remedial process can take the form of a report to the affected schools, on-site support and a two-hour to a one-day content workshop for all school in the district.

- The district takes full responsibility and accountability for moderation at school level.

6.5.2 Advantages offered by the teacher developmental model

It must be noted that at any time in the process an intervention can be instituted depending on the circumstances. For example, in the case of a learner displaying poor understanding of conceptual skills required for the Mini-PAT, the teacher intervenes and institutes an extension activity to develop the learners' understanding. This activity can be undertaken in many ways, such as showing a YouTube video, or advising extra reading, or the demonstration of a particular resource task.

New knowledge, values and conceptual skills can be constructed in this multi directional model, as all the components from 6.3.1 to 6.3.6 play a contributing role in constructing conceptual skills and concepts as well as application. The end result is that all the intellectual skills and practical applications are addressed.

This model is also applicable to monitoring the implementation of Technology, as it addresses the capability of both the teacher and learner, and supports the problem solving taxonomy (Plants *et al.* 1980) set out in the National Curriculum Statements for Technology (South Africa. Department of Education 2011b: 42-43).

6.6 Concluding thoughts

Technology education needs to be viewed in the social context of a post-liberation country in which technological knowledge and skills urgently need to be developed in the new generation. The consequences of this development will be that jobs will be available for future generations, to address the serious social ills of poverty and unemployment (Musgrave 2016; Padayachee 2016), and a skilled workforce will be available to transform the country into a global role player, rather than a country hovering on the brink of a rating downgrade to “junk” status (Brown 2017; Mkentane 2018).

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APPENDIX A: ETHICS STATEMENT AND LETTERS

DURBAN UNIVERSITY of TECHNOLOGY

ETHICS STATEMENT: Please complete and sign the attached Ethics Questionnaire.

All students who intend to complete research projects under the auspices of Durban University of Technology are required to complete this form. This is an abridged version of DUT's ethics questionnaire for students conducting research in the field of commerce.

Use the Durban University of Technology's Research Ethics Policy and Guidelines to ensure that ethical issues have been identified and addressed in the most appropriate manner, before finalizing and submitting your research proposal.

Please indicate [by an X as appropriate] which of the following ethical issues could impact on your research. Please type the motivations/further explanations where required in the cell headed COMMENTS. Copying and pasting the appropriate sections from your proposal may not suffice - please ensure that your justification/comments are addressed fully, as issues that inadequately answered will be returned to the student for further comment.

No	Question		
1.	**DECEPTION**		
	Is deception of any kind to be used? If so, provide a motivation for acceptability.	No	X
	Comment:	Yes	
2.	**CONFIDENTIALITY**		
	Does the data collection process involve access to confidential personal/organizational data (including access to data for purposes other than this particular research project) without prior consent of the subjects?	No	X
		Yes	
		N/A	
	Comment:		
3.	Will the data be collected and disseminated in a manner that will ensure confidentiality of the data and the identity of the participants? Please explain	No	
		Yes	
	Comment:	N/A	X

4.	Will the data obtained be stored and ultimately disposed of in a manner that will ensure the confidentiality of the participants? If “No” please explain. If “Yes” how long will the confidential data be retained after the study (and by whom) and how will it be disposed of at the end of the period?	No Yes	 X
	Comment: The data will be retained for the duration of the study by the researcher; copies would be given to DUT. At the end of the study period data will be deleted from all data bases. Printed material will be shredded by the researcher.		
5.	Will the research involve access to data banks that are subject to privacy legislation? If yes, specify and explain. Comment:	No Yes	X
	RECRUITMENT		
6.	Does respondent recruitment involve any direct personal approach from the researchers to the potential subjects? Refer to the sampling plan in your proposal and copy the relevant sections here. Comment:	No Yes	X
7.	Are participants linked to the researcher in a particular relationship i.e. employees, colleagues, family, students? If yes, specify how. Comment: Participants will be teachers involved in the researcher’s my training workshops	No Yes	 X
8.	If yes to 7, is there any pressure from researchers or others that might influence the potential subjects to enroll? Elaborate. Comment:	No Yes	X
9.	Does recruitment involve the circulation/publication of an advertisement, circular, letter etc? Specify. Comment:	Yes No	 X
10	Will subjects receive any financial or other benefits as a result of participation? If yes, explain the nature of the reward, and safeguards. Comment:	Yes No	 X
11	Is the research targeting any particular ethnic or community group? If yes, motivate why it is necessary/acceptable. If you have not consulted a representative of this group, give a reason. In addition explain any consultative processes, identifying participants. Should consultation not take place, give a motivation. Comment:	Yes No	 X
12	Does the research fulfill the criteria for informed consent? [See guidelines]. If yes, no further answer is needed. If no, please specify how and why. Comment:	Yes No	X
13	Does consent need to be obtained from special and vulnerable groups (see guidelines). If yes, describe the nature of the group and the procedures used to obtain permission. Comment:	Yes No	 X

14	Will a Subject Information Letter be provided and a written consent is obtained? If no, explain. If yes, attach copies to proposal. In the case of subjects who are not familiar with English (e.g. it is a second language), explain what arrangements will be made to ensure comprehension of the Subject Information Letter, Informed Consent Form and other questionnaires/documents. Comment: The Subject Information Letter, Informed Consent Form and Questionnaires will be translated in the mother-tongue language of need.	Yes No	X
15	Will results of the study be made available to those interested? If no, explain why. If yes, explain how. Comment: Copies of the dissertation will be displayed in the DUT library. The research findings will be made available to interested officials of the DoE.	Yes No	X
16	**RISKS TO SUBJECTS** Will participants be asked to perform any acts or make statements, which might be expected to cause, discomfort, compromise them, diminish self-esteem or cause them to experience embarrassment or regret? If yes, explain. Comment:	Yes No	 X
17	Might any aspect of your study reasonably be expected to place the participant at risk of criminal or civil liability? If yes, explain. Comment:	Yes No	 X
18	Might any aspect of your study reasonably be expected to place the participant at risk of damage to their financial standing or social standing or employability? If yes, explain. Comment:	Yes No	 X
19	Does the research involve any questions, stimuli, tasks, investigations or procedures which may be experienced by participants as stressful, anxiety producing, noxious, aversive or unpleasant during or after the research procedures? If yes, explain. Comment:	Yes No	 X
	BENEFITS		
20	Is this research expected to benefit the subjects directly or indirectly? Explain any such benefits. Comment: This research is expected to benefit the subjects only in terms of training in Technology Education.	Yes No	X
21	Does the researcher expect to obtain any direct or indirect financial or *other benefits* from conducting the research? If yes, explain. Comment: The researcher will be rewarded only by obtaining the degree Doctor of Technology.	Yes No	X
22	**SPONSORS: INTERESTS AND INDEMNITY** Will this research be undertaken on the behalf of or at the request of a company, or other commercial entity or any other sponsor? If yes, identify the entity. Comment:	Yes No	 X

23	If yes to 22, will that entity undertake in writing to abide by Durban University of Technology's Research Committees Research Ethics Policy and Guidelines? If yes, do not explain further. If no, explain Comment:	Yes	
		No	
		N/A	X
24	If yes to 23, will that entity undertake in writing to indemnify the institution and the researchers? If yes, do not explain further. If no, explain. Comment:	Yes	
		No	
		N/A	X
25	Does the researcher have indemnity cover relating to research activities? If yes, specify. If no, explain why not. Comment:	Yes	
		No	
		N/A	X
26	Does the researcher have any affiliation with, or financial involvement in, any organization or entity with direct or indirect interests in the subject matter or materials of this research? If yes, specify Comment:	Yes	
		No	X

The undersigned declares that the above questions have been answered truthfully and accurately.

STUDENT NAME : ROHITH RAMBRIJ

SIGNATURE

DATE : 16 November 2009

LETTER OF INFORMATION AND CONSENT

DURBAN UNIVERSITY of TECHNOLOGY

Dear Participant

Thank you for agreeing to participate in this research study entitled: *Technology literacy for teachers in rural schools: constructing key concepts in Technology Education for teachers in the Ilembe District.*

The study will investigate how teachers can develop the concepts needed to inform good teaching practice in Technology Education. It is hoped that results of this research will improve the teaching of Technology Education, particularly in rural schools.

The researcher undertakes to assure you of the following:

- To maintain your confidentiality;
- To protect your rights and welfare, i.e. to ensure that no harm comes to you as a result of your participation in this research;
- No manipulation or withholding of information is involved in this study;
- To present information and transcripts used in this research in such a way as to maintain the participant's dignity, and if in doubt to first consult with you;
- To make available to you the final copy of this research publication; and
- The participant is free to withdraw from this research process at any time, if the need should so arise.

I acknowledge your sacrifice in volunteering to add to a body of academic knowledge and your perseverance in carrying out this research to its completion.

Yours sincerely

____

R. Rambrij
Doctor of Technology Student
Student Number: 18850204

I, ____________________ (participant's name), agree to participate in this study.

____________________ ____________
Participant's signature Date

LETTER OF INFORMATION AND CONSENT IN ISIZULU

Mbamb'iqhaza

Ngiyabonga ngokuvuma kwakho ukuba ingxenye yalolu cwaningo lwe: *Technology literacy for teachers in rural schools: constructing key concepts in Technology Education for teachers in the Ilembe District.*

Lolu cwaningo luzosiza ukuphenya okuthi othisha baluthuthukisa kanyani ulwazi lwezobucwephesha ikakhulu ekufundiseni ezikolomi egisemakhaya. Kunetehmba lokhuti imiphumela yalolu cwaningo iyothuthu – kisa umfundiswe kwezobucwe pheshe ikakhulu ezikoleni zasemakhaya.

Umcwaningi uzokwenza loku okulandelayo njengesiqiniseko:

- Ukungadaluli igama lobambe iqhaza;
- Ukuvikele amalungelo nenhlalakahle yakho, ukuqiniseka ukuthi awuhlukumezeki ngokubamba iqhaza kulolu cwaningo;
- Akuzobakhona ukusetshenziswa nokufihlwa kolwazi kulolu cwaningo;
- Ukuveza ulwazi nokusetshenziswe kulolu cwaningo ngendlela ezovikela isithunzi sobambe iqhaza, okuyothi uma ngingenasiqiniseko ngixhumane naye;
- Ukukwenzela ikhophi yokugcina yokubhalwe kulolu cwaningo;
- Obambe iqhaza kulolu cwaningo ukhululekile ukuhoxa kulona noma ngasiphi isikhathi, uma kuvela isidingo;

Ngobonga ukuzinikela kwakho ngokuba ingxenye yokwandisa ulwazi emkhakheni wezemfundo kanye nokubekezela ukwenza lolu cwaningo luphothulwe.

Ozithobayo

____

R. Rambrij
Doctor of Technology Student
Student Number: 18850204

Mina, ______________________________ (igama lobambe iqhaza), ngiyavuma ukuba ingxenye yalolu cwaningo.

____________________ __________
Obamb'iqhaza Usuku

DEPARTMENT OF EDUCATION KWAZULU-NATAL: PERMISSION TO CONDUCT RESEARCH

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Nomangisi Ngubane | Tel: 033 392 1004 | Ref.:2/4/8/724

Mr R Rambrij
17 – 60th Avenue
UMHLATUZANA TOWNSHIP
4092

Dear Mr Rambrij

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"TECHNOLOGY LITERACY FOR TEACHERS IN RURAL SCHOOLS: CONSTRUCTING KEY CONCEPTS IN TECHNOLOGY EDUCATION FOR TEACHERS IN THE ILEMBE DISTRICT (GRADES 4 – 9)",** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 22 February 2016 to 31 March 2017.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

ILembe District

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 19 February 2016

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa ...dedicated to service and performance
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel. 033 392 1004 **beyond the call of duty**
EMAIL ADDRESS: kehologile.connie@kzndoe.gov.za / Nomangisi.Ngubane@kzndoe.gov.za
CALL CENTRE: 0860 596 363; Fax: 033 392 1203 WEBSITE: WWW.kzneducation.gov.za

APPENDIX B: WORKSHOP MATERIALS

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

ILEMBE DISTRICT

TECHNOLOGY PROGRAMME FOR G 7 CONTENT WORKSHOPS - 2017

1. WELCOME & REGISTRATION
2. PRAYER
3. PURPOSE OF WORKSHOP
4. MOTIVATION VIDEO
5. PRE-TEST
6. POLICY IMPLEMENTATION TECHNOLOGY

6.1 UNDERSTANDING THE VISION OF NDP/ WHITE PAPER 7

6.2 NCS CAPS REQUIREMENTS

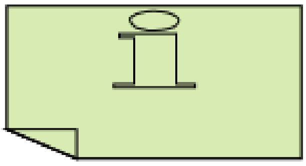
7. PLANNING -ORGANISING OF THE TEACHERS FILE –ACTIVITY (DATES)
8. VIDEO OF SAFETY SYSTEMS
9. MECHANICAL SYSTEMS AND CONTROL (JAWS OF LIFE)
10. ASSESSMENT: TEST & MIN- PAT REQUIREMENTS & MODERATION
11. TEACHING USING THE SPECIFIC AIMS IN LESSON PLANNING
12. POST -TEST
13. REGISTRATION - SACE
14. CLOSURE

Geared towards the Fourth Industrial Revolution

Championing Quality Education-Creating and Securing a Brighter Future

POWERPOINT SLIDES USED TO GUIDE WORKSHOP ACTIVITIES

TECHNOLOGY G 7
2017



CONTENT WORKSHOPS

1

GOOD MORNING

AND WELCOME
I AM EXCITED TO BE HERE WITH YOU TODAY

2

Programme

- PRAYER
- PURPOSE OF WORKSHOP
- MOTIVATION VIDEO
- PRE-TEST
- POLICY IMPLEMENTATION- VISION OF NDP/WHITE PAPER 7
- NCS CAPS REQUIREMENTS
- PLANNING

3

Programme continued

- VIDEO SAFETY SYSTEMS
- MECHANICAL SYSTEMS AND CONTROL (JAWS OF LIFE
- ASSESSMENT –TEST & MINI PAT & MODERATION REQUIREMENTS
- TEACHING USING THE SPECIFIC AIMS IN LESSON PLANNING
- POST TEST
- REGISTRATION SACE
- CLOSURE

4

Purpose of the workshop

- To prepare one to participate in the fourth industrial revolution of the 21st century
- Expose you to policy requirements for teaching and learning
- To equip you with the necessary knowledge and skills

5

NDP-2030

- ALL SOUTH AFRICANS SEEK A BETTER FUTURE FOR THEMSELVES AND THEIR CHILDREN.
- THE QUALITY OF SCHOOL EDUCATION FOR THE MAJORITY IS OF POOR QUALITY AND OUR STATE LACKS CAPICITY IN CRITICAL AREAS. P.1

6

THE STATE OF EDUCATION

"EDUCATION IS EVOLVING DUE TO THE IMPACT OF THE INTERNET. WE CANNOT TEACH OUR STUDENTS IN THE SAME MANNER IN WHICH WE WERE TAUGHT. CHANGE IS NECESSARY TO ENGAGE STUDENTS NOT IN THE CURRICULUM WE ARE RESPONSIBLE FOR TEACHING, BUT IN SCHOOL."- APRIL CHAMBERLAIN

7

EDUCATION

- EDUCATION IS ONE OF THE PILLARS OF THE NDP.
- THE PURPOSE OF TECHNOLOGY IN THE SENIOR PHASE IS TO INTRODUCE LEARNERS WITH THE BASICS NEEDED IN CIVIL,MECHANICAL,ELECTRICAL AND ENGINEERING GRAPHICS AND DESIGN IN THE FET PHASE.

8

THE TECHNOLOGY CLASSROOM

- IT IS THE MELTING POT FOR A HIVE OF ACTIVITIES.
- OUR JOB AS TEACHERS IS TO INSPIRE & MOTIVATE LEARNERS TO EXCEL,

ESPECIALLY IN THE TECHNOLOGY ROOM

AFTER ALL, TECHNOLOGY IS ACTIVITY BASED.

9

THE TECHNOLOGY TEACHER

- READ THE POLICY DOCUMENT AND UNDERSTAND THE REQUIREMENTS FOR THE SUBJECT.
- MAKE YOUR WORKING MODELS SO THAT YOU UNDERSTAND WHAT IS EXPECTED FROM THE LEARNERS .
- KNOW THE ASSESSMENT REQUIREMENTS
- PLAN YOUR ACTIVITIES

10

CONTINUED

- TECHNOLOGY IS A PRACTICAL HANDS ON SUBJECT.
- IT CANNOT BE TAUGHT IN AN ABSTRACT WAY.
- E.G. THIS IS HOW A GEAR WORKS, USING YOUR HANDS /FACIAL EXPRESSION.
- BE A LIFE LONG LEARNER.

11

ROLE OF SMT

- ALLOCATE CORRECT TEACHING TIME -2 HOUR PER WEEK
- PROVIDE RESOURCE AS PER CAPS DOCUMENT- PAGE 13
- APPROVED TEXTBOOK
- STATIONARY INCLUDING BASIC MATHEMATICAL SET
- "IT IS THE RSPONSIBILITY OF THE SHOOL TO PROVIDE EACH LEARNER WITH THE MINIMUM TOOLS AND MATERIALS TO MEET THE NEEDS OF THE SUBJECT AND TO DEVELOP THE TEACHERS APPROPRIATE KNOWLEDGE AND SKILLS"

12

CONTINUED !

- SUPERVISE & SUPPORT THE TEACHER.
- TEACHERS MUST FOLLOW THE PACE SETTERS AS PER THE CAPS DOCUMENT FOR EACH TERM.
- CAPS DOES NOT ALLOW FOR LOST TIME !!!
- THE TEACHER MUST HAVE A CATCH UP PROGRAMME IN PLACE TO MAKE UP TIME LOST, THIS COULD BE LUNCH TIME TEACHING, AFTER SCHOOL,WORKSHEETS AND HOMEWORK.

13

TEACHER FILE

- ASSESSMENT PROGRAME FOR THE YEAR
- PACE SETTERS
- POLICY DOCUMENT –NOT NEGOTIABLE
- LESSON PLANS & SUPPORT MATERIALS,E.G.
- WORKSHEETS, NEWS PAPER ARTICLES & DEMO MODELS
- A NEW LESSON PLAN FOR EVERY 2 HOURS- NON NEG
- CASS GRID
- ASSESSMENT RUBRICS
- MARKING MEMO
- QUESTION PAPERS

14

Activity one: Assessment Programme

- OPEN THE DOCUMENT AND TURN TO ATP
- OPEN TO PAGE 14/15 CAPS DOC
- LOOK AT THE YEAR PLANNER PROVIDED
- ENTER THE DATES FOR THE 9/10 WEEK IN MARCH- MINI PAD DUE DATE & TEST DUE DATE IN PENCIL
- NOW ENTER THE DATES ON YOUR OWN FOR THE NEXT THREE TERMS.

15

ACTIVITY 2 PACE SETTERS.

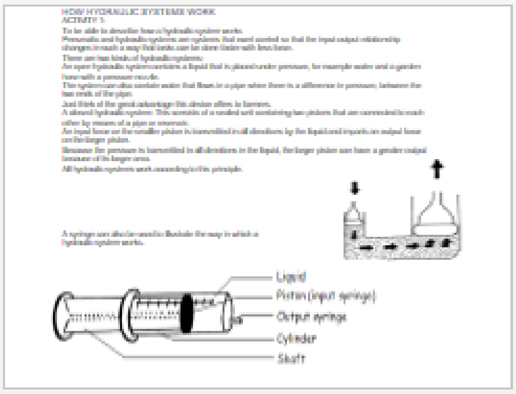
- OPEN TO THE PACE SETTER IN THE HAND OUT.
- USING THE YEAR PLANNER PROVIDED:
- ENTER THE DATES ON THE LEFT HAND SIDE IN PENCIL . THE DATE ENTERED ID THE BEGINNING OF THE WEEK. ON THE RIGHT HAND SIDE ALSO ENTER THE DATE COMPLETED AS WEEK ENDING.
- ALWAYS USE THE POLICY DOCUMENT TO GUIDE YOUDURING THE TEACHING PROCESS.

16

ACTIVITY 3 LESSON PLANNING

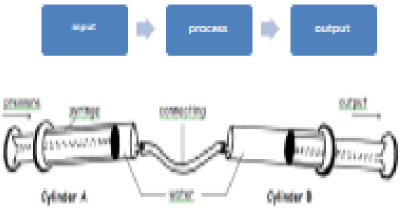
- USE THE TEMPLATE PROVIDED AND ENTER THE NECESSARY INFORMATION FOR A DEMONSTRATION LESSON.
- HOW HYDRAULICS WORK USING SYRINGES.
- USE A SYSTEMS DIAGRAM TO EXPLAIN INPUT-PROCESS-OUTPUT.

17



18

The piston on which the pressure is exerted, is called the master, or input, piston and the syringe that experiences the effect, is called the server, or output, piston.



19

1. Push the plunger of cylinder I in to a level of 2 cm deep.
2. Make a note of your observation of the distance output in cylinder.
3. Has any mechanical advantage been observed?
4. Summary:

The piston on which the pressure is exerted is called the master, or input, piston and the syringe that experiences the effect, is called the server, or output, piston.

In your own words, describe how a hydraulic system works. Also give two examples of hydraulic systems that are commonly used.

ACTIVITY 2:

To examine the transmission of pressure in a hydraulic system and to be able to describe it.

You need the following items for this research:

2 x 10 ml plastic syringes marked A and B

1 x plastic tube

Connect the cylinders as indicated in the figure and fill the system with water.

Wet both ends of the plastic tube and fix it to the syringes as indicated in the drawing.

20

JAWS OF LIFE

The jaws of Life Rescue tools can easily cut through the metal of a car body. They can also be used to bend or open the metal body of a car. Rescue workers have to work very carefully to ensure they don't hurt passengers inside. So the rescue tools should make small movements, compared to large movements made by the rescue workers operating them.

21

Types of jaws of life – rescue tools

- A spreader
- Cutter
- Combination tool
- A ram, that that makes large openings to free people who are trapped.

22

Activity

- In your own words, describe how a hydraulic system works. Also give two examples of hydraulic systems that are commonly used.
- ACTIVITY 2:
- To examine the transmission of pressure in a hydraulic system and to be able to describe it.
- You need the following items for this research:
- 2 x 10 ml plastic syringes marked A and B
- 1 x plastic tube
- Connect the cylinders as indicated in the figure and fill the system with water.
- Wet both ends of the plastic tube and fix it to the syringes as indicated in the drawing.

23

ASSESSMENT REQUIREMENTS

- AS PER CAPS FOR GRADE 7,8&9
- TERM 1: 1 TEST AND MINI PAT
- TERM 2: 1 TEST AND MINI PAT
- TERM 3: 1 TEST AND MINI PAT
- TERM4: EXAM AND MINI PAT
- TOTAL OF 4 MIMI PATS FOR THE YEAR
- THE PRACTICAL ACTIVITIES WILL VARY PER GRADE.
- E.G. G7 TERM 1 - MECHANICAL SYSTEMS & CONTROL, G8 TERM 1 STRUCTURES/MECHANICAL SYSTEMS & CONTROL
- G9 TERM 1 - STRUCTURES.

24

Jaws of life

- The jaws of life has multiple systems.
- It can have a system using levers and linkages as well as hydraulics/pneumatics.
- Specific aim 3 can address the issues prior to the arrival/invention of the hydraulic/ pneumatic tools.

25

Acknowledgements

- DBE-CAPS POLICY DOCUMENT
- DBE- SIYAVULA/ SASOL WORK BOOKS
- MASKEW MILLER LONGMAN - PLATINUM
- VIA AFRICA PUBLISHERS - TECHNOLOGY G 7
- SHUTER & SHOOTER - TOP CLASS
- OXFORD - SUCCESSFUL TECHNOLOGY
- CAMBRIDGE - STUDY & MASTER
- SPOT ON - TECHNOLOGY
- www.bbc.co.za
- www.youtube.co.za

26

THANK YOU

- PLEASE SIGN THE SACE REGISTER
- BEFORE YOU LEAVE

27

EXTENSION ACTIVITIES 2017

28

MARK ALLOCATION

- G-7 FINAL: 60 MARKS FOR THE EXAMPAPER
- G-8 FINAL: 100 MARKS FOR THE EXAMPAPER
- G-9 FINAL: 120 MARKS FOR THE EXAMPAPER

29

MARK ALLOCATION - CONTINUED

- AT LEAST 40 OUT OF THE 70 MARKS PER TERM MUST BE ALLOCATED TO PRACTICAL WORK, CAPS PAGE 39.
- ALL PRACTICAL WORK MUST BE MONITORED BY THE TEACHER – NO PRACTICAL WORK MUST BE DONE AT HOME
- WORK DONE OFF "CAMPUS" SHOULD NOT FORM PART OF THE ASSESSMENT.(PRACTICAL)

30

CONTINUED

- ALL REQUIREMENTS FOR TECHNOLOGY MUST BE DECLARED AND AGREED UPON, E.G
- DUE DATES & ASSESSMENT TOOLS
- EXAMINATION DATES FOR WRITTEN TEST
- MATERIALS TO BE COLLECTED BY THE LEARNER
- ALL REQUIREMENTS AS PER ATP&AAP.

31

ASSESSMENT

- SCHOOL TO HAVE AN ASSESSMENT YEAR PLAN FOR WHOLE SCHOOL
- REQUIREMENS FOR ASSESSMENT STARTS ON DAY ONE
- PROVIDE LEARNERS WITH ALL THE REQUIREMENTS AND DUE DATED
- STICK TO DUE DATES

32

ASSESSMENT ACTIVITY

- DO A LESSON PLAN TO TEACH A PRACTICAL ASPECT OF THE MINI PAT
- USE YOUR WORKBOOK/POLICY DOCUMENT AND DESIGN AND ASSESSMENT TOOL FOR THE PRACTICAL ASSESSMENT OF THE MINI PAT FOR 40 MARKS
- DESIGN A TOOL FOR ASSESSING THE 3 COMPONENTS OF THE DESIGN PROCESS

33

LEARNER PERFORMANCE ANALYSIS

CLASS WORK FORMAL& INFORMAL → TESTS MINI PAT → FROVIDE INFO FOR SUCCESSFUL TEACHING AND LEARNING

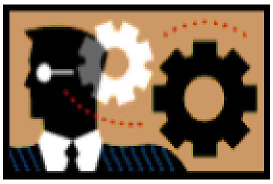
34

SUBJECT IMPROVEMENT PLAN

- THIS INFORMATION IS OBTAINED FROM THE LEARNERS WORK.
- A PLAN IS THEN PUT INTO PLACE TO IMPROVE THE RESULTS/UNDERSTANDING OF THE CONCEPTS TAUGHT.
- IT IS A TOOL USED TO IMPROVE THE QUALITY OF TEACHING AND LEARNING.
- CLASS WISE/GRADE & SCHOOL.

35

THE END



- THANK YOU

36

APPENDIX C: SURVEY QUESTIONNAIRE, INTERVIEW AND PRE/POST-TEST QUESTIONS

SURVEY QUESTIONNAIRE

[The letters of information in English and isiZulu given in Appendix A were attached at the beginning of the survey questionnaire sheet.]

Please answer these questions in the order they are numbered. If a question has a category block, simply place a tick in the applicable space.

SECTION 1: GENERAL INFORMATION

1. Gender of respondent: Male □ Female □

2. Age of respondent: 20-25 □ 25-35 □ 35-45 □ 45-55 □ 55-65 □

3. Qualifications of respondent:

3.1 Educational Qualifications e.g. Matriculation, NTC iii) ___________

3.2 Are you an under - qualified educator? Yes □ No □

3.3 Do you have a four year teaching qualification? Yes □ No □

3.4 Are you unqualified, educator? Yes □ No □

3.5 Do you have any professional teaching qualifications? Yes □ No □

3.6 Academic qualification(s) (e.g. BA, M.Ed. etc.) ___________

3.7 Professional qualification(s) (e.g. N.T.D HDE, FDE, PTC etc)________________

3.8 Do you have a technical college qualification? (e.g. NTC- 6)__________________

3.9 Do you have a technology university qualification? e.g. B.Tech, _______________

3.10 Is your qualification leaning towards your learning area? e.g. Technology

Yes□ No□

4.1 Have you attended any training offered by Engen/ Technology for all?

Yes □ No□

4.2 Do you belong to a Technology association or forum? Yes □ No□

4.3 If yes, has this impacted on your knowledge positively? Yes □ No□

5. Area of specialization (e.g. Mathematics) ______________________________

5.1 Phase specialization: Foundation □ Intermediate □ Senior □ LSEN □

6. Number of years appointed as educator _______________________________

7. Have you been trained at a teachers' training college/university /technikon prior to 1994? Yes □ No □

8. Are you on the permanent staff? Yes □ No □

9. Are you a temporary educator? Yes □ No □

SECTION 2: INFORMATION ABOUT THE SCHOOL

1. The school is situated in:

Urban area □ Peri-urban area □ Rural area □ Deep rural □

2. Do you use public transport to travel to and from school? Yes □ No □

3. Do you use private transport to travel to and back from school? Yes □ No □

4. Do you use more than one mode of transport to travel to school? e.g. taxi, train, bus

Yes □ No □

5. Do you live near the school? Yes □ No □

6. Do you board near the school? Yes □ No □

7. How many kilometers is your school from where you live?

Approx: 1 - 10 □ 10 - 20 □ 20 - 30 □ 30 - 40 □

40 – 50 □ 50 - 60 □ 60 - 80 □ 80 - 100 □ 100 - 200 □

8. Does the school have:

8.1 Electricity? Yes □ No □

8.2 Running / piped water? Yes □ No □

8.3 Telephone? Yes □ No □

8.4 Internet? Yes □ No □

8.5 Library? Yes □ No □

8.6 Computers for educators to use as part of their preparations? Yes □ No □

8.7 Photocopying machines/ copiers? Yes □ No □

9. Do you have access to the machines? Yes □ No □

10. Does the school have multi grade classes? Yes □ No □

10.1 Do you teach technology in any of the multi grade classes? Yes □ No □

11. Number of educators qualified to teach Technology Education: _____________

12 Number of educators teaching Technology Education at the school:

Males ☐ Females ☐

13. Are you employed by the Department of Education? Yes □ No □

14. Are you computer literate? Yes □ No □

15 Do you have a budget for technology? Yes □ No □

SECTION 3
Breakdown of the questionnaire according to themes

Theme 1: Promoting and fostering the successful implementing of Technology as a learning area

1. Do you have the necessary legislation and policies pertaining to the National Curriculum Statement and the implementation of Technology as a learning area in your planning file? Yes □ No □

2. If you answered 'no', state reasons for not having possession of the required documents.____
____
____

3. Is planning for the implementation of Technology as a learning area in your school done as:

- Work schedules? Yes □ No □
- Lesson plan? Yes □ No □

4. Motivate for not choosing one or more of the above plans.
____
____
____

5. Does your school have a continuous professional development program to orientate & develop Technology educators? Yes □ No □

6. If you answered 'yes', is this contained in a formalised policy? Yes □ No □

7. If 'no', please explain briefly the reasons why there is no formalised policy.
____
____
____

Do you have the knowledge and skills to teach the following areas?

8.1 Processing: Food, textile, paper clay, chemical Yes ☐ No ☐

8.2 Structures and model making Yes ☐ No ☐

8.3 Mechanical systems: cams, gears, leavers and pulleys Yes ☐ No ☐

8.4 Hydraulics and pneumatics Yes ☐ No ☐

8.5 Electrical system and control, logic gates, circuit diagrams Yes ☐ No ☐

8.6 How did you acquire these skills?

A. By attending workshops Yes ☐ No ☐

B. In-service training Yes ☐ No ☐

C. Self taught Yes ☐ No ☐

D. Specialised to teach Technology Yes ☐ No ☐

Theme 2: Problems experienced by educators in the implementation of Technology as a learning area.

9. Does your school have a subject head that is responsible for Technology?

Yes ☐ No ☐

10. Does the school have a specialist Technology educator?

Yes ☐ No ☐

11. Has the re-deployment of educators impacted on the implementation of Technology as a learning area in your school?

Yes ☐ No ☐

11.1. If you answered 'yes' please explain how.
____
____
____

12. How has the following impacted on the implementation of Technology as a learning area at your school? Please explain in detail.

12.1 Human resources: (e.g. existence or non-existence of specialist Technology educators in your school)
____
____

12.2 Physical resources: (e.g. classrooms and specialist rooms)

12.3 Financial resources:

12.4 Educator and learner support materials: (including tools and consumables) Please explain in detail.

12.5 Do you have a subject advisor for Technology? Yes □ No □

12.6 What kind of support was offered by the advisor?

School visit □ Cluster meeting □ Learning area committee meeting □

district notices □ telephonic □ Workshops □ electronic □ No support at all □

12.7 How accessible is your advisor?

Theme 3: How effective is the process of consultation with respect to the managing of the Technology curriculum?

13. Have you attended any workshops, seminars, training, to empower yourself so as to enable you to cascade to educators the information on Technology as a learning area, and implement changes that are necessary in the Technology curriculum?

Yes □ No □

14. Are members of your schools SMT knowledgeable about the requirements for implementing the Technology curriculum? Yes □ No □

15. Are you able to manage the assessment process that is linked to Technology as a learning area? Yes □ No □

16. If you answered ‘no’ Please explain the assessment process used.

____
____
____

17. In what way does the democratic consultation process hinder the implementation of Technology within the National Curriculum Statement?

____
____
____
____

18. In what way does the democratic process promote the implementation of Technology within the National Curriculum Statement?

____
____
____
____

19. How is the implementation of Technology as a learning area in your school monitored and evaluated?

Please explain in detail.

____
____
____
____

20. Has any member of your management written a supervision report on your teaching?

Yes □ No □

21. If ‘yes’, is a copy of this report available in your file? Yes □ No □

<u>Theme 4: What are your perceptions with regard to Technology being included as a learning area within the curriculum?</u>

22. Are you satisfied with the level of in-service training needed to achieve successful implementation of Technology? Yes □ No □

23. In what way is the information that is received at curriculum development workshops shared with other educators so as to empower them with necessary skills and knowledge?

24.1 Do you believe that Technology is beneficial for the learners?

Yes □ No □

24.2 Please explain your responses in detail.

25. What effects has Technology had on other learning areas?
Please explain in detail.

26. Do you have technology learning area committee meetings at your school?

Yes □ No □

27. If no, how is planning done for technology.
Please explain.

<u>Theme 5: What strategies have been put in place by the school to dovetail Technology as a learning area into the National Curriculum Statement?</u>

28.Does your school have a Technology co-ordinator? Yes □ No □

29. Is teaching-time for Technology allocated according to provincial norms?

Yes □ No □

30. Does the school have a budget allocated for Technology? Yes □ No □

31. Has the school developed a learning area policy to improve the management and implementation of Technology? Yes □ No □

32. If yes, please explain in detail the nature of the policy.

33. Please list and discuss other strategies that your school has developed to ensure that Technology as a learning area is in line with the National Curriculum Statement.

____
____
____

Theme 6: Your preparedness to implement technology effectively

34. Do you feel comfortable/ confident with assessment being aligned with the curriculum? Yes □ No □

35. If you answered 'no' please state why.

____
____
____

36. Has the lack of in-service/ pre-service training and development impacted on the delivery of Technology? Yes □ No □

37. Has the lack of cognitive knowledge and skills impacted on the implementation of the curriculum? Yes □ No □

38. If you answered 'yes', please elaborate.

____
____
____
____

39. Are you able to write /develop your own work schedule and lesson plan? Yes □ No □

40. Do you use working models during your lesson presentations? Yes □ No □

42. Do you use charts to enhance your lesson during your presentations? Yes □ No □

43. Do learners write on typed exam papers? Yes □ No □

44. Do learners write the questions down from the board and then write down the answers on answer sheets? Yes □ No □

45. Do learners only write down the answers and read the questions written on the board? Yes □ No □

46. Are the learners given practical tasks to complete? Yes □ No □

47. Are these tasks completed at home, Yes□ No □ or school? Yes□ No □

48. In what area of cognitive and practical skills would you like to be assisted?

48.1 Graphic communication Yes ☐ No ☐

48.2 Processing Yes ☐ No ☐

48.3 Structures Yes ☐ No ☐

48.4 Mechanical systems and control Yes ☐ No ☐

48.5 Electrical system and control Yes ☐ No ☐

48.6 Lesson planning Yes ☐ No ☐

48.7 Developing work schedules Yes ☐ No ☐

49. What are your views on the current curriculum review process?

____

____

____

____

____

ANY OTHER COMMENTS:

____

____

____

____

Thank you for participating in this research.

ROY RAMBRIJ

SENIOR EDUCATION SPECIALIST- TECHNOLOGY

(ILEMBE DISTRICT)

INTERVIEW QUESTIONS

INTRODUCTION:

- Good morning/afternoon. Thank you for agreeing to participate in this interview. I have four questions that I would like you to respond to/answer to the best of your ability. As explained to you earlier on, the contents of this interview are confidential. Your rights and welfare are protected and I assure you that no harm will come to you as a result of your participation in this research.

- If you are uncertain, I will repeat the question. Please take your time.

Q1. What do you understand by Technology? Or how do you see Technology?

Q1.2 Can you explain a bit further? Who/what influenced the way you see Technology?

Q2. Are you able to incorporate the specific aims into your lesson plans?

Q3. Do you have the practical knowledge of the four content areas to be taught? Can you explain further how you cope with the sections you do not have the necessary practical experience and pre-knowledge?

Q4. In which sections do you feel you need support/assistance?

Q5 Do you have the necessary resources at school to implement Technology successfully? What are these resources/examples? Please explain how you manage without these resources and what plans your school has in place to obtain these resources.

Q6 Do you think that Technology as a subject can play a meaningful role in contributing towards the critical skills shortage in the country? Please explain a bit further.

PRE-TEST QUESTIONS

Q1 What do you understand by the purpose of Technology? Or how do you see the importance of Technology?

Q2. Do you have the necessary conceptual knowledge and theoretical skills to teach it? If your response is “no”, how do you manage to teach it given that 70% of the marks is allocated to the practical aspect?

POST-TEST QUESTIONS

Q1 What do you understand by the purpose of Technology? Or how do you see the importance of Technology?

Q2 Has the way you see “Technology” changed in any way since this workshop?

Q3 If so, in what way has it changed, and why?

Q4 Is there any change in the way you would teach it, and why?

APPENDIX D: RESULTS OF EMPIRICAL WORK

Appendix D contains the results of the survey, interview and pre/post-tests in that order. For ease of interpretation, the questions are included where relevant.

SURVEY RESULTS

1. General information

Table S1.1 Gender of respondent

S1.1:Gender of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	25	45.5	45.5	45.5
	Female	30	54.5	54.5	54.5
	Total	55	100.0	100.0	100

Table S1.1 reveals that more female participation took place in the survey than male. The gender figures of respondents in this project show that 45.5% are male and 54.5% female. It is evident that there has been an increase (9%) in the number of females teaching Technology.

Table S1.2 Age of respondents

S1.2: Age of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-24 yrs	4	7.3	7.3	7.3
	25-34 yrs	16	29.1	29.1	29.1
	35-44 yrs	23	41.8	41.8	41.8
	45-54 yrs	12	21.8	21.8	21.8
	Total	55	100.0	100.0	100.0

Table S1.2 reveals the age groups of respondents in this project: 7.3% are between 20-24 years, 29.1% are between 25-34 years, 41.8% are between 35-44 years and 21.8% are between 45-54 years. It is important to note that 70.9% of the educators teaching Technology can be retained in the teaching profession to provide the relevant skills if schools have a management plan in place.

Table S1.3.1 Educational qualifications

S1.3.1: Educational qualifications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		13	23.6	23.6	23.6
	BCom	1	1.8	1.8	25.5
	BED	2	3.6	3.6	29.1
	BPED	1	1.8	1.8	30.9
	BSc	1	1.8	1.8	32.7
	Degree	2	3.6	3.6	36.4
	Diploma	7	12.7	12.7	49.1
	FDE	1	1.8	1.8	50.9
	HDE	1	1.8	1.8	52.7
	JPTD	1	1.8	1.8	54.5
	M+3	3	5.5	5.5	60.0
	M+4	3	5.5	5.5	65.5
	M4	1	1.8	1.8	67.3
	Matric	9	16.4	16.4	83.6
	N6	1	1.8	1.8	85.5
	NTC3	1	1.8	1.8	87.3
	NTC6	1	1.8	1.8	89.1
	PGE	1	1.8	1.8	90.9
	PTD	1	1.8	1.8	92.7
	SDE	1	1.8	1.8	94.5
	SPED	1	1.8	1.8	96.4
	SPTD	1	1.8	1.8	98.2
	STD	1	1.8	1.8	98.2
	Total	55	100.0	100.0	100.0

Table S1.3.1 provides an overview of the variety of educational qualifications that the educators possess. It is important to note that 16.4% of the educators have only matric. The possible reason for this could be that, due to a shortage of qualified educators in the deep rural areas, students with matric had to be employed to fill the vacancies at schools.

Table S1.3.2 Under-qualified educators

S1.3.2: Are you an under-qualified educator?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	21.8	22.6	22.6
	No	41	74.5	77.4	77.4
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S1.3.2 reveals perceptions of respondents in this project about being under-qualified: 22.6% "yes", 77.4% "no", 3.6% no reply. The possible reason for the 3.6% not responding could be that they felt the question was probing a personal question which might have implications for their continued employment or promotion prospects.

Table S1.3.3 Possession of a four year teaching qualification

S1.3.3: Do you have a four year teaching qualification?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	50.9	57.1	57.1
	No	21	38.2	42.9	42.9
	Total	49	89.1	100.0	100.0
Missing	System	6	10.9		
Total		55	100.0		

Table S1.3.3 reveals that 57.1% responded "yes", 42.9 % "no", and 10.9% did not respond. A possible reason for such a high percentage of educators not having a four year teaching qualification could be that the schools are in a deep rural area and thus educators have a problem accessing higher education institutions to further their studies.

Table S1.3.4 indicates that 17.6% of the educators lacked teaching qualifications. This could have a negative impact on the implementation of Technology. It is important to note that while 82.4% of the respondents said that they were qualified educators, many of them might not have obtained specialist training..

Table S1.3.4 Unqualified educators

S1.3.4: Are you unqualified educator?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	16.4	17.6	17.6
	No	42	76.4	82.4	82.4
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

Table S1.3.5 indicates that 25.9% of the educators did not have professional teaching qualifications. Unqualified educators would lack a clear knowledge of teaching practice and methodology to teach and cascade information.

Table S1.3.5 Professional teaching qualifications

S1.3.5: Do you have any professional teaching qualifications?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	72.7	74.1	74.1
	No	14	25.5	25.9	25.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S1.3.6 indicates the frequencies and percentages of the respondents' academic qualifications. It is important to note that none of these qualifications is leaning towards a Technology qualification, which could lead to a negative implementation of that learning area.

Table S1.3.6 Academic Qualification/s

S1.3.6: Academic qualification/s

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		16	29.1	29.1	29.1
	BA	1	1.8	1.8	30.9
	Bcom	1	1.8	1.8	32.7
	BCom	1	1.8	1.8	34.5
	BEd	1	1.8	1.8	36.4
	BED	4	7.3	7.3	43.6
	BPED	3	5.5	5.5	49.1
	BSc	2	3.6	3.6	52.7
	Certificate	1	1.8	1.8	54.5
	Degree	1	1.8	1.8	56.4
	Diploma	9	16.4	16.4	72.7
	JPTD	1	1.8	1.8	74.5
	M+4	1	1.8	1.8	76.4
	M6	1	1.8	1.8	78.2
	N6	1	1.8	1.8	80.0
	NA	2	3.6	3.6	83.6
	No	1	1.8	1.8	85.5
	NPDE	2	3.6	3.6	89.1
	PTD	1	1.8	1.8	90.9
	PTD ABET	1	1.8	1.8	92.7
	SDE	1	1.8	1.8	94.5
	SPTD	1	1.8	1.8	96.4
	Undergraduate	2	3.6	3.6	98.3
	Total	55	100.0	100.0	100.0

Table S1.3.7 indicates the frequencies and percentages of the respondents' professional qualifications. It is important to note that the respondents had studied towards other subjects and learning areas, and upon entering the classroom situation, were required to teach a learning area that requires high levels of knowledge and skills. This could lead towards a negative implementation of the learning area.

Table S1.3.7 Professional qualification/s

S1.3.7: Professional qualification/s

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		15	27.3	27.3	27.3
	Abet	1	1.8	1.8	29.1
	ABET	1	1.8	1.8	30.9
	Accounting	2	3.6	3.6	34.5
	Ace	1	1.8	1.8	36.4
	ACE	3	5.5	5.5	41.8
	Bcom	1	1.8	1.8	43.6
	Diploma	4	7.3	7.3	50.9
	FDE	4	7.3	7.3	58.2
	HDE	5	9.1	9.1	67.3
	JPTD	1	1.8	1.8	69.1
	NA	1	1.8	1.8	70.9
	No	1	1.8	1.8	72.7
	NPDE	1	1.8	1.8	74.5
	NTC6	1	1.8	1.8	76.4
	PED	1	1.8	1.8	78.2
	PGCE	1	1.8	1.8	80.0
	PGE	1	1.8	1.8	81.8
	PTC	1	1.8	1.8	83.6
	PTD	1	1.8	1.8	85.5
	SDE	1	1.8	1.8	87.3
	SPED	1	1.8	1.8	89.1
	SPTD	2	3.6	3.6	92.7
	SSTD	1	1.8	1.8	94.5
	STD	1	1.8	1.8	96.4
	UPED	1	1.8	1.8	98.2
	Youth Development	1	1.8	1.8	98.2
	Total	55	100.0	100.0	100.0

Table S1.3.8 indicates that 13.7% of the respondents have obtained qualifications from a technical college and 86.3% have not. This could be advantageous to the schools that have employed the 13.7%, as Technology requires educators with high levels of skills and knowledge, and educators coming out of technical colleges do possess these skills.

Table S1.3.8 Technical college qualification

S1.3.8: Do you have a technical college qualification?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	12.7	13.7	13.7
	No	44	80.0	86.3	86.3
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

Table S1.3.9 indicates that less than 10% of the educators had qualifications that were offered by the Universities of Technology. If 90.2% did not have or receive specialized training, then this could pose a negative long-term implementation problem.

Table S1.3.9 Technology university qualification

S1.3.9: Do you have a Technology university qualification?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	9.1	9.8	9.8
	No	46	83.6	90.2	90.2
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

Table S1.3.10 Qualification leaning towards educator's learning area

S1.3.10: Is your qualification leaning towards your learning area?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	43.6	46.2	46.2
	No	28	50.9	53.8	53.8
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S1.3.10 indicates that 53.8% of the educators had qualifications that leaned towards other learning areas. The possible reason could be that they were teaching Technology as part of their teaching load, lacking the necessary qualifications.

Table S1.4.1 indicates that 63% of the educators had not attended professional development training, but it is important to note that 37% had attended.

Table S1.4.1 Training offered by Engen/Technology for all

S1.4.1: Have you attended any training offered by Engen/Technology for all?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	36.4	37.0	37.0
	No	34	61.8	63.0	63.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S1.4.2 indicates that more than 85% of the respondents did not belong to professional development groups. The possible reason for this could be that they did not view this as being necessary, considering that the majority taught Technology as a filler subject (i.e. filling up their timetable allocation).

Table S1.4.2 Membership of Technology association or forum

S1.4.2: Do you belong to a Technology association or forum?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	12.7	13.0	13.0
	No	47	85.5	87.0	87.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S1.4.2 indicates that more 70.9% of the respondents either did not think a Technology association/forum had impacted on their knowledge positively or did not respond to the question. The possible reason for this could be that they did not see it as being important to belong to an association or forum to develop themselves. However, 23.1% did respond positively as to the benefits of belonging to an association or forum.

Table S1.4.3 Impact of Technology association/forum on educator's knowledge

S1.4.3: If "yes", has this impacted on your knowledge positively?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	21.8	23.1	23.1
	No	6	10.9	11.5	34.6
	NA	34	61.8	65.4	65.4
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S1.5 Area of specialization

S1.5.1: Area of specialization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		14	25.5	25.5	25.5
	All learning area	1	1.8	1.8	27.3
	Biology & Technology	2	3.6	3.6	30.9
	Business Studies	1	1.8	1.8	32.7
	Commerce	1	1.8	1.8	34.5
	Edu management	1	1.8	1.8	36.4
	English	2	3.6	3.6	40.0
	Gen Maths	3	5.5	5.5	45.5
	Geography	1	1.8	1.8	47.3
	Life sciences	2	3.6	3.6	50.9
	Maths	2	3.6	3.6	54.5
	Maths & Bio	1	1.8	1.8	56.4
	Maths & Life sciences	2	3.6	3.6	60.0
	Maths & Tech	2	3.6	3.6	63.6
	Maths &Geo	1	1.8	1.8	65.5
	Maths &Tech	2	3.6	3.6	69.1
	Maths and Tech	1	1.8	1.8	70.9
	Maths& Art	1	1.8	1.8	72.7
	Natural science	1	1.8	1.8	74.5
	NS English	1	1.8	1.8	76.4
	Physical Education	1	1.8	1.8	78.2
	Physical Science	1	1.8	1.8	80.0
	Science	2	3.6	3.6	83.6
	Science & Tech	1	1.8	1.8	85.5
	Social Sciences	1	1.8	1.8	87.3
	Social Sciences & IsiZulu	2	3.6	3.6	90.9
	Technical	1	1.8	1.8	92.7
	Technology	4	7.3	7.3	92.8
	Total	55	100.0	100.0	

Table S1.5 indicates that only 22.3% of the educators were specialized to teach Technology. This is not a healthy situation, since these schools are all in a deep rural area. It also reveals that educators were moved around to teach as the needs arose without due consideration of excellence for teaching the subject, and need training to empower themselves.

Table S1.5.1 Phase specialization

S1.5.1: Phase specialization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Foundation	1	1.8	2.0	2.0
	Intermediate	25	45.5	49.0	49.0
	Senior	25	45.5	49.0	49.0
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

From Table S1.5.1, it can be seen that there was an even distribution of educators teaching in the intermediate and senior phase. The missing system of 7.3% educators could be unqualified educators in the system.

Table S1.6 Number of years appointed as educator

S1.6: Number of years appointed as educator

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5 yrs	22	40.0	40.0	40.0
	6-10 yrs	11	20.0	20.0	60.0
	11-15 yrs	11	20.0	20.0	80.0
	16-20 yrs	6	10.9	10.9	90.9
	21-30 yrs	5	9.1	9.1	100.0
	Total	55	100.0	100.0	

Table S1.6 indicates that 40% of the educators had been in service for a maximum period of five years, showing a relatively young workforce. If these educators were ultimately not properly orientated and mentored, then this could become problematic, as Technology is a learning area requiring high levels of knowledge and skills.

Table S1.7 Training pre-1994

S1.7: Have you been trained at a teachers' training college/university / technikon prior to 1994?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	41.8	42.6	42.6
	No	31	56.4	57.4	57.4
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

\

Table S1.7 shows that 57.4% of the educators received their training in post-apartheid South Africa. This would have a positive effect on curriculum delivery, as these respondents would have a vision of the expectations of the democratic government, thereby promoting quality education. It is noted that 42.6% of the respondents received their training under the old fragmented system, which could make them resistant to changes in the curriculum.

Table S1.8 Permanent staff member

S1.8: Are you on the permanent staff?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	70.9	72.2	72.2
	No	15	27.3	27.8	27.8
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S1.8 indicates that 72.2% of the respondents were on permanent staff. This indicates that there was a relatively stable workforce, with only 27.8% stating that they were not on permanent staff. The possible reasons could be that they were newly recruited into the system or lacked the necessary professional qualifications to be put on permanent staff.

Table S1.9 confirms the "no" results of Table S1.9 where the respondents presented a "no" response. It is important to note that while 30.8% responded "no", this can have a negative impact in the long term, especially when there is uncertainty around job prospects with respondents not guaranteed to give of their best.

Table S1.9 Temporary staff members

S1.9: Are you a temporary educator?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	29.1	30.2	30.2
	No	37	67.3	69.8	69.8
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

2. Information about the school

Table S2.1 School area

S2.1: The school is situated in

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Urban area	1	1.8	1.8	1.8
	Peri-urban area	2	3.6	3.6	5.5
	Rural area	37	67.3	67.3	67.3
	Deep rural	15	27.3	27.3	27.3
	Total	55	100.0	100.0	

Table S2.1 indicates that 94.6% of the respondents had stated that they were teaching in rural and deep rural schools. The small percentage (5.5%) could have misunderstood the question, and thereby responded incorrectly. Schools situated in these areas have great difficulty in attracting qualified and experienced educators because of the location, traveling distance and lack of resources.

Table S2.2 indicates that nearly 50% of the respondents travelled by public transport to and from school. Public transport to and from school is erratic and unreliable and this poses the possibilities of educators arriving at school late and at irregular times, which often affects the implementation of the learning area.

Table S2.2 Use of public transport to travel to/from school

S2.2: Do you use public transport to travel to and from school?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	43.6	45.3	45.3
	No	29	52.7	54.7	54.7
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S2.2 contains a number of respondents who had responded with a "yes" answer *and* a "no" answer. There is a possibility that the respondents did not read and understand the questions posed to them. The "yes" response should have been 54.7%.

Table S2.2 Use of private transport to travel to/from school

S2.3: Do you use private transport to travel to and back from school?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	43.6	45.3	45.3
	No	29	52.7	54.7	54.7
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S2.4 More than one mode of transport to travel to school

S2.4: Do you use more than one mode of transport to travel to school? e.g. taxi, train, bus

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.5	26.4	26.4
	No	39	70.9	73.6	73.6
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S2.4 indicates that 26.5% of the respondents used more than one mode of transport to travel to and from school. In a deep rural area this could pose a problem for successful implementation of teaching/learning, especially if the respondent misses a ride, or arrives late to access one mode of transport. Regular public transport is scarce in rural areas.

Table S2.5 Residence near school

S2.5: Do you live near the school?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	27.3	29.4	29.4
	No	36	65.5	70.6	70.6
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

Table S2.5 indicates that the majority of the respondents (70.6%) did not live near the school and therefore travelled large distances to their place of employment, while only 29.4% lived near the school.

Table S2.5 Boarding near school

S2.6: Do you board near the school?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	29.1	32.7	32.7
	No	33	60.0	67.3	67.3
	Total	49	89.1	100.0	100.0
Missing	System	6	10.9		
Total		55	100.0		

Table S2.5 indicates that only 32.7% of the respondents boarded near the school, while the majority 67.3% of the respondents travelled daily from their homes. The reason for 10.9% not responding could be that they did not want to disclose this information.

Table S2.7 indicates that 54.75% of the respondents travelled between 1 to 30 km, 22.7% travelled between 30 to 60 km and 22.6% travelled between 60 to 200 km to school in a single trip. The 22.6% of the respondents would spend a great deal of time traveling to and from school, leaving very little time for lesson preparation. This could result in the implementation of Technology being hampered, especially with a lack of adequate preparation and planning.

Table S2.7 Distance from domicile to school

S2.7: How many kilometers is your school from where you live?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-10 km	19	34.5	35.8	35.8
	11-20 km	8	14.5	15.1	50.9
	21-30 km	2	3.6	3.8	54.7
	31-40 km	7	12.7	13.2	67.9
	41-50 km	3	5.5	5.7	73.6
	51-60 km	2	3.6	3.8	77.4
	61-80 km	1	1.8	1.9	79.2
	81-100 km	5	9.1	9.4	88.7
	101 -200 km	6	10.9	11.3	90.2
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S2.8.1 indicates that the majority of the respondents' schools had electricity. This would contribute positively to the teaching and learning process, especially if electronic equipment and teaching aids were to be used. A cause for concern would be the small percentage (13%) that did not have electricity at schools. The possible reasons for this could be that the school had been vandalized and the cable stolen.

Table S2.8.1 Electricity

S2.8.1: Electricity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	85.5	87.0	87.0
	No	7	12.7	13.0	13.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.2 shows that the majority 57.4% of the respondents' school did not have piped water, while 42.6% did have it. The non-availability of piped water could have affected the quality of teaching and learning. The possible reasons for schools not having piped water could be due to the lack of infrastructure in the area. It is heartening to note that 42.6% did have piped water.

Table S2.8.2 Running/piped water

S2.8.2: Running/piped water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	41.8	42.6	42.6
	No	31	56.4	57.4	57.4
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.3 Telephone

S2.8.3: Telephone?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	58.2	59.3	59.3
	No	22	40.0	40.7	40.7
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.3 shows that 59.3% of the respondents' schools did have a fixed line telephone while 40.7% did not. The possible reason for not having a telephone could be due to a lack of infrastructure, cable theft or unpaid accounts. The lack of a fixed line has the potential to affect communication negatively.

Table S2.8.4 Internet

S2.8.4: Internet?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	12.7	13.2	13.2
	No	46	83.6	86.8	86.8
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S2.8.4 presents a poor picture of the status of the Internet at the respondents' schools. The majority (86.8%) of the respondents' school did not have this essential tool to access information to improve teaching and learning. It is a positive sign that 13.2% of the schools did have the Internet.

Table S2.8.5 School library

S2.8.5: Library?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	20.0	20.4	20.4
	No	43	78.2	79.6	79.6
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.5 provides a poor picture of the status of libraries in the respondents' schools. Only 20.4% of the schools had libraries, while the majority 79.6% did not. Technology is a new learning area which requires high level of skill and knowledge, the non-existence of libraries in schools poses a serious problem for effective implementation, as most educators and learners then lack access to learning materials.

Table S2.8.6 Computers for educators' use as part of their preparations

S2.8.6: Computers for educators to use as part of their preparations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	10.9	11.1	11.1
	No	48	87.3	88.9	88.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.6 provides a poor picture also of the status of computers in the respondents' schools. Only 11.1% of schools had computers to use as part of their preparations, while the majority 88.9% did not have access to computers for their daily preparations. The clear lack of access to computers for lesson planning posed a serious threat to the effective implementation of Technology.

Table S2.8.7 Photocopying machines/copiers in school

S2.8.7: Photocopying machines/copiers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	50	90.9	92.6	92.6
	No	4	7.3	7.4	7.4
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.8.7 shows that 92.6% of the respondents' schools did have photocopying machines and only 7.4% of the respondents' schools did not. Possible reasons could be that the machines had been stolen due to thefts or that the school did not have electricity.

Table S2.9 Educator access to photocopying machines/copiers

S2.9: Do you have access to the machines?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	61.8	65.4	65.4
	No	18	32.7	34.6	34.6
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S2.9 indicates that 65.4% of the respondents had access to photocopying machines/copiers while 34.6% indicated that they did not. The possible reason for them not having direct access to the machines could be for control and management purposes.

Table S2.10 shows that 48.1% of the respondents' schools had multi-grade classes. This poses its own challenges. Without proper training and on-going support educators would encounter problems with lesson delivery. The 51.9% of the respondents' schools that did not have multi-grades could have large learner enrolment, which allows for single grade teaching.

Table S2.10 Existence of multi-grade classes

S2.10: Does the school have multi-grade classes?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	26	47.3	48.1	48.1
	No	28	50.9	51.9	51.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.10.1 indicates that 46.2% of the respondents taught in multi-grade classes. This would include both Senior and FET phases. This is almost half of the total number of schools involved in the survey. The 5.5% of the respondents that did not respond to the question possibly did not want to provide a response. The 53.8% of the respondents' schools that did not have multi-grades could be teaching in schools with large learner enrolment, which allows for single grade teaching.

Table S2.10.1 Teaching Technology in multi-grade classes

S2.10.1: Do you teach Technology in any of the multi grade classes?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	43.6	46.2	46.2
	No	28	50.9	53.8	53.8
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S2.11 provides information regarding the number of educators who were qualified to teach Technology. 8.2% of the respondents' school did not have any qualified Technology educators, and 36.7% had only one such educator, while 18.2% of the schools had two educators who were qualified. 8.2% of the respondents' school had three educators who were qualified to teach Technology, 2% had four educators, and 2% had six educators who were qualified to teach Technology. The 10.9% of the respondents that did not supply a response could be newly appointed educators.

Table S2.11 Number of educators qualified to teach Technology

S2.11: Number of educators qualified to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	15	27.3	30.6	30.6
	1	18	32.7	36.7	67.3
	2	10	18.2	20.4	87.8
	3	4	7.3	8.2	95.9
	4	1	1.8	2.0	98.0
	6	1	1.8	2.0	99.0
	Total	49	89.1	100.0	100.0
Missing	System	6	10.9		
Total		55	100.0		

To give a clear picture of gender figures, the responses for question 2.12 are displayed separately in Tables 2.12.1 (for males) and 2.12.2 (for females).

Table S2.12.1 Number of male Technology educators

S2.12.1: Males: no of Technology educators

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	28	50.9	53.8	53.8
	1	18	32.7	34.6	88.5
	2	3	5.5	5.8	94.2
	3	2	3.6	3.8	98.1
	8	1	1.8	1.9	98.7
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S2.12.1 provides information regarding the number of male respondents teaching Technology: 53.8% of the respondents' schools had no males, 34.6% had one male, and 5.8% had two males. 3.8% of the respondents' schools had three males with, 1.9% having the highest number of males teaching Technology, eight. The high number of males teaching Technology in one school could possibly have been that Technology had been allocated to all the males in the school establishment.

Table S2.12.2 Number of female Technology educators

S2.12.2: Females: no of Technology education educators

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	30	54.5	57.7	57.7
	1	15	27.3	28.8	86.5
	2	3	5.5	5.8	92.3
	3	3	5.5	5.8	98.1
	6	1	1.8	1.9	98.6
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S2.12.2 provides information regarding the number of female respondents teaching Technology. 57.7% of the schools had no females, while 88.8% had one female teaching and 5.5% had two females teaching Technology. 5.8% of the respondents' schools had three females, with 1.9% having the highest number of females teaching Technology, six. The high number of females teaching Technology in one school could be due to the fact that Technology was either allocated to all the females in the school establishment, or that there were no males on the staff.

Table S2.13 State-employed educators

S2.13: Are you employed by the Department of Education?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	52	94.5	96.3	96.3
	No	2	3.6	3.7	3.7
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S2.13 indicates that the majority of the educators were employed by the state. This is a positive point as it provides stability in ensuring service delivery. A very small percentage (3.7%) were not employed by the Department. The possible reason for this could be that they were employed by the school governing body.

Table S2.14 indicates that half of all the respondents were not computer literate, which is not a positive sign, as it would affect teaching and learning, as the respondents would not be able to access information using ICT.

Table S2.14 Computer literacy of educators

S2.14: Are you computer literate?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	26	47.3	50.0	50.0
	No	26	47.3	50.0	50.0
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S2.15 indicates that the majority (82.7%) of the respondents' schools did not have a budget to support Technology, which is a resource-driven learning area. Tools and teaching aids including demonstration models are a must, especially in schools that are in rural and deep rural areas where resources are scarce.

Table S2.15 Budget for Technology

S2.15: Do you have a budget for Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	16.4	17.3	17.3
	No	43	78.2	82.7	82.7
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

3. Themes

3.1 Theme 1: Promoting and fostering the successful implementing of Technology as a learning area

Table S3.1 indicates that 83.3% of the respondents' schools had the necessary legislation and policies to support the implementation of Technology as the content is contained in the policy documents. The small percentage that responded that their schools did not have these documents (16.7%) could be new educators who had not be supplied with the documents by their management teams, as all schools were supplied with the necessary documents by the Department of Education and at cluster meetings and workshops.

Table S3.1 Legislation and policies

S3.1: Do you have the necessary legislation and policies pertaining to implementation of Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	81.8	83.3	83.3
	No	9	16.4	16.7	16.7
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Responses to question 3. In Theme 1 are displayed as two separate tables, S3.3.1 and S.3.3.2, to show the difference between responses for work schedules and lesson plans. Question S.3.4 was open ended, so responses are not included in the tables.

Table S3.3.1 Work schedules

S3.3.1: Work schedules?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	50	90.9	94.3	94.3
	No	3	5.5	5.7	5.7
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.3.1 indicates that the majority (94.3%) of the respondents had work schedules, while only 5.7% responded that they did not have work scheduled. These documents were handed to schools by district officials at cluster meetings, workshops and during school support visits. The possible reason for them not having these documents could be that the previous educator teaching

Technology did not hand them over when they changed schools or learning areas, or were transferred.

Table S3.3.2 indicates the majority (94.5%) of the respondents had lesson plans, while only 5.5% responded that they did not. These documents were handed to schools by district officials at cluster meetings, workshops and during school support visits. The possible reason for them not having these documents could be that the previous educator teaching Technology did not hand them over when they changed schools, learning areas or were transferred. Both lesson plans and work schedules were handed to schools and are contained in one document.

Table S3.3.2 Lesson plans

S3.3.2: Lesson plans?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	52	94.5	94.5	94.5
	No	3	5.5	5.5	5.5
	Total	55	100.0	100.0	100.0

Table S3.5 indicates that only 27.3% of the respondents' schools had a professional development programme to orientate and develop Technology educators, while the majority of the respondents (72.7%) did not have one in place. Professional development programmes are essential for the successful implementation of Technology as they provide a platform to support successful teaching and learning.

Table S3.5 Professional development programme

S3.5: Does your school have a continuous professional development programme to orientate & develop Technology educators?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	27.3	27.3	27.3
	No	40	72.7	72.7	72.7
	Total	55	100.0	100.0	100.0

Table S3.6 indicates that only 25.9% of the respondents' schools had a professional development programme formalized in a policy. The fact that 74.1%

said “no”, or did not respond, indicates either that school management teams lacked the capacity to formalize a programme or did not see it as being relevant. Policies are important, as they provide a guideline for successful implementation and provide a platform for collaboration.

Table S3.6 Formalised policy for professional development programmes

S3.6: If you answered ‘yes’, is this contained in a formalised policy?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.5	25.9	25.9
	No	13	23.6	24.1	50.0
	NA	27	49.1	50.0	50.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Question S.3.7 was open ended, so responses are not included in the tables.

Table S3.8.1 indicates that 72.7% of the respondents were able to teach this section, specific aim 2 and strand 2, while only 27.3% had a problem teaching this section. The possible reasons for this could be that the latter respondents were teaching it for the first time and therefore lacked the necessary knowledge and skill to teach it.

Table S3.8.1 Ability to teach processing: food, textile, paper, clay, chemical

S3.8.1: Processing: Food, textile , paper clay, chemical

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	72.7	72.7	72.7
	No	15	27.3	27.3	27.3
	Total	55	100.0	100.0	100.0

Table S3.8.2 indicates that 89.1% of the respondents were able to teach this section, specific aim 2 and strand 1, while 10.9% were not. This section requires the respondents to demonstrate high levels of knowledge and skills, and, if they are lacking in these skills, it will impact negatively on the transfer of knowledge and skills.

Table S3.8.2 Ability to teach structures and model making

S3.8.2: Structures and model making

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	89.1	89.1	89.1
	No	6	10.9	10.9	10.9
	Total	55	100.0	100.0	100.0

Table S3.8.3 Ability to teach mechanical systems: cams, gears, levers and pulleys

S3.8.3: Mechanical systems: cams, gears, levers and pulleys

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	56.4	56.4	56.4
	No	24	43.6	43.6	43.6
	Total	55	100.0	100.0	100.0

Table S3.8.3 indicates that 56.4.1% of the respondents were able to teach this section, specific aim 2 and strand 3. The fact that 43.6% were not able to this to teach this section is reason for concern. This section requires the respondents to demonstrate high levels of knowledge and skills. If they are lacking these skills, it will impact negatively on the transfer of knowledge and skills and result in poor learner attainment, especially in Grade 9, where these sections are tested externally.

Table S3.8.4 Ability to teach hydraulics and pneumatics

S3.8.4: Hydraulics and pneumatics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	32.7	32.7	32.7
	No	37	67.3	67.3	67.3
	Total	55	100.0	100.0	100.0

Table S3.8.4 indicates that 32.7% of the respondents were able to teach this section, specific aim 2 and strand 3, while the majority, 67.3%, were not. This gives reason for concern, for the same reasons given in S3.8.3 above.

Table S3.8.5 Ability to teach electrical system and control, logic gates and circuit diagrams

S3.8.5: Electrical system and control, logic gates, circuit diagrams

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	56.4	56.4	56.4
	No	24	43.6	43.6	43.6
	Total	55	100.0	100.0	100.0

Table S3.8.5 indicates that 56.4% of the respondents were able to teach this section specific aim 2 and strand 3, while 43.6% were not. This, once more, is reason for concern, for the same reasons given in S3.8.3 and S 3.8.4.

Table S3.8.6A Attending workshops

S3.8.6A: Attending workshops

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	56.4	57.4	57.4
	No	23	41.8	42.6	42.6
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.8.6A indicates that 57.4% of the respondents had empowered themselves by attending workshops, while 42.6% had not. The possible reason for non-attendance could be that they were teaching Technology as a filler subject, and thus saw no reason to attend workshops to develop their knowledge and skills further.

Table S3.8.6B In-service training

S3.8.6B: In-service training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	23.6	24.1	24.1
	No	41	74.5	75.9	75.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.8.6B indicates that only 24.1% of the respondents had attended in-service training, while the majority 75.9 had not. The possible reason could be that the Department of Education and the district did not train the educators owing to budgetary constraints.

Table S3.8.6C Self-taught educators

S3.8.6C: Self taught

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	61.8	61.8	61.8
	No	21	38.2	38.2	38.2
	Total	55	100.0	100.0	100.0

Table S3.8.6C indicates that the majority of the respondents, 61.8% were self-taught in the area of Technology. This gives reason for concern. Technology is a learning area requiring the respondents to have specialized knowledge and skills, and in the absence of these, specialist service delivery will be hampered.

Table S3.8.6D indicates that only 25.5% of the respondents had specialized in teaching Technology. The possible reasons for 74.5% of the respondents not having specialized to teach Technology could be the following:

- Technology is being used as a filler to make up their work load, and/or
- since Technology is a relatively new subject, this was not offered as a specialized module.

The high percentage of non-specialist Technology educators would impact negatively on learners choosing Technology based courses at FET level, as they would not be exposed to all the relevant knowledge and skill required for these courses.

Table S3.8.6D Specialised to teach Technology

S3.8.6D: Specialised to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.5	25.5	25.5
	No	41	74.5	74.5	74.5
	Total	55	100.0	100.0	100.0

3.2 Theme 2: Problems experienced by educators in the implementation of Technology as a learning area

Table S3.9 Subject head responsible for Technology

S3.9: Does your school have a subject head that is responsible for Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.5	25.5	25.5
	No	41	74.5	74.5	74.5
	Total	55	100.0	100.0	100.0

Table S3.9 indicates that only 25.5% of the respondents had a subject head responsible for Technology. The possible reasons for 74.5% of the respondents not having a subject head could be that, in the primary schools, the HoDs are appointed as phase HoDs, and not subject heads. The lack of monitoring and support of the teachers' work would result in challenges in obtaining teaching and learning resources such as Technology kits, computers and learners' text books.

Table S3.10 Specialist Technology educator

S3.10: Does the school have a specialist Technology educator?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	29.1	29.1	29.1
	No	39	70.9	70.9	70.9
	Total	55	100.0	100.0	100.0

Table S3.10 indicates that only 29.1% of the respondents' schools had a specialist Technology educator, while the majority 70.9% did not. The possible reasons could be that these educators were new in the system and still studying towards specializing, and others were using it as a filler subject. Educators lacking the key conceptual knowledge and skills would impact negatively on the quality of assessment, considering that seventy percent of the assessment marks come from the Mini-PAT, as certain sections would not be taught.

Table S3.11 indicates that 18.2% of the respondents had been affected by re-deployment. That 81.8% of the respondents had not been affected by re-deployment, indicates that most schools in the area of research had relatively stable staff establishments.

Table S3.11 Impact of re-deployment of educators on the implementation of Technology

S3.11: Has the re-deployment of educators impacted on the implementation of Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	18.2	18.2	18.2
	No	45	81.8	81.8	81.8
	Total	55	100.0	100.0	100.0

Question S3.11.1 is open ended, so responses are not included in the tables. Questions S.12.1-4 are also ended, and responses are not included here.

Table S3.12.5 Technology subject advisor

S3.12.5: Do you have a subject advisor for Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	69.1	69.1	69.1
	No	17	30.9	30.9	30.9
	Total	55	100.0	100.0	100.0

Table S3.12.5 indicates that 69.1% had responded as having a subject advisor, while 30.9% responded negatively. The possible reason for this could be that they did not read the question properly or that they felt that the question was intrusive, and that responses might be forwarded to their subject advisor, in spite of assurances of confidentiality.

Table S3.12.6 indicates that 81.2% of the respondents had responded as having received some sort of support from the subject advisor. The small number of respondents that had responded in the negative could have not read and understood the requirements of question correctly, as all the respondents were supported at cluster meetings where the questionnaire was presented.

Table S3.12.6 Type of support offered by the advisor

S3.12.6: What kind of support was offered by the advisor?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	School visit	8	14.5	15.1	15.1
	Cluster meeting	14	25.5	26.4	41.5
	Learning are committee	1	1.8	1.9	43.4
	District notices	3	5.5	5.7	49.1
	Workshops	17	30.9	32.1	81.1
	No Support at all	6	10.9	11.3	92.5
	NA	4	7.3	7.5	96.5
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

3.3 Theme 3: How effective is the process of consultation with respect to the managing of the Technology curriculum?

Table S3.13 indicates that 61.1% of the respondents had made attempts to attend workshops, seminars and training to develop their knowledge and skill to improve teaching and learning. The possible reason for 38.9% not attending could be because of the venue being too far away, a lack of funds to attend or that they saw it as having no relevance for them. Educators are expected to be lifelong learners and are expected to keep up with and embrace the changes taking place in their subject areas.

Table S3.13 Attendance at workshops, seminars and/or training

S3.13: Have you attended any workshops, seminars, training?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	33	60.0	61.1	61.1
	No	21	38.2	38.9	38.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.14 School SMT's knowledge of the requirements for Technology

S3.14: Are members of your school's SMT knowledgeable about the requirements for Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	58.2	58.2	58.2
	No	23	41.8	41.8	41.8
	Total	55	100.0	100.0	100.0

Table S3.14 indicates that 58.2.1% of the respondents' school SMTs had knowledge of the requirements for Technology while 41.8% did not. This would have the potential to impact negatively on the implementing of Technology, as it is a subject that is practical and therefore dependent on resources such as portable hand tools, Technology kits and computers.

Table S3.15 Ability to manage the Technology assessment process

S3.15: Are you able to manage the assessment process that is linked to Technology as a learning area?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	69.1	69.1	69.1
	No	17	30.9	30.9	30.9
	Total	55	100.0	100.0	100.0

Table S3.15 indicates that 69.1% of the respondents were able to manage the assessment process, while 30.9% of the respondents needed support. Assessment forms the backbone of teaching and learning, and that such a high percentage of educators were not able to manage the assessment process is cause for concern.

Questions S3.16-19 are open ended, so responses are not included in the tables.

Table S3.20 indicates that 53.8% of the respondents had supervision reports done to monitor their teaching and learning process. It is noted that 46.2% of the respondents had not had supervision reports done on them. This can be problematic, as the supervision reports serve as a monitoring tool to support teaching and learning.

Table S3.20 Supervision reports by school management

S3.20: Has any member of your management written a supervision report on your teaching?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	50.9	53.8	53.8
	No	24	43.6	46.2	46.2
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S3.21 indicates that 39.2% of the respondents had supervision reports in their files as part of their monitoring while 29.4%of the respondents said that no copies were on record. It is important to note that 31.4% of the respondents did not respond. In effect, then, 60.8% of the respondents were not monitored, as there is no evidence of supervision. This could have impacted on the implementation of the curriculum.

Table S3.21 Record of supervision reports on file

S3.21: If “yes”, is a copy of this report available in your file?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	36.4	39.2	39.2
	No	15	27.3	29.4	68.6
	NA	16	29.1	31.4	31.4
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

3.4 Theme 4: What are your perceptions with regard to Technology being included as a learning area within the curriculum?

Table 3.22 indicates that the majority of the respondents 55.8% were not satisfied with the level of in-service training. The possible reasons for this could be that the DoE does not have in-service training to develop educators over an extended period exceeding one day. The 44.2% of the respondents who have responded that they are satisfied could have had sufficient pre-knowledge to teach successfully and therefore regarded the one-day training as being sufficient.

Table 3.22 Educators' satisfaction with level of in-service training for Technology

S3.22: Are you satisfied with the level of in-service training needed to achieve successful implementation of Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	41.8	44.2	44.2
	No	29	52.7	55.8	55.8
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S3.24.1 Whether Technology is beneficial for learners

S3.24.1: Do you believe that Technology is beneficial for the learners?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	52	94.5	94.5	94.5
	No	3	5.5	5.5	5.5
	Total	55	100.0	100.0	100.0

Table S3.24.1 indicates that 94.5% of the respondents believed that Technology is beneficial for the learners. Only 5.5% of the respondents believed that Technology is not beneficial for the learners. The possible reason for this response could be that these respondents were teaching Technology for the first time, were unqualified and therefore unaware of the benefits of Technology. Question S3.25 is open ended, and responses are not included in the tables.

Table S3.26 indicates that 31.5% of the respondents had learning area/subject committee meetings at school while the majority 68.5% of the respondents did not. Learning area committee meeting are an essential part of whole school planning. It allows educators to plant their activities around the resources available at school, including the use of specialist rooms, tool and equipment and the drawing up of budgets. Other important aspects that would also be discussed are the relevant forms and of assessment. It is alarming to note that in the majority of the schools this did not happen, which could have resulted in the quality of teaching and learning being affected. Question S3.27 is open ended, so responses are not included in the tables.

Table S3.26 Technology learning area/subject committee meetings

S3.26: Do you have Technology learning area/subject committee meetings at your school?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	30.9	31.5	31.5
	No	37	67.3	68.5	68.5
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

3.5 Theme 5: What strategies have been put in place by the school to dovetail Technology as a learning area into the National Curriculum Statement?

Table S3.28 indicates that only 18.2% of the respondents' schools had a coordinator for Technology. The majority (81.8%) of the schools did not have a coordinator for Technology. In the absence of a Technology HoD, subject coordinators play an essential role in planning for the successful implementation of Technology at schools. They ensure that regular meetings are held, resources are shared and notices for meeting/workshops are circulated.

Table S3.28 School Technology co-ordinator

S3.28: Does your school have a Technology co-ordinator?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	18.2	18.2	18.2
	No	45	81.8	81.8	81.8
	Total	55	100.0	100.0	100.0

It is important to note from Table S3.29 that 87% of the respondents were allocated the correct teaching time for Technology. Only 13% of the respondents stated that they were not allocated the correct time. The possible reasons for this could be that times that are taken away from Technology are often allocated to computers.

Table S3.29 Teaching-time allocated to Technology

S3.29: Is teaching-time for Technology allocated according to provincial norm?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	85.5	87.0	87.0
	No	7	12.7	13.0	13.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.30 indicates that only 20.4% of the respondents' schools allocated a budget for Technology. The majority of the respondents' schools (79.6%) did not. Technology is a learning area dependent on a variety of resources for teaching and learning, especially in rural and deep rural areas where there are high levels of unemployment, and parents unable to pay school fees. This would definitely have impacted negatively on successful implementation.

Table S3.30 Budget allocation for Technology

S3.30: Does the school have a budget allocated for Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	20.0	20.4	20.4
	No	43	78.2	79.6	79.6
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.31 indicates that 23.5% of the respondents' schools had developed a learning area policy to improve the management of Technology. While this is a small percentage, it is important to note that it would contribute to the successful implementation of Technology. The fact that 76.5% that did not have these policies at their schools could be as a result of a lack of capacity in the school management teams to develop one, or that they saw it as being unimportant. Questions S3.32 -33 are open ended, so that responses are not included in the tables.

Table S3.31 Learning area policy

S3.31: Has the school developed a learning area policy to improve the management of Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	21.8	23.5	23.5
	No	39	70.9	76.5	76.5
	Total	51	92.7	100.0	100.0
Missing	System	4	7.3		
Total		55	100.0		

3.6 Theme 6: Your preparedness to implement technology effectively

Table S3.34 indicates that 75.9% of the respondents felt confident with assessment being aligned to the curriculum. This is a very important factor in the implementation of Technology, especially as it is activity based. The fact that 24.1% of the respondents that were not confident with assessment could be as a result of their being new educators and unqualified, lacking the necessary knowledge and skills to conduct assessment. Question S3.35 is open ended, so responses are not included in the tables.

Table S3.34 Alignment of assessment with curriculum

S3.34: Do you feel comfortable/confident with assessment being aligned with the curriculum?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	74.5	75.9	75.9
	No	13	23.6	24.1	24.1
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.36 indicates that 73.6% of the respondents believed that the lack of in service/pre service training had impacted on the delivery of Technology. Only 26.4% of the respondents believed that it had not. The possible reason could be that these respondents attended workshops and conferences conducted by NGOs.

Table S3.36 Impact of lack of training on delivery

S3.36: Has the lack of in–service/pre-service training and development impacted on the delivery of Technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	70.9	73.6	73.6
	No	14	25.5	26.4	26.4
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.37 indicates that 45.3% of the respondents believed that the lack of cognitive knowledge and skill had impacted on the positive implementation of the curriculum. This is a high percentage of respondents needing support. It is noted that 54.7% of the respondents believed that the lack of cognitive knowledge and skills did not impact on the implementation of the curriculum. The possible reasons could be that they have obtained the necessary cognitive knowledge and skills by attending workshops and conferences and through tertiary qualifications. Question S3.38 is open ended, so responses are not included in the tables.

Table S3.37 Impact of lack of cognitive knowledge and skills on implementation

S3.37: Has the lack of cognitive knowledge and skills impacted on the implementation of the curriculum?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	43.6	45.3	45.3
	No	29	52.7	54.7	54.7
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.39 indicates that 84.9% of the respondents were able to write /develop their own work schedules and lesson plans. The 15.1% of the respondents who responded with a "no" would need to have these skills developed. The possible reason for the deficit could be that they were new to the learning area and were teaching it for the first time. It must be noted that the district office has supplied all school with sample copies of work schedules and lesson plans for educators to use as part of their teaching resource pack.

sTable S3.39 Ability to write/develop work schedule and lesson plan

S3.39: Are you able to write/develop your own work schedule and lesson plan?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	81.8	84.9	84.9
	No	8	14.5	15.1	15.1
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.40 indicates that 69.2% of the respondents used working models as part of their lesson presentations to support teaching and learning. It is noted that 30.8% of the respondents did not use working models. This would impact negatively on the implementation, as learners would have to visualize how certain aspects in Technology work, and this would be highly problematic for learners who experience barriers to learning.

Table S3.40 Use of working models during lesson presentations

S3.40: Do you use working models during your lesson presentations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	65.5	69.2	69.2
	No	16	29.1	30.8	30.8
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S3.42 indicates that 82.7% of the respondents used charts to enhance their lesson presentations. This is a very positive result as learners in the rural and deep rural areas are unable to access libraries and other forms of media to extract information. The charts assist in supporting verbal explanations of how the various processes work/operate. The 17.3% that did not use charts probably did not see the benefits of using teaching aids to improve classroom practice. This can have a very negative impact on teaching and learning.

Table S3.42 Use of charts to enhance lessons

S3.42 Do you use charts to enhance your lesson during your presentations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	78.2	82.7	82.7
	No	9	16.4	17.3	17.3
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S3.43 indicates that only 50% of the learners at the respondents' school wrote on typed exam papers while the other 50% of the learners did not. Writing on typed exam papers assists in preparing learners to participate in national annual assessments and provincial end of year assessment tasks. This could impact negatively on the learning process as learners would spend excessive time reading questions written on the board.

Table S3.43 Learners write on typed exam papers

S3.43: Do learners write on typed exam papers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	49.1	50.0	50.0
	No	27	49.1	50.0	50.0
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.44 Learners transcribe board questions and write answers

S3.44 Do learners write the questions down from the board and then write down the answers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	25	45.5	47.2	47.2
	No	28	50.9	52.8	52.8
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.44 indicates that 47.2% of the learners at the respondents' school wrote down the questions from the board while the 52.8% of the learners did not. The majority of the respondents had reported that they had photocopying machines at their schools. This Technology should be used to improve the quality of teaching and learning. The possible reason for nearly 50% of the learners having to write down questions from the board could be that educators were not computer literate enough to prepare typed exam papers.

Table S3.45 Learners read board questions and write answers

S3.45: Do learners only write down the answers and read the questions written on the board?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	26	47.3	48.1	48.1
	No	28	50.9	51.9	51.9
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.45 indicates that 48.1% of the learners at the respondents' school had to read the question written on the board and then write down the answers. This is not a positive situation as the legibility of the hand writing could be a barrier to the learners' understanding the question correctly, and it could be time consuming for the educator to write and draw diagrams in a short space of time. It has the potential to affect successful teaching and learning if the writing of exams is not standardized.

Table S3.46 Practical tasks performed by learners

S3.46: Are the learners given practical tasks to complete?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	89.1	90.7	90.7
	No	5	9.1	9.3	9.3
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.46 indicates that 90.7% of the learners at the respondents' schools were practical tasks to complete. It is noted that 9.3% of the learners were not. The possible reasons for this could be that educators were not equipped to demonstrate the skills necessary for the practical tasks, and that there was a shortage of the necessary resources.

Table S3.47.1 Practical tasks completed at home

S3.47.1: Tasks completed at home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	70.9	73.6	73.6
	No	14	25.5	26.4	26.4
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.47.1 indicates that 73.6% of the learners at the respondents' school completed the practical task at home. Only 26.4% of the learners at the respondents' school did not. It is noted, that with such a high percentage of learners completing the practical tasks at home, fair assessment is not possible. Learners are supposed to demonstrate the skills and knowledge in the presence of the educator, who will then assess them accordingly using a recording tool called a rubric. The possible reason for learners not completing the practical task in school could be as a result of learners not collecting the resources for the practical task on due date, and that educators themselves lacked the necessary resources, skills and knowledge to demonstrate the activities to the learners. This would impact negatively on the implementation of Technology, as Technology is a skill-based learning area.

Table S3.47.2 Practical tasks completed at school

S3.47.2: Tasks completed at school

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	74.5	75.9	75.9
	No	13	23.6	24.1	24.1
	Total	54	98.2	100.0	100.0
Missing	System	1	1.8		
Total		55	100.0		

Table S3.47.2 indicate that 75.9% % of the learners at the respondents' schools complete the practical task at school. Only 24.1% of the learners at the respondents' school do not. The fact that these figures do not correspond exactly with the figures in Table S3.47.1 can be explained by the missing responses in both tables.

Table S3.48.1 Assistance needed with graphic communication

S3.48.1: Graphic communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	78.2	81.1	81.1
	No	10	18.2	18.9	18.9
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.48.1 indicates that 81.1% of the respondents needed assistance with graphic communication and only 18.9% did not require assistance. The high percentage of respondents requiring assistance would ultimately have affected learner performance. Graphic communication is included as part of the design process, and learners would have to sketch and draw different views of the Mini-PAT. One of the reasons for this could be that unqualified educators not having the necessary skills and knowledge to teach graphic communication were given Technology to teach.

Table S3.48.2 Assistance needed with processing

S3.48.2: Processing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	56.4	66.0	66.0
	No	16	29.1	34.0	34.0
	Total	47	85.5	100.0	100.0
Missing	System	8	14.5		
Total		55	100.0		

Table S3.48.2 indicates that 66% of the respondents needed assistance with processing, and only 34% of the respondents seemed confident to teach processing. Processing is one of the simpler areas of knowledge to teach. The high percentage of respondents requiring assistance would ultimately have affected learner performance. One of the reasons for this could be that unqualified educators not having the necessary skills and knowledge to teach processing were given Technology to teach.

Table S3.48.3 Assistance needed with structures

S3.48.3: Structures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	49.1	57.4	57.4
	No	20	36.4	42.6	42.6
	Total	47	85.5	100.0	100.0
Missing	System	8	14.5		
Total		55	100.0		

Table S3.48.3 indicates that 57.4% of the respondents needed assistance with processing and only 42.6% of the respondents seemed confident to teach structures. The high percentage of respondents requiring assistance also means that the respondents would experience problems integrating Technology with other learning areas, as aspects such as measurement, angles and pricing of materials are linked to maths. EMS would ultimately affect learner performance, as learners would not be able to link common aspects of maths and Technology.

Table S3.48.4 Assistance needed with mechanical systems and control

S3.48.4: Mechanical systems and control

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	78.2	82.7	82.7
	No	9	16.4	17.3	17.3
	Total	52	94.5	100.0	100.0
Missing	System	3	5.5		
Total		55	100.0		

Table S3.48.4 indicates that 82.7% of the respondents needed assistance with skills to teach mechanical systems and control and only 17.3% of the respondents seemed confident to teach it. The high percentage of respondents requiring assistance also means that the respondents would experience problems demonstrating the necessary skills and knowledge to learners for them to complete their practical activities, thus denying the learners the opportunity to empower themselves and perform well in provincial examinations.

Table S3.48.5 Assistance needed with electrical systems and control

S3.48.5: Electrical systems and control

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	74.5	77.4	77.4
	No	12	21.8	22.6	22.6
	Total	53	96.4	100.0	100.0
Missing	System	2	3.6		
Total		55	100.0		

Table S3.48.5 indicates that 77.4% of the respondents needed assistance with skills to teach electrical systems and control and only 22.6% of the respondents seemed confident to teach it. Electrical systems and control requires the respondents to have high levels of skills and knowledge in order to capacitate the learners. The high percentage of respondents requiring assistance also means that the respondents would experience problems demonstrating the necessary skills and knowledge to learners for them to complete their practical activities, thus denying the learners the opportunity to empower themselves and perform well in provincial examinations.

Table S3.48.6 Assistance needed with lesson planning

S3.48.6: Lesson planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	35	63.6	72.9	72.9
	No	13	23.6	27.1	27.1
	Total	48	87.3	100.0	100.0
Missing	System	7	12.7		
Total		55	100.0		

Table S3.48.6 indicates that 72.9% of the respondents needed assistance with skills for lesson planning, while 27.1% were able to do lesson planning. Lesson planning requires that the respondents design activities using the necessary resources for teaching and learning at the level of the classroom. Respondents are also to list the forms of assessment and state the knowledge, skills and values that learners are to demonstrate.

Table S3.48.7 Assistance needed with developing work schedules

S3.48.7: Developing work schedules

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	65.5	73.5	73.5
	No	13	23.6	26.5	26.5
	Total	49	89.1	100.0	100.0
Missing	System	6	10.9		
Total		55	100.0		

Table S3.48.7 indicates that 73.5% of the respondents needed assistance with skills for developing work schedules, while 26.5% of the respondents were are able to develop work schedules. Work schedules are planning tools used to project what will be taught, how it will be assessed and what resources will be required to implement Technology at the school during the year. It is also a tool used to monitor the teaching and learning progress within the grade.

Question S3.49 is open ended and responses are not included in the tables.

INTERVIEW RESULTS

Q1. What do you understand by Technology? Or how do you see Technology?

Table Q1 Perception of Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	93.34	93.34	93.34
	No	1	6.66	6.66	6.66
Missing	System	0	0	0	0
Total		15	100	100	100

Table Q1 indicates that more than 93.34% of the respondents had a clear understanding of Technology and its importance in society. Only one (6.66%) of the respondents did not have an idea of Technology and if it was relevant in the school curriculum. This respondent did not have qualifications to teach Technology, and could view this as not being necessary, considering that it is being taught as a filler subject.

A qualitative analysis of responses to an "open ended" question was used to arrive at an understanding of how respondents understood or saw technology.

Responses were as follows:

- I see technology as everything around [us]. As I used to explain to the children in my classroom, everything that we see around us has gone through the technological process, it has undergone planning processes, designing processes and a testing process and as a result we have these things in front of us.
- Basically technology nowadays is more advanced, learners need to be well developed through technology. Basically in technical drawings technology must be involved, teach the learners how to draw.
- Using knowledge, skills and values. It is good for the learners and it develops learners.

- It is the subject that deals with equipping learners with knowledge on how to create solutions to problem. It gives learner information to make their lives easier.
- Technology is a way forward in the present situation everything hinges around technology.
- I see the combination of the knowledge, skills and resources that people can use to build things and can use as resourceful opportunities for them to prosper in life.
- It is important and develops our learners in an early stage.
- One of the things that helps us to make life easier.
- [It] is a modern way of doing things.
- It brings about dimension to learners who were disadvantaged before. It allows learners to do practicals and know exactly what they doing.
- [It] is a subject that help the learners to understand how to solve the problem. They must also know that if they are solving a problem, they must create something that is a need and a want.
- I don't understand anything about technology.

Q1.2 Can you explain a bit further? Who/what influenced the way you see Technology?

Table Q1.2 Influences on the way participants perceived Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	93.34	93.34	93.34
	No	1	6.66	6.66	6.66
Missing	System	0	0	0	0
Total		15	100	100	100

Table Q1.2 indicates that more than 93.34% of the respondents had been influenced by the changes taking place around them and also how technology/ICT was influencing the changes, so that they had a clear understanding of the technology and its importance in society. 6.66% of the respondents did not have an idea of Technology and if it was relevant in the school curriculum.

Responses were as follows:

- Well in the modern age when we think about technology we think of telephones, computer, and gadgets. I see technology in modern era as more technologically inclined as in being electronics and things that used to make our lives easier.
- Our lives revolve around technology so we can't do a thing without it. That why Government is also supporting some schools with facilities like laptops.
- As I teach sometimes I have to google and it helps you type.
- When I'm teaching in the class I turn to see things that I didn't know assisted in the modern world.
- With regards to that we are living in a technological literate society and some of the devices around us influences the way I see technology and in terms of a classroom content the way learners develop and construct various projects.
- Problem solving: it influences technology.
- Equipment that we have in schools and drawing and demonstrations.
- It teaching us about western things that we didn't know.
- It helps a lot since everything is based on technology. It useful and helps the learners to make their choice and solve problems.
- It is the way it is structured.
- Don't know anything about Technology
- As time goes on where [you] use tech the world will be easy. Small child [will] use it.

Q2. Are you able to incorporate the specific aims into your lesson plans?

Table Q2 Ability to incorporate the specific aims into lesson plan

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	53.33	53.33	53.33
	No	7	46.67	46.67	46.67
Missing	System	0	0	0	0
Total		15	100	100	100

From Table Q2, it is clear that only 53.33% of the respondents were able to incorporate the specific aims into the lesson plans, while 46.67% of the respondents were grappling to include these. This is not a healthy situation, as Technology as a subject contributes towards learners' technological literacy by giving them opportunities to develop and apply specific design skills to solve technological problems, understand the concepts and knowledge used in technology education, and use them responsibly and purposefully. They would also be learning to appreciate the interaction between peoples' values and attitudes, technology, society and the environment.

Q3. Do you have the practical knowledge of the four content areas to be taught during the year? Can you explain further how you cope with the sections you do not have the necessary practical experience and pre-knowledge?

Table Q3 Possession/lack of practical knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	53.33	53.33	53.33
	No	7	46.67	46.67	46.67
Missing	System	0	0	0	0
Total		15	100	100	100

From Table Q3, it is clear that only 53.33% of the respondents had the necessary knowledge to teach the four content areas, while 46.67% of the respondents did not have the necessary knowledge to teach the four content areas. Teachers of Technology are expected to have high levels of knowledge and skills so as to scaffold the specified concepts to the learners. These concepts are mechanical systems, electrical systems, structures and processing. This lack of practical knowledge impacts on the delivery of quality teaching and learning.

Responses to the question: “Do you have the practical knowledge of the four content areas to be taught during the year?” were as follows:

- I’m able to - well, when teaching the children technological skills we always have a project. During the teaching process of the project, all these technological skills I taught them: investigation (how they go about researching on the Internet using books, magazine and going to the library), the designing process (children involved in the designing process: I asked them to sketch out their ideas), the making process (children are all involved in the groups to make the project), evaluating process (test if the model works), and in communicating with every child and every group: [this] is communicating their findings in the form of a portfolio.
- I use the policy document as a supporting document and other resources like text books and charts so I can go to class well prepared.
- Designing skill, concepts and knowledge, values and skill, learners do activities in the class.
- I am not sure if I do it accordingly, technology was not my area of speciality; sometimes I learn as I prepare for the lesson.
- Yes, always try to incorporate all three.
- Yes, learners will make use of case studies, technological design processes and the various skills. We focus on different stances and the aims linked to different stances.
- I’m still struggling but will be ok as time goes on.
- Yes, I look at the aim and compare with topic. If you are an architect you must know how you will go about [designing] the house.
- Yes, in my lesson I used to tell them what was happening before and what is happening now.

- Yes, I tell them the aim of the technology to make their choices, be able to be creative and to be able to make things.
- Yes, sometimes I only collaborate only two.
- Don't have knowledge.
- Yes I do. Now I can see through your support.

Responses to the question: "Can you explain further how you cope with the sections you do not have the necessary practical experience and pre-knowledge?" were as follows:

- Yes, I do attend workshops to keep updated. I think my knowledge is relevant to communicate with Grade 7 that I teach. I do ask for help: my subject advisor helps a lot, and in cases when I'm stuck I use the Internet and research online, I ask other educators. I also attend workshops and seminars that are held by the department to keep updated.
- Yes, these are the tools that I'm using to make the learners to understand levers. Technology is a hands-on subject - that is why I always allow my learners to do practical work. Practical is basic foundation of the technology.
- No, I ask the learner to carry some of the things that can be used to demonstrate.
- Yes, I do have some knowledge in all of them. I do try to understand and explain to learners with my understanding.
- Yes, I've been teaching technology for four years now: for each I've been gaining insight into certain areas.
- As a new educator, I feel like I do have relevant knowledge to teach technology. I make use of the Internet and collaborate with other educators to give me more insight to the learning area.
- No, but I am trying. With that am failing to do well on I consult other educators for assistance.
- Yes, I don't have any problems in teaching technology.

- No, but I'm aware of those things. I only do what I know.
- Yes, design, structures, mechanism, electrical and processes. It is hard but I try by doing copies for the learners and go to the internet.
- Yes, it very difficult to [teach] those areas that I don't have enough information on.
- I don't have knowledge.
- I ask sister for assistance.
- Not exactly. First time teaching technology. The subject is easy if you are willing to learn.

Q4. In which sections do you feel you need support/assistance?

From Table Q4, it is clear that over half (53.33%) of the respondents needed support in mechanical systems, and a third (33.33%) of the respondents needed support in electrical systems. It is also noted that 13.33% needed support in all sections. The possible reasons for this could be that they were introduced to teaching Technology for the first time, and had not being exposed to its requirements. This would impact negatively on the implementation of Technology and deprive learners of quality teaching and learning. The fact that two content areas, structures and processing, were understood by 86.66% of the respondents provides some consolation, as the teachers did have some limited content knowledge.

Table Q4 Sections in which educators need support/assistance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mechanical	8	53.33	53.33	53.33
	Electrical	5	33.33	33.33	33.33
	Structures	0	0	0	0
	Processing	0	0	0	0
	All sections	2	13.33	13.33	13.33
Missing	System	0	0	0	0
Total		15	100	100	100

Responses were as follows:

- With the project I need more assistance.
- Levers and linkages.
- Electrical systems and controls.
- Mechanical systems and control
- Electrical systems.
- In terms of practical tasks, I feel the time allocation sometimes is time consuming for the learners to complete it in class, [as] they constantly have to link the knowledge to the practical. Electrical systems and practicals.
- Hydraulics and designs.
- Electrical systems because of the shortage of the resources.
- Drawings (measure sizes), Mini-PAT pat and electric systems.
- Hydraulics.
- Grade 7 electrical part.
- All sections.
- Teacher at school assists. We don't have a clue. Teacher develops [content].
- Mechanical systems.

Q5 Do you have the necessary resources at school to implement Technology successfully? What are these resources/examples? Please explain how you manage without these resources and what plans your school has in place to obtain these resources.

From Table Q4, it is clear that only 33.33% of the respondents had Technology kits/resources, while the vast majority of respondents did not have the necessary Technology kits/resources to implement Technology successfully. When asked to explain how they managed, they responded by stating that they improvised and asked the learners to bring resources from home. The CAPS Document clearly states that it is the responsibility of the school to provide all the requirements for Technology (South Africa. Department of Education 2011b:13).

Without these basic requirements, the teachers would not be able to scaffold the key concepts of the four content areas effectively. Essentially the teachers would not be able to demonstrate concepts without working models to the learners, the omission of which would impact negatively on the quality of teaching and learning.

Table Q4 Resources to implement Technology successfully

		Frequency	Percent	Valid Percent
Valid	Yes	5	33.33	33.33
	No	10	66.66	66.66
Missing	System	0	0	0
Total		15	100	100

Responses were as follows:

- I do have resources and technology kit that were supplied and we did buy item from our stock. The resources that we have, I do have electrical kit, mechanical instruments like gears, levers to teach them mechanics, we have batteries and wires.
- No, but I have technology kit. As a teacher we have to improvise. I used to make some models for them and allow them to draw.
- No, I don't have technology kit, it's hard to manage without enough resources.
- No, I just look at the area we are in and ask the learners to bring what we can use to create what needs to be created.
- Yes we do have a technological kit but we don't have a room for our practicals. I try to network with other teachers to give me what we don't have to teach the learners.
- Yes, we have the essentials but we don't have electrical appliances. I collaborate with other educators and bring my own resources.
- No, it's hard to work without them.
- No, I used to develop the chart to demonstrate.

- No, children don't have text books and I can't make copies for them. It's very difficult to manage without a kit.
- No, sometimes I use my money to buy resources. I spoke to the principal about the shortage of the resources.
- No, we don't have science kit. I borrow from other schools.
- Not sure of technology kit.
- Do have some but not all. No tech kit - school to order.

Q6 Do you think that Technology as a subject can play a meaningful role in contributing towards the critical skills shortage in the country? Please explain a bit further.

From Table Q6, it is clear that the majority of the respondents (93.3%) were positive about Technology playing a meaning role towards contributing to the critical skills shortage. Only one respondent responded negatively. The possible reason could be that this teacher was unqualified and lacked the necessary skill and conceptual knowledge to teach Technology. When asked to explain further, participants responded by stating that Technology plays a pivotal role in promoting the skill required to be an electrical, mechanical or civil engineer; it further contributes to job creation and to cope in a changing country.

Table Q6 Technology and critical skills shortage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	93.3	93.3	93.3
	No	1	6.7	6.7	6.7
Missing	System	0	0	0	0
Total		15	100	100	100

Responses were as follows:

- Yes, technology forms a basis of everything; in Technology you are taught basics skills. If you want to be an engineer (electrical, mechanical or civil engineer) the basis that we taught in Technology plays a vital role, it forms the foundation to all these skills.

- Yes, it also needs to be done even at tertiary level. We are running out of the learners with the skills.
- It can create jobs for learners.
- Yes, it is one of the subjects where learners learn to be practical, where they put their theory into practice. We need some support so we can teach them to be creative.
- Yes, looking at the way we are moving in the technological field, everything that we doing this days revolves around technology.
- Yes, because in Technology we are working with designing processes and other technological steps, training the learners to be critical thinkers and innovative thinkers.
- Yes, learners they need to use simple things so they can create useful things.
- Yes, as the world is changing, things are done electronically. Learners have to be developed technologically so they can cope in the changing country.
- Yes, if the child can understand technology [he/she] can become an engineer.
- Yes, without technology there will be no future.
- Yes, we don’t have enough engineers. The learners start science study late but if there are encouraged to start it when they are young they can be good engineers.
- I don’t know, not sure
- Yes I think so, if I observe everything will depend on technology. As time goes by learners will do away with paper and pen

PRE-TEST RESULTS

Q1 What do you understand by the purpose of Technology? Or how do you see the importance of Technology?

A qualitative analysis of responses to an "open ended" question was used to arrive at an understanding of what respondents saw as the purpose of the subject Technology, and how they saw the importance of Technology. All eighty-five respondents provided an explanation.

Responses were as follows:

- Technology is the use of knowledge skills, values and resources to meet people's needs.
- To equip the learners with technological practical and creativity skills that could be used to solve problems taking place in our communities.
- It is vitally important as learners are taught skills that they can use in many different career paths.
- Technology helps to produce people like engineers, technicians and artisans who help people with their daily needs.
- It is about improving our world and making it a better place to live in.
- It is showing the learners how technology changes the society. It also teaches them that technology varies from one generation to the other.

From the above responses, it is evident that the respondents have a basic understanding of Technology and its importance. This basic knowledge is important as the information gathered is used to plan further activities to develop the conceptual knowledge and skill of the teachers teaching Technology.

Q2. Do you have the necessary conceptual knowledge and theoretical skills to teach it? If your response is "no", how do you manage to teach it given that 70% of the marks is allocated to the practical aspect?

Table Pre Q2 Pre-workshop conceptual knowledge and theoretical skills to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	57.65	57.65	57.65
	No	36	42.35	42.35	42.35
Missing	System	0	0	0	0
Total		85	100	100	100

Table Q2 indicates that only 57.65% of the respondents had the necessary conceptual knowledge and theoretical skills to teach Technology. The results also indicate that 42.35% of the respondents did not have the necessary conceptual knowledge and theoretical skills. This must have impacted negatively on the implementation of Technology and might also have contributed to students not selecting technical subjects at Grades 10-12 level.

A qualitative analysis of responses to the open ended question was used to arrive at an understanding of how respondents managed to teach Technology without the necessary conceptual skill and knowledge.

Responses were as follows:

- No, I need to research and find more information and find out from subject advisors.
- We use the information from the text books and visit libraries to get knowledge before we do our practical task Mini-PAT.
- No, it will be the first year to teach it this year.
- No, but we try to use our policy document’s as our guide throughout the lesson
- No, I find difficulties in doing practical work myself but I use books and rubric to help me guide learners.
- No, I follow the information on the policy document and ATP.
- No, I ask other educators to assist in allocating marks.
- No, it’s my first time teaching Technology and I’m hoping to get more relevant and vital knowledge and teaching skills.

- No, I am a novice at the subject but I try by all means to equip myself through different learning materials and seek for assistant from senior educators.
- No, I have to because of the shortage of Technology educators in our school.
- Sometimes I face difficulties when I’m supposed to go deeper on teaching something more technically.
- No, I need to research and find more information and find out from subject advisors.
- We use the information from the text books and visit libraries to get knowledge before we do our practical task Mini-PAT.
- No, it will be the first year to teach it this year.
- No, but we try to use our policy documents as our guide throughout the lesson.

From the above responses, it is evident that the respondents were experiencing challenges in implementing Technology successfully in their classrooms owing to their not having the necessary conceptual knowledge and theoretical skills. Some of the reasons could be attributed to teachers teaching Technology as a filler subject for the first time and not being orientated, change in post provisioning norms at schools, drop in learner enrolment or transfer of Technology teacher. This often results in the Mini-PAT not being done by the learners.

POST-TEST RESULTS

Q1 What do you understand by the purpose of Technology? Or how do you see the importance of Technology?

A qualitative analysis of responses to the open ended question was used to arrive at an understanding of the purpose of Technology and how respondents saw the importance of Technology. All eighty-five respondents provided an explanation.

Responses were as follows:

- Its purpose is to improve our standard of living upgrading and developing our country with modernized and advanced knowledge of technical objects such as gadgets and buildings.
- To equip learners with various skills such as design skills, communication skills, critical thinking and innovative skills and problem solving skills.
- It introduces learners to the basic skills, knowledge and values they need in civil, mechanical, electrical and EGD in the FET phase.
- It has an impact on everyone's lives. It teaches us the skills for designing, making evaluating and communicating on ideas and models.
- To instil the basic knowledge and passion of different types of engineering career path.
- It stimulates learner to be innovative and develops their creative and critical thinking skills.
- It helps to produce engineers and artisans who works hard to solve problems and make products to satisfy peoples' needs and wants.
- It is how we can use available material/resources to solve our daily problems and meet our needs and wants however taking into consideration the environmental and societal effect.

From the above responses, it is evident that the respondents had a more detailed understanding of Technology and its importance after the workshop was conducted. Also, any possible misconceptions held by the respondents had to some extent been corrected.

Q2 Has the way you see "Technology" changed in any way since this workshop?

Table Post Q2 Post-workshop changes in the perception of Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	84	98.82	98.83	98.83
	No	1	1.176	1.17	1.17
Missing	System	0	0	0	0
Total		85	100	100	100

Table Post Q2 indicates that 98.83% of the respondent had benefitted from the workshop content. It is evident that through continuous professional development the goal of providing quality teaching and learning can be achieved. The fact that only one respondent said that s/he had not benefitted is not necessarily a reflection on the workshop, and this could have been one of the few educators who had understood Technology before the workshop.

A qualitative analysis of responses to the question was used to gain understanding of: "Has the way you see 'Technology' changed in any way since this workshop?"

Responses were as follows:

- Yes, it has changed tremendously.
- Yes, before I used to teach them theory to help them do practicals, but now I can be able to show them so they can understand more.
- Yes, the role of ICT is important in the teaching of Technology education.
- Yes, children are more likely to show interest in the lesson.
- Yes, Technology is vital in educating youth.
- Yes, it can be taught by the use of ICT.

- Yes, it changed a lot to me since I’ve lot of skills.
- Yes, was developed in various ways of this subject e.g. lesson plan, how to do a mini.
- Yes, I’ve come to realize that I need to make use of as many as visual resources as possible.
- Yes, I can now see that as for resources we not have to worry, we just need to use the available material.
- Yes, I can now differentiate between input and output processes and I am clear about lot of things.
- Yes, I have developed some new ideas and skills to solve some of the problems I had.
- Yes, importance of ICT emphasized.
- Yes, I have realized that even though our school faces challenges as a Technology educator we can still make it an existing subject and must strive to make it interactive.
- Yes, I have developed deeper appreciation for processes and have learned how to effectively demonstrate models.
- Yes, I am a new Technology teacher and fortunately now I understand my role as an educator.
- Yes, on how to work with learners in Technology classes and the material that you can use to make project.
- Yes, [previously] I was little bit confused about Mini-PAT for Jaws of Life. I’ve gained a lot from this workshop.
- Yes, Technology is everything around us and I see the importance of teaching the children properly, the skills they need to become engineer, etc.
- Yes, I understand pneumatics and hydraulics, how they work, output, process input.

- Yes, the various ways and methods where you can bring reality to the classroom.
- Yes, I enjoyed the practical aspect of the workshop as it promoted the understanding.
- Yes, I was lazy to create equipment to be utilized in the classroom as a demonstration but now I will be creative and be passionate about my work.
- Yes, it changed from unknown to known, there was some things I didn't understand but with this workshop I have even better understanding.
- Yes, I was unable to use the jaw of life tool and I was a little bit confused about the use of technology in other things.
- Yes, I didn't understand the importance of Technology in our learners' lives.
- Now I know what and how to teach Grade 7 class.
- Yes, I have realized that nothing is impossible to learn and understand.
- Yes, this makes our understanding more advanced than the previous knowledge
- Yes, I learned a lot from the workshop and I enjoy the subject.
- Yes, because now I know how to do demonstration, drawing, the ways of assessing the learners.
- Yes, it was hard for me to draw but after the workshop I can easily demonstrate through drawing.
- Yes, I actual thought it hard to do some practical work but now I've got clarity in most of the things.

From the above responses it is evident that the respondents had benefitted from the training workshop and would be able to scaffold their new-found knowledge and skills to the learners, thereby positively contributing to the quality of teaching and learning.

Q3 If so, in what way has it changed, and why?

A qualitative analysis of responses to the “open ended” question was used to arrive at a further understanding of what had changed and why.

Responses were as follows:

- I have seen that the problem I have of less resources is not an issue. I can use what I have to make learners understand.
- It has changed in a way that in Technology is more about hands on work more than written.
- I have a better understanding after attending this workshop.
- More clear understanding of how to teach Technology, how to handle LTSM, how to formulate works and how to fully involve learners all through your lessons.
- Focus should be on creative/innovative ways of using various resources for projects.
- It equips learners with necessary skills and knowledge to communicate on a global scale and create innovative design. More ICT.
- That the usage of ICT in classrooms will attract learners’ attention.
- We found that learners’ attention is greater when they are exposed to visual activities.
- Technology is something that is best understood practically.
- Reduce the time spent explaining verbally to learners and use more models and visual aids.
- It stressed the importance of training artisans for the S.A. Market, as we have a huge shortage of skilled labourers.
- It enabled and empowered me with skills and more tactics of how to teach my learners and make them more involved in any activity.
- Understand that practical work leads to better understanding. Promote active participation.
- I’ve come to realize that it is a very visual and practical subject.

- It has increased my level of understanding and confidence.
- I will now do more research for demonstration purposes, by always bringing models to class and have videos wherever necessary.
- I know now that I must be creative and innovative before I am going to class.
- It enlightened me with new ways of cascading information to learners.
- Teachers need to be proactive.
- Keep the subject interesting by utilizing models and other media.
- Developed in different areas on the subject.
- The ability to demonstrate certain processes has become better.
- I have also learned to plan effectively.
- I will teach with more clarity and more demonstration.
- I should teach learners to see Technology as a skill that they should have to make life easy.
- I've seen projects which are the product of the thing that we all have, e.g. cardboard.
- It is not about teaching theory we as educators need to show demonstration, videos etc. in order for learner to fully understand the concept.
- Yes, I know what exactly I'm going do with my learners.
- It has changed my own teaching style into multiple possibilities to ensure learners have understood all concepts and aspects of the lesson.
- I understand many things now, how pneumatics and hydraulics works, how to make a model and how to distribute the marks on Mini-PAT
- The explanation and demonstration with videos has made it easier for me to understand the various concepts.
- Acknowledgement from various text books and videos clips made the lesson more meaningful and understanding.

- I have been empowered to teach the subject better.
- Now we can incorporate ICT within our Technology lesson so that learners come out with a better understanding.
- Teach and show for better understanding and better knowledge.
- I've gained more understanding of the subject and the ways to teach learners.

From the above responses it is evident that the respondents were more knowledgeable, confident and empowered with the relevant skills to implement Technology, and, most importantly, had gained new knowledge in keeping with the goals of lifelong learning.

Q4 Is there any change in the way you would teach it, and why?

Table Post Q4 Post-workshop changes in proposed Technology pedagogy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	100	100	100
	No	0	0	0	0
Missing	System	0	0	0	0
Total		85	100	100	100

Table Post Q4 indicates that all 100% of the respondent had responded positively towards the idea of making changes in the way they would teach Technology. It is important to note that the quality of the workshop had contributed to the respondents becoming motivated to make changes it the way they would teach it.

A qualitative analysis of responses to the question was used to arrive at an understanding of why they would make changes in the teaching approach.

The responses were as follows:

- Use more models when explaining concepts.

- Use more ICT in lessons.
- Include more videos as these are more informative and helpful in teaching learners about how Technology works.
- I am going to be more practical and make sure that I bring models to the class and use the Internet and videos.
- This time I will not just refer to notes but also demonstrate and engage learners in a lesson.
- Now I am clear about things that used to give me problems.
- I changed my way of teaching because now I know methods of teaching Technology.
- I can use my cell phone in the classroom to demonstrate, use waste materials, team work so that they can be 21st century learners.

From the above responses, it is evident that after the workshop, the respondents were motivated and excited to embrace the changes they foresaw in their teaching styles. This is a positive step towards improving the quality of teaching, given the fact that 42.35% of the respondents did not have the necessary conceptual knowledge and theoretical skills to teach Technology prior to the training workshop taking place.

Table Pre Q2, from the pre-test Q2, supports the above statement:

Table Pre Q2 Pre-workshop conceptual knowledge and theoretical skills to teach Technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	57.65	57.65	57.65
	No	36	42.35	42.35	42.35
Missing	System	0	0	0	0
Total		85	100	100	100

APPENDIX E: CELEBRATING LEARNER ACHIEVEMENT

Appendix E celebrates learner achievement by showing some of the award-winners from the Ilembe district at the *Eskom EXPO for Young Scientists - International Science Fair*, 4-5 October 2017.

GRADE 7
CATEGORY: ENGINEERING AND INNOVATION.
JAWS OF LIFE

The Jaws of Life artefact displayed in Figure E1 was made using recycled materials, and only the jig-saw blades and syringes were purchased. Two models were made, including a prototype. The student used the Internet and visited the fire station to gather first-hand knowledge on how the Jaws of Life operate. The evidence was presented using a portfolio and charts. The learner, who attends a rural school, received the judge’s Recommendation Award.

Figure E1 Jaws of Life

GRADE 7
CATEGORY: ELECTRICITY AND INNOVATION
SOLAR POWERED CAR

The vehicle shown in Figure E2 was made using recycled waste materials, and was presented in a project portfolio together with a set of charts. The learner won a Bronze Medal for his work.

Figure E2 Solar powered car

GRADE 12
CATEGORY: AGRICULTURE AND INNOVATION
NATURAL CHICKEN FEED

The student in Figure E3 researched the use of natural feed as opposed to GM-assisted feeding of chicken, presenting Charts as evidence of the research.

Figure E3 Natural vs. GM-assisted chicken feed

GRADE 11
CATEGORY: SAFETY AND SECURITY
ELECTRIC POWERED CAR WITH REMOTE SECURITY FEATURES

The car in Figures E4a and b was made from recycled materials. It is powered by two AAA batteries and is remotely controlled. In Figure E4b, a building with the garage door open can be seen in the background. When the car enters the garage, the door closes automatically as part of the security features. The learner received the judge's Recommendation Award.

Figure E4a Electric powered car with remote security features

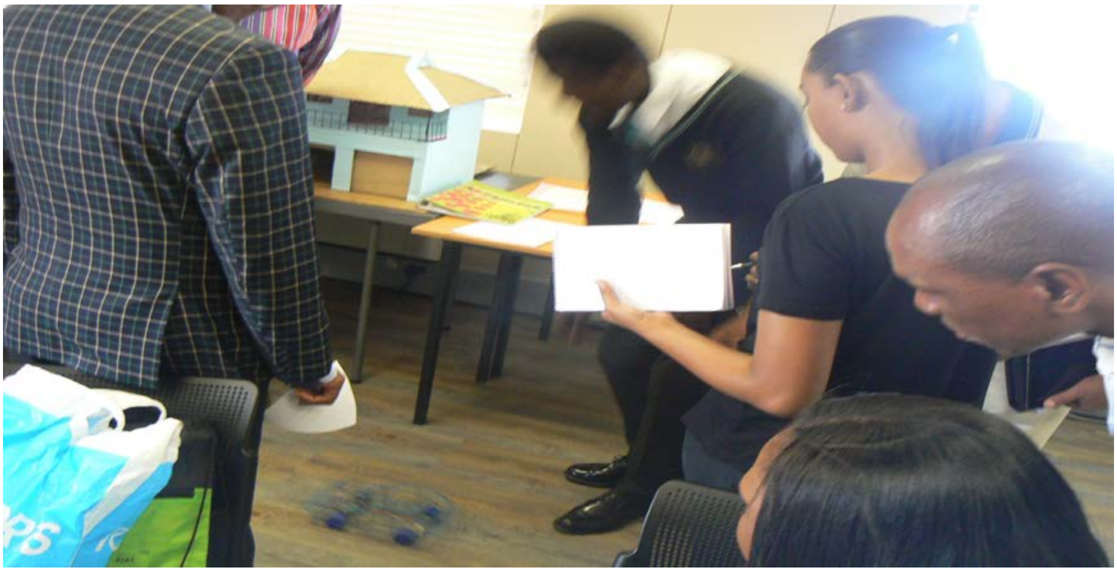


Figure E4b Student demonstrating his electric powered car with remote security features to the local press and invited guests.