Primary school teachers' experiences of Professional Development in teaching Coding

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Declaration

I, ZAINOEDIEN PETERSEN, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology (CPUT).

Signed: 

Date: _____

Abstract

This is a qualitative study that centres on teachers' experiences during development and their understanding of the development process to teach coding as an innovative subject in the South African primary school curriculum. It further seeks to determine how the development program is comprehended by teachers in a professional development programme in three public primary schools in the Western Cape.

A constructivist perspective guided by a conceptual framework is employed to develop and support this study. It further employs an interpretive paradigm as it taps into teachers' experiences, and use in-depth semi-structured interviews to construct and interpret the data gathered. Findings suggests that teacher experiences of the training received in teaching coding contributes widely to successful implementation of the subject.

Concerning this study, the outcomes does not fully reflect the intended ideals and thus recommendations are suggested to facilitate a more suitable development programme. This study further contributes to a deeper understanding of teacher motivations and experiences of their training and how it contributes to future implementation of an innovative subject into the primary school curriculum.

Keywords:

Teacher professional development, teacher experiences, teacher motivations, coding, expectations, innovative, qualitative, case study.

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Dedication

This work is dedicated to my late mother (and all mothers who work tirelessly and unselfishly behind the scenes) who granted me the opportunities and the inspiration to become a useful member of society, and planted the seeds of realisation that success is attainable, no matter your personal circumstances.

May her (their) ultimate reward be in the hereafter.

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List of Acronyms and Abbreviations

ANC	African National Congress
CAPS	Curriculum and Assessment Policy Statement
CCSSO	Council of Chief State School Officers
COVID	Corona Virus Disease
CPD	Continuous Professional Development
CPTD	Continuous Professional Teacher Development
CPUT	Cape Peninsula University of Technology
CS	Computer Science/Skills
CTLI	Cape Teaching and Leadership Institute
CUMSA	Curriculum Model for Education in South Africa
DBE	Department of Basic Education
DHET	Department of Higher Education and Training
DoE	Department of Education
DNE	Department of National Education
ECD	Early Childhood Development
4IR	Fourth Industrial Revolution
FET	Further Education and Training
GDP	General Domestic Product
HoD	Head of Department
ICT	Information & Communication Technology
FP	Foundation Phase
ICH	International Council for Harmonisation
IP	Intermediate Phase
IT	Information Technology
ITE	Information Technology Establishments
NCCA	National Council for Curriculum and Assessment

NCS	National Curriculum Statement
NDoE	National Department of Education
NICPD	National Institute for Curriculum and Professional Development
OECD	Organisation for Economic Co-operation and Development
Ofsted	Office for Standards in Education
PD	Professional Development
PLC	Professional Learning Communities
SA	South Africa/n
SACE	South African Council for Educators
SP	Senior Phase
STEM	Science, Technology, Engineering & Mathematics
TALIS	Teaching and Learning International Survey
TELI	Technology enhanced learning investigation
TPD	Teacher Professional Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNO	United Nations Organisation's
WCED	Western Cape Education Department

Chapter I: Introduction

1.1 Introduction and Background

This is the age of the computer, and computational skills have become a necessary tool to ensure that you do not get lost or left behind amongst the numerous digital innovations and technologies that is required to engage with after the onset of the 4th Industrial Revolution (4IR). The 4IR has been described as the fourth major industrial era since the initial Industrial Revolution of the 18th century, in which new technologies are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries (Schwab, 2016).

Those at the head of the major world economies such as the USA, United Kingdom, European countries, that includes Italy, Denmark, Greece, and Finland amongst others, some Pacific countries such as Australia, and a number of Middle Eastern countries that includes Kuwait and the UAE have embraced these innovative technologies and ingrained them into their curriculum (Vladko, 2015). Globally, there is a realisation that innovative subjects are more than just a gateway to successfully manage modern economies, but that they hold within their core many skills that are sorely needed within the classrooms to allow learners to excel in their various content subjects. Buabeng-Andoh (2012) further informs that there is a growing demand on educational institutions to use ICT to teach the skills and knowledge students need for the 21st century.

While the economic and labour markets have become more streamlined and automated thanks to technology, the impact of it on the work environment has also created specific challenges, as it necessitated the development of new skills. Modernisation and globalisation has impacted on work and civic life to the extent that specific skills are required to navigate these areas successfully. A technological world that is geared towards the 4th Industrial Revolution requires innovative skills to effectively traverse its innovative demands. Saavedra & Opfer (2013) inform that education such as Information Technology, Computer Science and coding is one that prepares learners for the challenges of employment, civic duty, and life and is directed towards the future. Therefore, citizenship and successful navigation of civic life, requires levels of information and technological literacy that go far beyond the basic knowledge that was sufficient in the past. For this reason, curricula are being adopted to accommodate increasingly diverse learner populations and prepare graduates for their future roles in the workplace and society (Andrade, 2016).

Throughout the world, but particularly in the United States, Europe and selected Asian countries, educators are using computers for learning activities across the curriculum. These sentiments and ideals have likewise been echoed by the South African President, Cyril Ramaphosa, who recently indicated in the Government Gazette of 2020 the need to align the education curriculum with global trends and thus formally steer the country and its future workforce into the digital era of the 4th Industrial Revolution (RSA, 2020).

The reality, however, is that South Africa's system of education was constructed for an economy and a society that has changed profoundly. According to Meek and Meek (2008), since the changeover from South Africa's apartheid system and government in 1994, much has been expected of the post-apartheid government in terms of greater equalisation of opportunities in all aspects of life. Meek & Meek (2008: 506) further informs that

> although South Africa's education system is definitely structured differently than it was prior to the end of apartheid, unfortunately, access to high-quality education for all citizens regardless of race has yet to be fully realised.

This applies in particular to those citizens who were previously disadvantaged by apartheid policies. Presently, wealthy and middle-class Blacks have been able to access the best education available to any White child, but for poor and working- class Black families which make up the majority of South African citizens, this is not the case (Meek & Meek, 2008: 506). To facilitate the required change, the National Development Plan 2030 (RSA, 2012: 296) informs that

> the education, training, and innovation system should cater for different needs and produce highly skilled individuals. The graduates of South Africa's universities and colleges should have the skills and knowledge to meet the future and present needs of the economy and society. The education system will play a major role in building an inclusive society, providing equal opportunities and helping all South Africans to realise their full potential.

Furthermore, the different parts of the education system should work together allowing learners to take different pathways, and create clear linkages between Further Education & Training (FET) colleges and Universities of Technology, between education and training, and the world of work (RSA, 2020: 296). For today's students to compete in a technological global society, they must be proficient communicators, creators, critical thinkers, and collaborators. Education experts in many countries are finding that there is a mismatch between the skills learners acquire in the course of ordinary school learning

and the kinds of versatility and varied literacies employers require (Mcnulty, 2018). Innovative skills enthusiasts profess, however, that coding as a curriculum subject offer solutions to some of these current hindrances by embracing its embedded 'Cs' of change; creativity, critical thinking, collaboration, communication, and comprehension (Van Roekel, 2005: 2).

In the global context, the importance of coding skills has been widely recognised, and within the South African perspective, the South African president announced in his 2020 State of the Nation Address (SoNA) (RSA, 2020) that "this year, we will be introducing coding and robotics in Grades R to 3 in 200 schools, with a plan to implement it fully by 2022". As South Africa is at the threshold of the 4th Industrial Revolution, the emphasis of the Department of Higher Education & Training (DHET) to realign the existing curriculum to accommodate these innovative skills (DHET, 2019) have motivated this investigation.

1.2 Problem Statement

The Teaching and Learning International Survey (TALIS) 2018 Report informs that teachers in developing nations generally, lack the necessary Information and Communications Technology (ICT) skills to incorporate technology into their daily teaching and learning (OECD, 2018). This applies to many teachers in South Africa as well. In contrast, the 2010 Millennium Development Goals (MDG) report launched in New York indicates that in the developed regions, ICT teacher skills is much higher than in the developing world (Khan, Hassan & Clement, 2012).

Within the South African context, the inequalities and disparities enforced by the former privileged minorities contributed largely to the restrictions and limitations of quality digital skills training of teachers and learners of colour at school level. According to Gallo (2020: 3), because of Bantu Education and its lasting legacy in South Africa, many non-white South Africans have historically been denied access to quality education, depriving them of employment opportunities.

One of the greatest challenges facing the South African education system is the absence of sufficient competent teachers, who can provide quality teaching for all school subjects and phases. In this regard, Information Technology Establishment (ITE) programmes over the years have also not equally promoted technology in their programmes and thus the DHET informed at a session with the Parliamentary Monitoring Group (PMG), that

ITE programmes must equip teachers with skills for the 21st century, including the Fourth Industrial Revolution (PMG, 2018).

Ghobadi & Ghobadi (2013:12) in their analysis of how access gaps shapes the digital divide, found that vast inequities still exist in access to, and the utilisation of ICT amongst individuals, mainly in developing countries. Also, many older teachers in the current education system have a limited background in digital technologies, as they stem from an era of 'chalk and talk' with very little exposure to Teacher Professional Development (TPD) in ICTs. Therefore, teacher development opportunities in (ICT) need to be created for teachers to bridge the current divide for learners to explore and excel in the digital field. Accessing and participating successfully in the 4th Industrial Revolution, South African teachers require the necessary skills to prepare learners to successfully participate in the digital world that the 4th Industrial Revolution requires.

1.3. Rationale

This study was initiated from my position as an educator and school manager to investigate the advantages of coding as a primary school subject in the curriculum and to investigate primary school teachers' motivations and experiences in teaching coding in their pursuit to prepare learners with skills required for the demands of future work placement.

Within the South African context, research informs that the exploration of this area of skills deserves attention as there is sound evidence of a knowledge gap that exists within the primary school curriculum to prepare learners with the skills required for the 4th Industrial revolution (Government News Agency, 2019). In addition, teacher professional development in coding will also require attention to support the introduction of this innovative subject into the school curriculum.

As a seasoned educator and primary school manager, I have also become sensitised during teacher appraisal classroom visits, to the hindrances that primary school teachers' experience in their quest to transfer content knowledge to many of the learners in the classroom. The inability of many learners to proficiently comprehend subject content is underscored to a further degree when the quarterly assessment results in the Intermediate Phase (IP) and Senior Phase (SP) at school are reviewed. It has, thus, become apparent that existing teaching strategies require re-evaluation to enhance learner performance in many of their academic subjects

Interest to investigate the benefits that coding as a subject affords the curriculum was stimulated by the recent announcement by the South African Minister of Basic Education, Angie Motshekga, that the South African government is developing coding curricula for initial implementation in primary schools by the year 2020 (RSA, 2019).

1.4 Research Questions and Aims

Aims

The principal aim of this research is to explore primary school teachers' experiences during the process of their development in coding instruction. Moreover, the research further seeks to identify how successful or not, this development is experienced at three public educational institutions belonging to different quintiles[1] in the Western Cape, South Africa. According to the DoE (2004:8).

> quintile 1 is the group of schools in each province catering for the poorest 20% of learners. Quintile 2 schools cater for the next poorest 20% of schools, and so on. Quintile 5 schools are those schools that cater for the least poor 20% of learners. Poorer quintiles have higher targets than the less poor quintiles. The 'adequacy benchmark' is the school allocation amount that Government believes is the minimum needed by each learner in each school.

To realise these aims, the following research question were formulated.

The main research question for the study is:

What are the professional development experiences of South African primary school teachers who teach coding as a novel subject?

In line with the research question, the following sub-questions are proposed:

- What are primary school teachers' motivations for undertaking professional development to teach coding?
- What are primary school teachers' experiences of the training they have received to teach coding?

[1] A *schools' quintile* ranking is important as it determines the amount of funding that it receives each year and whether or not the school can charge fees.

1.5 Overview of the research approach

To accommodate the assimilation of innovative skills and knowledge successfully into the existing curriculum, teachers' rationales and incentives to acquire the knowledge and skills are explicitly explored. The research is centred on a qualitative approach with an interpretive social constructivist framework. In-depth interviews (2 x 60-minute sessions) of five teachers who teach coding at three sites took place rotationally according to their availability. This was supported by field notes and audio recordings taken during the interviews.

As there are currently only a limited number of schools that offer coding in South Africa, this study focused on three public primary schools in the Southern Suburbs of the Western Cape that follow the Continuous Assessment Policy Statement (CAPS) curriculum. Information Technology (IT), including coding, forms part of their core curriculum, and the schools have suitably trained instructors within the field of programming or coding and Information Technology. As coding will be introduced by the Department of Basic Education as an innovative curriculum subject from Grade 1 after a pilot programme in 2020, primary school teachers were deemed to be the ideal candidates for this research.

An inductive approach was used for the purpose of data analysis. The observational protocol and the data gathered from the interviews were transcribed and followed up by thematic analysis to build a list of themes and opinions that were held by the participants. Clearance to conduct research was obtained from the all relevant parties, including the participants and the Education Department. Participation in the study was voluntary and participants were able to withdraw from the research at their discretion.

1.6 Structure of the thesis

This chapter introduces the study by highlighting the significance of innovative skills with specific relevance to coding or programming. It seeks to highlight the consequence of digital skills such as ICTs globally and nationally, and the support it might provide for transferring academic content knowledge to the learners

Chapter 2 primarily set the context of the South African landscape, the socio-economic conditions that prevail in the country specifically the Western Cape, existing e-learning features in this province and how the introduction of innovative subjects could impact on a future workforce. It further provides a brief historical overview of ICTs and coding both

globally and nationally as a curriculum subject. Finally, it aims to highlight teacher professional development pedagogies used to develop teachers in coding practice.

Chapter 3 presents a review of the literature for this study and is divided into six sections. The first section describes and reviews literature globally and nationally that pertains to innovative skills, with relevance to ICTs and more specifically coding instruction within the primary school. The second section reviews the relationship between coding as a subject and the curriculum. In the third section the research defines how coding is introduced by teachers as a subject. The fourth section focuses on motivations for teacher professional development in coding. Section 5 discusses teachers' personal experiences of the development. The chapter concludes with a summary of the conceptual framework used in the study.

In Chapter 4, the research methods and procedures used to collect the data are explained, together with the rationale for their use. The data collection instruments are detailed, including the analysis and semi-structured interviews used.

In Chapter 5, the findings are reported and written up according to the interrelated research questions that have guided this study.

Chapter 6 provides a blueprint of the research synthesis. Brief discussions of the findings and emerging themes based on the conceptual framework model and the findings from Chapter 5 are analysed according to the research questions.

Chapter 7 is the conclusion of the thesis. It provides a summary of the research, recommendations for future study, policy and practice as well as the contribution of the study.

CHAPTER 2: Context

2.1. Introduction

This chapter is divided into three sections. The first section discusses the demography of South Africa relating to population, ethnicity, political overview, socio-economic and geographic profile, an overview of post-apartheid education, an overview of education and technology, the school curriculum, and finally an overview of teacher professional development.

The second section explores the Western Cape context in which the study is located, describing briefly the Western Cape and some of its e-learning features as it relates to my focus of coding in the curriculum and teacher professional development.

The final section in this chapter discusses the Western Cape schools used for the research and its distinct district features.

2.2. The South African context

2.2.1. Population

According to Statistics South Africa (STATS SA, 2020), South Africa's mid-year population is estimated to have increased to 59,62 million in 2020. According to the report released by Statistics South Africa (RSA, 2020). The report indicates that

> approximately 51,1% (approximately 30,5 million) of the population is female. According to the report about 28,6% of the population is aged younger than 15 years and approximately 9,1% (5,4 million) is 60 years or older. Of those younger than 15 years of age, the majority reside in KwaZulu-Natal (21,8%) and Gauteng (21,4%). Of the elderly (those aged 60 years and older), the highest percentage 24,1% (1,31 million) reside in Gauteng. The proportion of elderly persons aged 60 has grown from 7,6% in 2002 to 9,1% in 2020 (RSA, 2020).

The report further shows that for the period 2016–2021, Gauteng and Western Cape are estimated to experience the largest inflow of migrants of approximately, 1 553 162 and 468 568 respectively (RSA, 2020). This relocation from the rural areas to the urban areas and suburbs are due to the poorer population seeking employment and a better quality of life.

2.2.2. Ethnicity

For 2019, Stats SA estimates that approximately 51,2% (approximately 30 million) of the population is female. The black African population is in the majority (47,4 million) and constitutes approximately 81% of the total South African population. The white population is estimated at 4,7 million, the coloured population at 5,2 million and the Indian/Asian population at 1,5 million (RSA, 2020).

South Africa is a multicultural society that is characterised by its rich linguistic diversity. Language is an indispensable tool that can be used to deepen democracy and also contribute to the social, cultural, intellectual, economic and political life of the South African society (RSA, 2020). The country is multilingual with 11 official languages, each of which is guaranteed equal status. Most South Africans are multilingual and able to speak at least two or more of the official languages.

According to STATS SA (RSA, 2020)

> the Indian/Asian population group was the most monolingual with 92,1% who spoke English at home. More than three-quarters (77,4%) of coloured individuals spoke Afrikaans at home while 20,1% used English. More than three-fifths (61,2%) of white South Africans spoke Afrikaans and 36,3% spoke English. By comparison, black Africans spoke a much larger variety of languages.

The overwhelming number of languages spoken in South Africa is from a variety of black indigenous, and formally disenfranchised communities. The Afrikaans language was developed from the Dutch and serves as the first language of most coloured and white South Africans, and English reflects the legacy of British colonialism (Jansen, 2017).

Almost 80% of South African population adheres to the Christian faith. Other major religious groups are Hindus, Muslims and Jews. A minority of South African population does not belong to any of the major religions, but regard themselves as traditionalists or of no specific religious affiliation. Freedom of worship is guaranteed by the Constitution.

2.2.3. Historical Political Overview

South Africa has been under colonial rule from various European kingdoms for many centuries since the arrival of the first colonist in 1652 which led to the slavery and forced labour model (Jansen, 2017). These subjugations led to many deadly conflicts between

the indigenous inhabitants and colonists and finally ended when the British handed over power to a white minority Afrikaner group of settlers.

The Afrikaners were opposed to the British system of education because they saw it as a way of alienating them from their cultural practices. The Afrikaners then established their own schools based on Christian National Education (CNE) and this eventually led to a system of segregation that evolved into the ideology of apartheid by the National Party in 1948 (Giliomee, 2003).

The African National Congress (ANC) has dominated politics in South Africa since the end of apartheid in 1994. Corruption scandals forced former two-term president Jacob Zuma to resign in 2018, and he was subsequently replaced by current President Cyril Ramaphosa who secured his own five-year term when the ANC won the May 2019 elections with 57 percent of the vote, the lowest percentage in ANC history.

According to the Index of Economic Freedom (2020) South Africa has a highly developed economy and advanced infrastructure. One of the world's largest exporters of gold, platinum, and other natural resources, it also has well-established financial, legal, communications, energy, and transport sectors as well as the continent's largest stock exchange. High rates of formal-sector unemployment and high levels of crime have however offset the current economic growth.

2.2.4. Socio-economic and Geographical profile

In 1994, at the introduction of the Interim Constitution and the first non-racial election, South Africa's original provinces and Bantustans were abolished and nine new provinces were established. The following (figure 1) is an illustration of the nine provinces.

Figure 1: Provinces of South Africa **Mabin, A.S. (2020) Encyclopaedia Britannica**

According to the OECD (2017) low growth and the high unemployment rate within the economy has disappointed in the last few years. Growth has trended down

markedly since 2011 due to constraints on the supply side, in particular electricity shortages, falling commodity prices, and policy uncertainty (OECD, 2017). Unemployment rose from 25% to 27%. The youth are particularly hard hit by the economic slowdown, with an unemployment rate of 53% in 2016.

Though there are signs of improvement persistent low growth has led to the stagnation of GDP per capita compared to more rapidly growing emerging market economies. The following graph (figure 2) indicates the current economic growth and unemployment trends in South Africa.

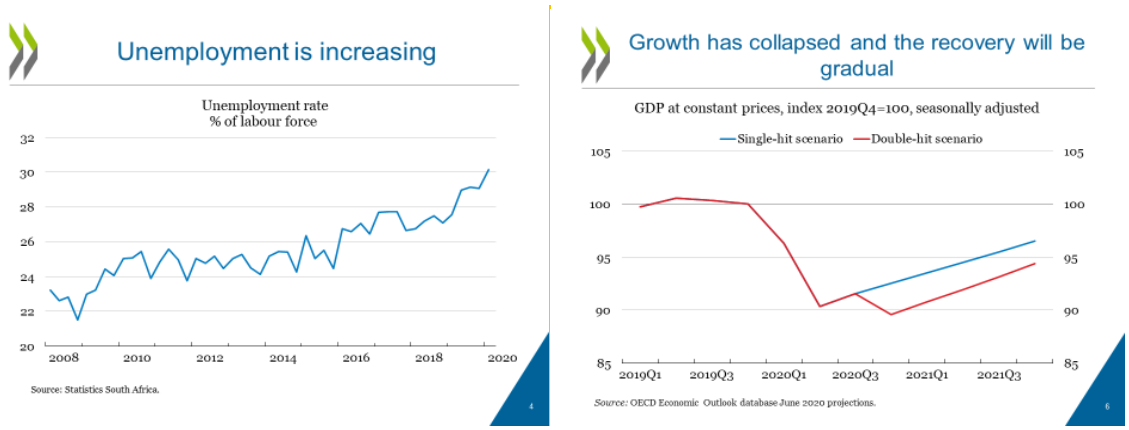


Figure 2: Economic and unemployment trends in South Africa ***Source: OECD. Economic Forecast Summary (2020)***

2.2.5. Overview of Post-Apartheid Education

The transition from apartheid education to the present education system in South Africa has not been without problems. South African history informs us that apartheid education was used as a tool to divide society as it constructed certain forms of identity among learners. Under apartheid education, schools were divided according to race, and education enhanced the divisions in society (DoE, 2001).

These divisions reinforced the disparities of a segregated society. The majority of the South African population deemed the curriculum irrelevant and mono-cultural since it served to strengthen the citizenship of one race over others. Apple (1993: 1) points out that education was never a neutral enterprise. Furthermore, he declares that by the very nature of the institution, the educator was involved (whether consciously or not) in a political act. Shor (1987:13) supports this in stating that education is grossly influenced

by economics, by community life and literacy, by commercial mass culture and by political action outside the classroom.

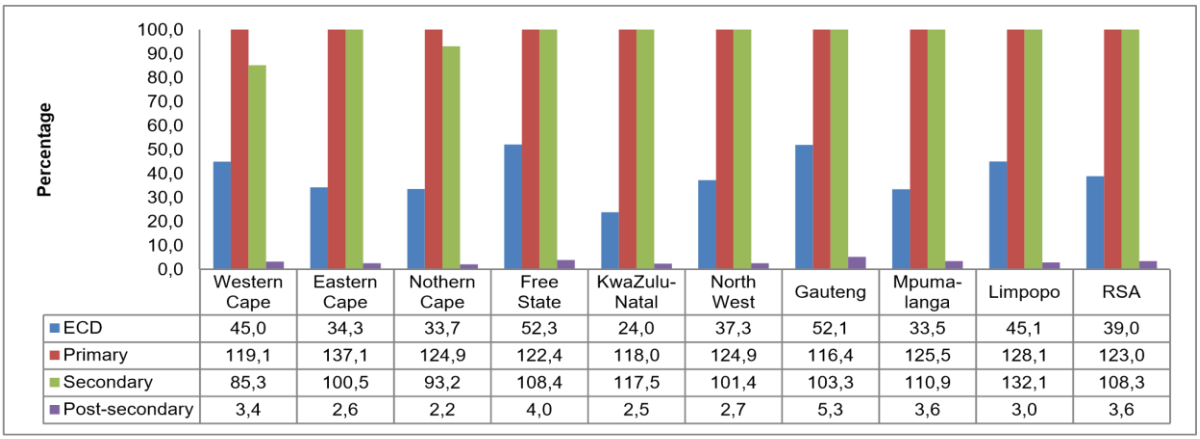
Apartheid education was a practice of maintaining and preserving the master-servant relationship between the whites and the Africans. According to Tshifhumulo, et al. (2020) it was intended to 'entrench apartheid capitalism', as was noted by delegates from the private sector and a range of educational institutions at the Conference on People's Education in December 1985. Kallaway (2002) points out that apartheid education not only domesticated the people but indoctrinated them as well. In the white schools in South Africa, the government policy in the past included various 'educational programmes' where the young students would be indoctrinated to enhance the superiority complex of the white South African over the African.

The Eiselen Commission report (RSA, 1951) in 1951 led to the Bantu Education Act of 1953 Act No. 47 (South Africa, 1953) and under this Act, the Department of Native Affairs, headed by Hendrik Verwoerd, was made responsible for the education of black South Africans (Christie & Collins, 1982). The Act required black children to attend government schools and was aimed at training the children for the manual labour and menial jobs that the government deemed suitable for those of their race (Gerhard, 2011).

The South African education system consists of three phases: primary, secondary, and post-secondary. Learners may spend one to two years in early childhood development centres, and one year in Grade R/0, which is currently part of the primary schooling system. By law, children have to start attending school the year before the calendar year in which they turn seven (age of compulsory schooling). Therefore, they should reach Grade 1 by age seven, and spend eight years in primary school, which ends in Grade 7. The primary school phase is followed by five years of secondary school, which should be completed by the time the children reach age 18. The duration of the phase is from Grade 8 to Grade 12.

Compulsory schooling ends at age 15 or after completing Grade 9, depending on which event occurs first. Participation in all the educational phases varies by region and population group in South Africa. Primary and secondary education are relatively well developed and almost within reach to most South Africans. By contrast, pre-primary education and post-secondary-level education are underdeveloped and population group disparities in enrolment rates are more pronounced (Stats SA, 2016). The following graph

(figure 3) illustrates the gross enrolment rate (GER) in Early Childhood Development ECD, primary, secondary, and post-secondary institutions.



	Western Cape	Eastern Cape	Nothern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpuma-langa	Limpopo	RSA
ECD	45,0	34,3	33,7	52,3	24,0	37,3	52,1	33,5	45,1	39,0
Primary	119,1	137,1	124,9	122,4	118,0	124,9	116,4	125,5	128,1	123,0
Secondary	85,3	100,5	93,2	108,4	117,5	101,4	103,3	110,9	132,1	108,3
Post-secondary	3,4	2,6	2,2	4,0	2,5	2,7	5,3	3,6	3,0	3,6

Source: General Household Survey, 2015

Figure 3: Gross enrolment rate **in ECD, primary, secondary and post-secondary institutions by province, 2015**

Concerning the above enrolment statistics, Table 1 indicates enrolment by population group throughout the country.

Table 1: Gross enrolment rate in ECD, primary, secondary and post-secondary institutions by population group, 2015. *Source: Statistics South Africa. General Household Survey 2015*

Educational level	Population group			
	Black African	Coloured	Indian/Asian	White
ECD	39,0	30,9	28,6	55,1
Primary	124,3	115,1	115,9	116,7
Secondary	112,1	82,8	85,9	99,7
Post-secondary	3,5	2,4	5,6	4,5

The role of education has had a fundamental shift in global expectation from knowledge-growth and skills development, to becoming an instrument of poverty alleviation and a global reduction in illiteracy, as laid out in the United Nations Organisation (UNO) and World Millennium Goals (WMG) of which South Africa was a signatory.

These goals align with the country's National Development Plan which states that 'by 2030 we seek to eliminate poverty and reduce inequality' (South Africa, 2015). This was later enhanced with a new set of United Nations Sustainable Development Goals (SDGs) that will carry on the momentum generated by the MDGs and fit into a global development framework beyond 2015.

2.2.6. Overview of Education and Technology

Not only was apartheid education racially segregated, but it was also promulgated to prevent learners of colour being trained in technological subjects. According to Gudmundsdottir (2010: 84) one aspect of the disparity in education includes access and use of information and communication technology (ICT) which is often connected to the concept of a digital divide. In this regard, though technology was less advanced than it is now, white learners were ensured of receiving training in the more technologically advanced fields to the detriment of black learners, as the apartheid government was of the view that people of colour were destined to only be hewers of wood and drawers of water, as was infamously quoted by former South African statesman, H.F. Verwoerd (Lumadi, 2020).

In broad terms, the shortcomings of the existing education system are that the racial basis which underpinned the education system led to problems of disparity in education, the inability for a large number of learners to benefit from the system, problems of relevancy in education as a result of the predominantly Eurocentric curriculum, its affordability and the lack of legitimacy in the system (ANC, 1994: 2).

Apartheid education never prepared the marginalised communities in South Africa in the areas of technology and science for them to participate more proficiently in developing their country and to meaningfully participate in the world economies. A discussion document, known as ‘Curriculum Model for Education in South Africa’ (CUMSA) was released on 20 November 1991 by the Department of National Education (DNE). The document aimed to table a draft curriculum model for pre-tertiary education that would eventually contribute to the development of a curriculum that would serve the needs of the total South African population (DNE, 1991).

One of the suggestions which has emerged out of CUMSA and which has been generally well received is the provision for technology education. In assessing it one needs to look at it in terms of the needs and demands of a new education dispensation for South Africa. According to CUMSA, seven fields of study are distinguished, of which technology is a separate one. In the Field of Study: Technology the emphasis falls on humankind's purposeful mastery and creative use of knowledge and skills regarding products, processes, and approaches in order better to manage their environment. Processes in this connection include problem identification, design, execution, and evaluation (DNE, 1991:31).

After arduous years of transforming the education and training system, all liberation movements, including some intellectuals from the Department of National Education (DNE), sat together in July 1994 and resolved that education should promote the development of a national identity (Mda & Mothata, 2000). A new curriculum (called Curriculum 2005) was then conceived (Cross, Mkwanazi & Klein, 1998) based on the principles of cooperation, critical thinking, and social responsibility and the empowering of individuals to participate in all aspects of society.

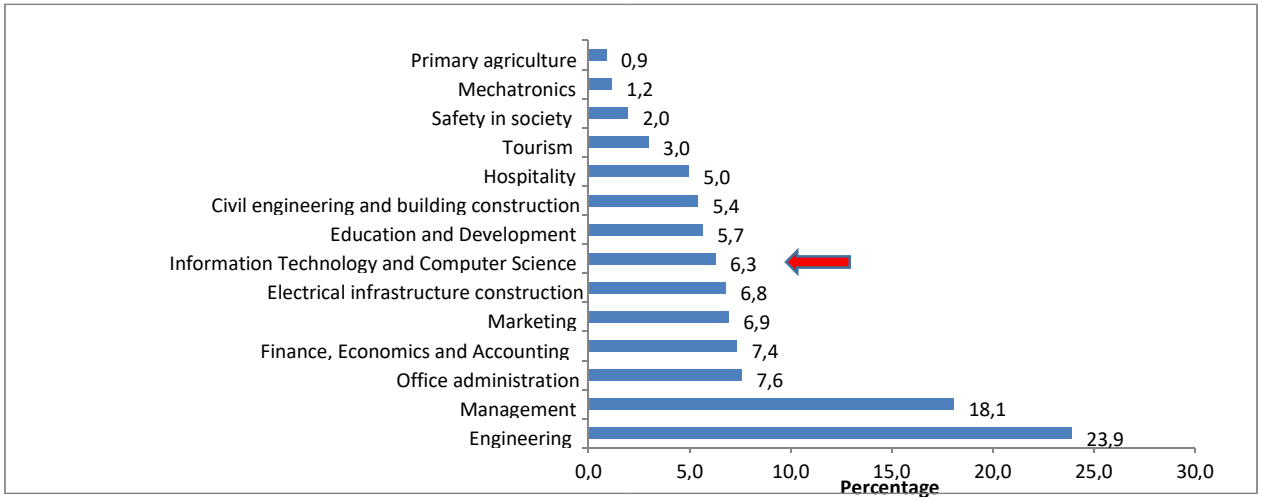
Since 1994 several new policies have been developed and implemented which have substantially altered the education system in South Africa, the most important of these being the establishment of a single, education system to replace the separate, racially defined, education departments that previously existed (Lundell & Howell 2000:52). Policy in South Africa has moved a long way towards promoting and understanding the role of information and computer technologies (ICTs) in society in general and in education in particular. During this period of transformation, it became apparent that of the many policy texts dealing with ICTs, the most comprehensive and thought-provoking was the Technology Enhanced Learning Investigation (TELI) commissioned by the Department of Education in 1995.

Lundell & Howell (2000:55) indicate that the report presented many productive suggestions for promoting technology-enhanced learning in schools, including information literacy courses, an information clearing house, and a learning site on the World Wide Web. Perhaps the most significant aspect of the TELI investigation is the emphasis (captured in the title) that technology is a means for improving education and not an end in itself. In other words, technology is a tool for learning if carefully deployed, and is an aid to improving teaching.

The South African Draft White Paper on e-Education published in the Government Gazette of 2004 (South Africa, 2004:8) which was a precursor to Outcomes-Based Education (OBE) noted that ‘education systems have an obligation to deliver on public expectations of quality education for economic growth and social development’. It further indicated that within the context of developing countries, quality improvement and the enhancement of excellence must take into consideration the need for increased access, equity, and redress, and within that context, ICTs have the potential and capacity to overcome most of these barriers. Locally, as is the case within the global scenario, the ICT revolution has had an impact on curriculum development and delivery. To this end,

the draft White Paper (2004) aspired to empower all the components of the education system (managers, teachers, and learners) to be ICT-capable by 2013 by implementing a three-phased approach to achieve this outcome.

Since 2014, the Department of Higher Education and Training (DHET) has been gazetting a list of occupations in high demand in the country. While the main purpose of the list is to support planning, resource allocation and career advice by the DHET, other stakeholders involved in the sector are also expected to use the list to back their own planning and operations. The DHET defines occupation in high demand as 'those occupations that show relatively strong employment growth, or are experiencing shortages in the labour market' (DHET, 2016). It should be noted, however, that the institutions of higher learning in South Africa are still dealing with the mismatch of students preparing themselves for the future job market, as many of them are not studying in the fields that the 4th Industrial Revolution requires. To support this claim, the following graph (figure 4) indicates student preference in study fields at university level.



Source: Community Survey, 2016

Figure 4: Distribution of TVET **attendance by field of study.** ***Source STATS SA. 2016. Education Series Volume iii.***

Figure 4 represents university attendance by field of education. Apart from engineering, the major fields of study do not match the scarce skills areas in professions such as Information Technology, Computer Sciences and Natural and Physical sciences. The highest percentage of individuals studied Business, Economics, and Management sciences (21,5%), followed by individuals who studied Education (18,7%). Close to 9% were enrolled in health-related qualifications, whereas Information and Computer Sciences accounts for only 6,3% of enrolments.

2.2.7. Curriculum and CAPS

The National Curriculum Statement Grades R-12 (DBE, 2011) stipulates policy on curriculum and assessment in the schooling sector. As noted in the National Curriculum Statement (NCS) on Technology (DBE, 2011: 3) itself, the National Curriculum Statement was amended, with the amendments coming into effect in January 2012. A single comprehensive Curriculum and Assessment Policy (CAPS) document was developed for each subject to replace Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines in Grades R-12.

The National Curriculum Statement Grades R-12 gives expression to the knowledge, skills and values worth learning in South African schools (DBE, 2011). The curriculum aims to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives. Some of the critical ideals of the NCS are to equip learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment, and meaningful participation in society as citizens of a free country, and to use science and technology effectively.

The aim of the curriculum is thus to ensure that, learners must be made aware of the interrelationship between technology, society and the environment, and where applicable, be made aware of different coexisting knowledge systems such as indigenous technology systems (CAPS, 2011). Emphasis is placed on the impact of technology, both positive and negative, on people's lives, and learners should be made aware of bias in technology and should be able to express opinions that explain how certain groups within society might be favoured or disadvantaged by products of technology.

2.2.8. An overview of teacher professional development (TPD)

Major policy changes occurred in the immediate post-apartheid period. During this period teachers and teaching formed an important part of policy interest. One area of policy intervention was the promotion of teacher professional development, but despite the multitude of available policies on teachers and teaching, teacher development received scant attention (Sayed & Kanjee, 2013).

In line with the implementation of the White Paper on Education and Training (DoE, 1995) the Education Ministry identified teacher education as one of the central pillars of a human

natural resource development strategy. It further stated that the growth of professional expertise and self-confidence was key to teacher professional development. In reality, however, Curriculum 2005 failed to attain these aims. This was due mainly to its technicist approach and its failure to address the realities of the education system in South Africa.

Within the South African context, the Revised Policy on the Minimum Requirements for Teacher Education Qualifications (South Africa, 2015: 64) identifies a minimum set of competencies required of newly-qualified teachers. Within this document, guidelines concerning teacher training and qualifications are clearly stipulated. Significantly, one of the areas that it focuses on is that teachers should know how to teach their subject(s) and how to select, and determine the sequence and pace of the content in accordance with both subject and learner needs. It further indicates that teachers should be able to reflect critically on their own practice in theoretically informed ways and in conjunction with their professional community of colleagues to constantly improve and adapt to evolving circumstances.

To effectively meet these challenges, the Declaration of the Teacher Development Summit of 2009 (DBE, 2011) called for the development of a new, strengthened, recent integrated national Plan for teacher development. The collaborative work towards the development of such a plan has led to the production of the Integrated. Strategic Planning Framework for Teacher Education and Development in South Africa, 2011-2025 (DBE/DHET, 2011). The primary outcome of this planning framework is to improve the quality of teacher education and development in order to improve the quality of teachers and teaching.

The Strategic Planning Framework is strongly aligned with national imperatives that are currently in place, including the Department of Basic Education Action Plan 2014 (DBE, 2014) which has among its goals the following: to attract a new group of young, motivated and appropriately trained teachers into the teaching profession each year; to improve the professionalism, teaching skills, subject knowledge and computer literacy of teachers throughout their entire careers; and to strive for a teaching workforce that is healthy and enjoys a sense of job satisfaction.

The Department of Basic Education has among its strategic objectives contained in the Integrated Strategic Framework for Teacher Education and Development: 2011-2025, that teacher unions have a responsibility to

> promote teacher professionalism through advocating, supporting and encouraging teachers to access opportunities to identify and address their development needs;

promote teacher professionalism through advocating and supporting the establishment of PLCs and encouraging teachers to participate actively and meaningfully in these; and assist in growing the profession by enhancing the status and image of teaching and teacher (DBE, 2011:3).

Furthermore, DBE (2011:3) states that the South African Council for Educators (SACE) has an important quality management role to play in promoting and supporting the system of identifying and addressing teacher development needs. This would include that providers of teacher development programmes are fully approved by SACE and that the professional development courses available for teachers are endorsed and can lead to the accrual of Continuous Professional Development (CPD) points on successful completion.

The National Institute for Curriculum and Professional Development (NICPD) will function to bring together expert teacher educators, academic subject specialists, excellent practising teachers, and NGOs and other organisations to develop the system for teachers to identify and address their developmental needs. This will be achieved through developing and maintaining an Information and Communication Technology (ICT)

platform to support the system, so making quality professional development opportunities accessible to teachers all over the country (DHET, 2011:5).

2.3. The Western Cape context

The Western Cape is the southern-most province of South Africa and it constitutes a total population of almost 59,7 million inhabitants. Almost two thirds of this population lives in the Metropolitan area of Cape Town. Though the Western Cape represent the rainbow nation, it has the highest number of coloured inhabitants in South Africa. Regrettably, this community is one of the most vulnerable communities in South Africa and is plagued by crime and violence in most of the Southern suburbs in which they reside.

In 1994, at the introduction of the Interim Constitution and the first non-racial election, South Africa's original provinces and Bantustans were abolished and nine new provinces were established. The former Cape Province was divided into the Western Cape, Northern Cape, Eastern Cape and part of North West. The Western Cape is the joint 2nd largest contributor to the country's total GDP, and also has one of the fastest-growing economies in the country (Mabin, 2020).

2.3.1. Socio-economic and political demography and profile

According to the latest Socio-economic profile report (2017a) the City of Cape Town's population is expected to expand rapidly across the next 5 years, growing from 4 055 580 people in 2018 to 4 232 276 in 2023. This equates to a 0.9% year-on-year growth rate.

The following table depicts the expected growth rate for the city.

Table 2: Expected growth rate. ***Source: (2017a) WC Socio-economic Profile: City of Cape Town***

	Cape Winelands District	Central Karoo District	City of Cape Town	Eden District	Overberg District	West Coast District
2018	864 028	75 688	4 055 580	619 224	284 272	433 445
2019	874 413	76 354	4 094 582	625 186	287 752	439 036
2020	884 565	77 020	4 131 722	631 005	291 150	444 497
2021	894 441	77 685	4 167 003	636 682	294 466	449 847
2022	904 058	78 350	4 200 484	642 220	297 701	455 051
2023	913 391	79 014	4 232 276	647 627	300 860	460 132

The total population is broken down into three different groups: Age 0 - 14: children; Age 15 - 65: working age population; Age 65+: seniors. A comparison between the 2018 and 2023 estimates shows that the aged population will increase at 3.4% year-on-year whereas the child cohort will only increase by 1.2%. The working-age population is in turn expected to only grow at 0.8% year-on-year. These dynamics will increase the City's dependency rate which implies a greater strain on social systems and the delivery of basic services.

The following table indicates the breakdown of the age cohort.

Table 3: Age cohorts ***Source: (2017b) WC Socio-economic Profile: City of Cape Town***

Year	Children: 0 – 14 Years	Working Age: 15 – 65 Years	Aged: 65 +	Dependency Ratio
2011	**928 334**	**2 604 209**	**207 494**	**43.6**
2018	**1 061 002**	**2 733 119**	**261 460**	**48.4**
2023	**1 073 016**	**2 849 207**	**310 051**	**48.5**

2.3.2. Education context in the Western Cape

According to the WCED (2012), the Western Cape is divided into eight education districts, which manage the quality of education and education institutions within their jurisdictions. The districts include four rural districts (West Coast, Cape Winelands, Eden and Karoo, and Overberg), and four urban districts (Metro North, Metro South, Metro East, and Metro Central). Learner enrolment within the Cape Metro area increased at an average annual rate of 2.1% between 2014 and 2016. This is the second-highest learner enrolment rate amongst the various districts of the Western Cape, with the West Coast District growing at 2.4% across the same period. The Western Cape's average annual learner enrolment growth is 1.8%.

The learner-teacher ratio within the City of Cape Town is rising at a dramatic rate from 30.3 in 2014 to 39.8 in 2015 and 40.1 in 2016 (Western Cape Government, 2017). It is therefore evident that the increase in the number of learners in the City of Cape Town is not being met by a reciprocal increase in the number of teachers. Increased learner-teacher ratios are a major concern as it is commonly assumed that children receive less personalised attention in larger class environments and that high learner-teacher ratios are detrimental to improved educational outcomes.

The Socio-Economic Profile: City of Cape Town (2017) reports that the high school drop-out rate for the City of Cape Town increased from 31.9% in 2014 to 33.7% in 2015 but improved to 32.7% in 2016. Although this rate improved between 2015 and 2016, it is still concerning to note that 32.7% of all learners enrolled in Grade 10 within the Metro in 2014 dropped out of school by the time they reached Grade 12 in 2016. These high levels of dropouts are influenced by a wide array of economic factors, but also because of the high levels of crime that spills over into the schools.

The effect on learning is huge and impacts on many learners' ability to prosper. Violence in schools has short and long-term consequences for the victims as well as for the perpetrators and bystanders (UNESCO, 2017; Burton & Leoschut, 2013). School violence transforms the school environment into one of fear and anxiety (UNESCO, 2017). This hampers the educational environment and consequently prevents young people from accessing and/or fully benefiting from their educational opportunities.

In this regard, the Centre for Justice and Crime Prevention (CJCP), a Section 21 company that works to develop, inform, and promote evidence-based crime prevention practice, with a particular focus on children and youth. According to the CJCP (2017)

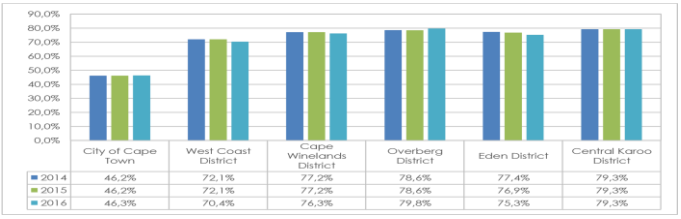
the National School Safety Framework (NSSF) was developed because the school environment is often one where learners fear for their safety and are subject to direct and indirect forms of violence. This led to the CJCP providing a comprehensive document to guide the Department of Basic Education, schools, districts and provinces on a common approach to achieving a safe, healthy and violence-free learning environment.

The pressure placed on education by the National Development Plans' (RSA, 2015) commitments to the global agenda is enormous, particularly in the light of the national fiscal constraints from which the Western Cape cannot escape. The availability of adequate education facilities such as schools, especially schools equipped with libraries and media centres, and FET colleges could affect academic outcomes positively.

The number of schools within the greater City of Cape Town has increased gradually since 2014 amidst rising population figures, which increased the demand for educational facilities. There were 760 schools within the greater City of Cape Town in 2016 which accommodated 639 251 learners (Western Cape Government, 2017). The number of schools equipped with libraries increased from 576 in 2014 to 587 in 2015 but remained unchanged towards 2016.

The Western Cape is a province of great contrasts regarding its economy which clearly influences the makeup of no-fee-paying schools. The following graph depicts the percentage of no-fee schools within the various districts of the Western Cape.

Table 4: No-fee paying schools ***Source: (2017c) WC Socio-economic Profile: City of Cape Town)***



There were a total of 760 schools in the City of Cape Town in 2016 of which 352 were considered to be no-fee schools (46.3%). Economic constraints will particularly be hard felt within the Metro, which will give rise to an increasing number of parents who are unable to pay school fees.

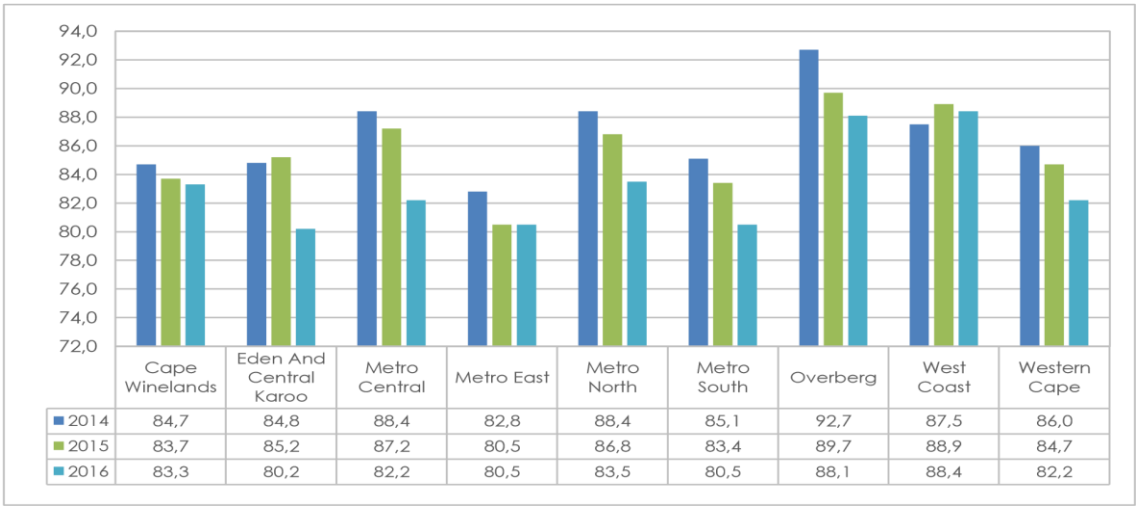
According to the Western Cape Government (2017), the average matric pass rate in 2016 in the Western Cape was 82.2%, a gradual decline from 86.0% in 2014 to 84.7% in 2015. The highest pass rate in 2016 was attributed to the West Coast District with

88.4%, followed closely by the Overberg District with 88.1%. The lowest pass rate in 2016 was that of the combined Eden and Central Karoo District 80,2%.

Despite having the second-highest pass rate in 2016, the Overberg District's rate has been deteriorating in the last few years. This is concerning, given that the Overberg in 2014 achieved the highest pass rate (92.7 per cent) of any district across the last three years. Within the City of Cape Town, the Metro-North region had the highest pass rate at 83.5% in 2016 with the Metro East and South each achieving an 80.5% pass rate.

The graph that follows depicts the 2016 matric pass rates of these eight education districts.

Table 5: Western Cape matric pass rates. ***Source: (2017d) WC Socio-economic Profile: (City of Cape Town)***



	Cape Winelands	Eden And Central Karoo	Metro Central	Metro East	Metro North	Metro South	Overberg	West Coast	Western Cape
2014	84,7	84,8	88,4	82,8	88,4	85,1	92,7	87,5	86,0
2015	83,7	85,2	87,2	80,5	86,8	83,4	89,7	88,9	84,7
2016	83,3	80,2	82,2	80,5	83,5	80,5	88,1	88,4	82,2

In preparing learners for the future, the Western Cape Education Department (WCED) has developed an e-Education Vision that will see the expansion of the existing technology base and digital resources and the introduction of appropriate solutions that are responsive to changing educational needs (WCED, 2012). The vision involves a shift from traditional methods of teaching and learning in conventional education environments, where appropriate, to e-teaching, e-learning and virtual learning environments where digital resources and systems are more readily available to schools, and the engagement between educators and learners will be more enhanced than before.

According to the WCED (2012) the ultimate aim is to ensure capacity, for teachers, education managers, and learners to be empowered to use technology effectively and innovatively; models, methodologies, pedagogies and digital content that are responsive to the educational needs of learners; and technology-enriched environments that enable effective learner-centred e-learning.

According to the Ed-Tech Challenge Project Final Report (Western Cape Government, 2018:12) the Western Cape Government is committed to quality education and believes its most important function (as articulated by the then Premier Helen Zille in her State of the Province Address (2017) is 'to prepare young people to use their freedoms to enrich their own lives and develop our country.' One of the crucial purposes of this initiative is 'to utilise a design-thinking process to identify core challenges which can be addressed through digital technologies and other enablers of change and to develop these challenges into briefs which can be sent to market' (Western Cape Government, 2018:13).

2.3.3. Economy and schools affected by poverty

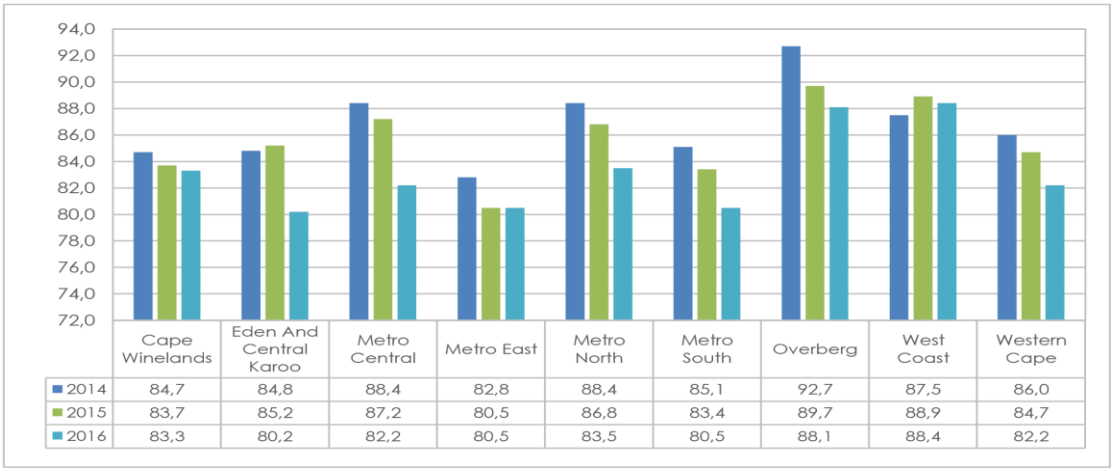
The social contexts within which the learners live, and teachers teach, have had a profound impact on the psyche and physical well-being of the teachers and learners. This can be evidenced in an increase in the number of violent incidents at school especially within the lower-income areas, including violence against teachers, high absenteeism (teacher and learner), poor academic performance, apathy, low staff morale, high learner and teacher attrition, emotional disconnect, general burnout, and resistance (Grobler, 2019). It is within this context that the Superintendent General (SG), together with the Executive Committee (EXCO) of the WCED, have recognised the need to shift the hearts and minds of all officials, teachers, learners, parents, and communities to varying degrees.

This has led to the development of the Transform to Perform Strategy as an integral part of the WCED Strategic Framework. The Transform to Perform Strategy is based on the fundamental shift in global expectation on the role of education and the contribution it makes to transforming society. To bolster its vision, the WCED has also adopted six core values to spearhead its values-driven initiative of which competence and innovation are two of the significant components (WCED, 2017).

The deteriorating financial health of households and individuals under the weight of economic pressures, specifically between 2011 and 2015, has increased poverty levels, according to the Poverty Trends in South Africa (Statistics South Africa, 2017) report released by Statistics South Africa in 2017. The report cites rising unemployment levels, low commodity prices, higher consumer prices, lower investment levels, and policy uncertainty as the key contributors to the economic

decline in recent times. The following graph indicates the GDPR per capita in the Western Cape.

Table 6: Western Cape GDPR per capita (2017 Socio-economic Profile: City of Cape Town)



	Cape Winelands	Eden And Central Karoo	Metro Central	Metro East	Metro North	Metro South	Overberg	West Coast	Western Cape
2014	84,7	84,8	88,4	82,8	88,4	85,1	92,7	87,5	86,0
2015	83,7	85,2	87,2	80,5	86,8	83,4	89,7	88,9	84,7
2016	83,3	80,2	82,2	80,5	83,5	80,5	88,1	88,4	82,2

These recent findings indicate that the country will have to reduce poverty at a faster rate than previously planned. Therefore, to ensure that learners become compliant for the 4th Industrial Revolution demands, the introduction of coding throughout the learners schooling years can offset the downward trend of the poverty rate as there is an enormous demand for computational thinking subjects such as coding for a future workforce that demands these technological skills. Furthermore,

> computational thinking opens doors for more than just students of technology. It is a way of thinking through problems and processing the steps which can lead to a solution, helping develop the capacity and limits of computing (Wing, 2016).

McClelland & Grata (2018:32) informs that with the constant evolution of technology, it is imperative that teachers empower their students to become digital citizens. Integrating these innovative subjects from the Foundation Phase (FP) to the Further Education and Training Phase (FET) throughout the curriculum, will have the potential to reduce the poverty rate, and prepare skilled learners for future 21st-century job placements.

2.3.4. An overview of ICT Teacher Professional Development in the WC.

The WCED has also embarked on an exciting pathway of providing digital infrastructure to schools (e.g. local and wide area networks (LAN and WAN respectively), software, and hardware) over time, and professional development for teachers and principals to ensure

the increased use and integration of e-learning to enhance the quality of teaching and learning.

In the Western Cape Province, planned provision of CPTD is normally organised and facilitated by the employer, in this instance, the WCED, the teacher unions, and private providers such as non-governmental organisations (DoE, 2011:6). The Western Cape Education Department's professional development centre, the Cape Teaching and Leadership Institute (CTLI), hosts hundreds of teachers on a weekly basis, while many others attend professional learning opportunities elsewhere in the province.

According to the WCED (2016) training of educators for e-learning began in 2015 at the CTLI and has so far included:

- basic training for educators on how smart classroom technology works,
- sessions with principals to provide them with tools to ensure that the technology is utilised and that its use is sustained, and
- courses for educators on basic ICT skills.

The main aim of the CTLI is to enhance the professional development of teachers to enable them to manage and implement the curriculum (WCED, 2015). This recent snapshot (Table 7) is a simple indication in this regard:

Table 7: TPD in ICT at CTLI. ***Source: CTLI (2019f) Western Cape Government: Directorate-CTLI***

ICT INTEGRATION INTERVENTIONS 2020			
Course	Term 1	Term 2	Term 3
Smart Classroom Level 1	31 January & 01 February	03 & 04 April	10 & 11 July
Smart Classroom Level 2	28 & 29 February	08 & 09 May	31 July & 01 August
Google Essentials Level 1	25 January		11 July
Google Essentials Level 2	15 February		01 August

In addition to attending weekday interventions, teacher commitment is further confirmed through their dedicated participation on weekends and during holidays. These teachers demonstrate the WCED's mantra for teachers: enter to serve, continue to learn.

Information and Communication Technology (ICT) solutions and integration interventions are central to all the CTLI courses, which empower teachers to be masters of ICT-enabled classrooms. The Education Library and Information Services (EDULIS), as a primary source of information, research, and related materials, is regarded as a key partner in promoting professional development and is situated on the CTLI campus.

2.4. Schools and district features

2.4.1. Athenian Primary school

Athenian Primary, a school selected as one of the research sites, is a public primary school situated in the more affluent suburbs of Cape Town. The school is a co-educational primary school that was founded in 1948 as a dual-medium school with 94 pupils. Currently, the school has 571 learners and there is a continuous demand for access. The school has 25 teachers and the teacher to learner ratio is currently pegged at 1:32. The smallest class of learners is 27 with the largest class being 35.

Athenian Primary falls within the district of Metro Central which has a ratio of approximately 65% of formerly marginalised schools. As a well-resourced school Athenian Primary falls within quintile 5, as many of its parents are middle to upper-class citizens of Cape Town. The district has continuously delivered matric results that measure above national averages and there is a real culture of learning that permeates throughout the entire district.

The school provides a happy and safe yet stimulating learning environment for pupils in Grades 1 to 7 in which they can learn and develop to their full potential. The school was officially opened and named Athenian Primary school on 8 June 1949. The parents of the well-known actor and comedian, Pieter Dirk Uys, wrote the words for the school song and composed the music, as he was a pupil at the school at the time.

By providing learners with a stimulating learning environment, where they focus on all aspects including academic work, sport, and culture, the school ensures that all children are ready for high school by the time they need to leave. With a vibrant team of committed staff members, the school seeks to develop each child's full potential. They encourage family involvement and value their relations with the wider community.

Athenian Primary is one of only fifteen public primary schools in the country that are recognised for excellence in their inclusive approach to learning. Their capacity-building model ensures that teachers and teacher aides, in collaboration with various specialists, help all children to learn more effectively. The schools' guiding principle of inclusivity in education relates not only to children with physical and learning disabilities but also to the brightest children. Athenian Primary has a unique programme of enrichment and extension for children with a higher ability which focuses on both academic and social skills. The learners' creativity is further nurtured through various art and cultural projects,

and special attention is afforded to the development of innovative skills such as IT and coding in particular.

2.4.2. Trojans Primary School

Trojans Primary was established in 1900, and moved to its present location in 1968. Trojans Primary is a small and close-knit school in an upmarket suburb of Cape Town. The school cater from Grade 1 - 7, and has one class per grade consisting of maximum 36 learners per class. Currently the school accommodates 247 learners with 8 academic staff and 1 school manager. The school also offers sport and extramural activities.

Originally strictly a whites-only school, with the end of apartheid in 1994 it was able to embrace a multi-racial, multi-denominational approach, though the school fees attracts mostly the middle to upper income sections of the community. Their current principal, believes firmly in remembering the school's roots while looking to the future. The school falls within the boundaries of Metro Central and is a fee-paying school registered as a quintile 5 institution.

Though the school has recently developed an open policy regarding race, the overwhelming majority of learners come from the higher income white community, with a number of learners currently enrolling from middle-income and formerly disadvantaged communities who are able to afford the school-fees.

2.4.3. Spartans Primary School

Spartans Primary is situated in a sought-after area of the Cape Peninsula, and one can be forgiven if an image of grandeur comes to mind regarding the history and financial situation of the institution. However, Spartans Primary came into being from humble beginnings, servicing a community that was downtrodden during the apartheid era.

The school services 279 learners that reflects the legacy of a bygone era. Situated in Metro South, and categorised as a no-fee school in quintile 2, it is surrounded by both opulent and disadvantaged communities and schools within the surrounding Constantia area, servicing the upper income groups of the Western Cape, and Steenberg Primary that caters for the lower income communities. The average number of children per class is approximately 35,57 learners.

There has always been a desperate need for a primary school in this area since Reconstruction and Development Programme (RDP) houses were built by the government in 1999. The children of the area have been attending over 14 schools in the surrounding areas, such as Constantia Primary, Thomas Wildschutt junior and senior primary schools in Retreat, Heathfield Primary, Steenberg Primary, etc. Four buses were used to transport them to the various schools until Spartans Primary was established. Now they can walk to school.

The diverse and multicultural school is a home away from home for learners with 13 different home languages from all over Africa. The learners are encouraged to celebrate their diversity by providing opportunities to promote social cohesion. Visitors to the school are welcomed by a big bold sign stating, 'When you enter this loving school, consider yourself one of the special members of an extraordinary Spartans Primary family'. In and around the school, values such as their celebration of their diversity, pride in their surroundings and community have been visible since 2011 when the school was built; the school has sustained its values-driven approach and infused it with the current WCED Transform to Perform (T2P) strategy and approach to education.

The school manager, is very passionate about her values-driven school environment as well as her values-based leadership and management, while learners are impacted by social issues like poverty, gangsterism, and alcohol and substance abuse. She is a winner of the auspicious National Teaching Award for Excellence in Secondary School Leadership, and strongly believes that current social circumstances cannot determine the intelligence of a learner.

CHAPTER 3: Literature review

3.1. Introduction

Having set the context for the study in the previous chapter, this chapter expounds comprehensively on the theoretical and empirical literature and comprises several interconnected sections. This literature review is divided into seven sections which relate directly to the research question and sub-questions. The rationale for selecting the themes as my focus is to ensure alignment with my research question, 'What are the professional development experiences of South African primary school teachers who teach coding as a novel subject?'

The first section offers an introduction to the subject Coding followed by an overview of computational thinking skills such as Information Technology (IT), ICT, and Computer Studies (CS) within a global and South African perspective, with emphasis on where coding fits into this area of computer literacy. It further seeks to determine the perceived value that it affords learners in the learning process and future local and global economy.

The second section reviews the relationship, both locally and globally, between the curriculum and coding as a curriculum subject. Empirical research from a range of countries is reviewed and employed to substantiate the research outcomes.

The third section aims to define how teachers teach ICTs, focusing specifically on the innovative area of coding instruction both locally and globally, and relates directly to the research question.

The fourth section of this chapter alludes to teacher professional development (TPD). Within the confines of this section, the first part of the section focus on delineating teacher professional development in ICT and coding instruction, models of TPD, and the perceived teacher motivations of TPD for teaching coding.

Section five refers specifically to research question 2 and deals with teacher participants' experiences of the training received in teaching coding. It further speaks to areas of disquiet that are discussed under headings that refer to the facilitators' knowledge, methodological approach, duration of the programmes, and collegiality.

Section 6 introduces the conceptual framework with a visual presentation that informs the study.

The final section supplies concluding remarks and a short summary of the chapter. Though there is currently a scarcity of literature on teaching coding in the South African

primary school context, the research has employed available literature on computational thinking to underpin the study.

3.2. Coding skills

In recent years, the popularity of coding as a learning area has led to the development of many new tools, teaching approaches, and curricular interventions for young children to explore the subject (Balanskat & Engelhardt, 2015). It is becoming increasingly evident that knowledge alone is not enough to prepare learners for the rigours of the modern world. In today's digital age, communication skills have become more important and more varied.

The business world requires graduates who are innovative with cutting edge expertise and skills to traverse and surmount the expectations of the 21st century. In this regard, Bialik & Fadel (2015:1) hold that 'to truly have the expertise, students must learn what to do with the information they learn'.

3.2.1 Definition of coding

Ada Lovelace is regarded as the first computer programmer**.** Lovelace's contribution to coding, however, was just the beginning**.** Many consider the 1980s to be the golden age of technological developments, and from the perspective of coding history, it probably was. This period saw the conception of C++**,** a language in use consistently today (think Adobe, Google Chrome, and Microsoft Internet Explorer), while 1987 was the year PERL debuted, a language currently in use by IMDB, Amazon, and Ticketmaster, amongst others. By 1989, Tim Berners-Lee had invented the internet**,** which has arguably had the biggest impact on our modern working lives (Bryant, 2011). More recent and updated versions of coding programmes include Python, Java, JavaScript, Swift, and Scratch 3.0.

Though coding forms a crucial component in managing world industries and economies, its full potential and value have seldom been recognised. Coding is what makes it possible for us to create computer software, apps, and websites. A program is simply a text file, written in a certain coding language. Coding or programming is the process of taking an algorithm and encoding it into a notation, a programming language so that it can be executed by a computer. Without an algorithm, there can be no program. It takes a programming language to get a computer to behave how you want it to. Sterling (2016:80) notes that

the distinction between computational thinking and programming is subtle; in principle computational thinking does not require programming at all, although in practice, representing a solution to a problem as a program provides a perfect way to evaluate the solution, as the computer will execute the instructions to the letter, forcing the student to refine their solution so that it is very precise.

3.2.2 ICT, CT and IT Skills

According to the National Council for Curriculum and Assessment (NCCA) (2018:5), there is a growing recognition across various countries around the globe that computer science has enormous educational benefits such as critical thinking and problem-solving skills, understanding a world saturated with digital technology, as well as economic benefits as enterprises struggle to recruit well-educated graduates. These are important skills for learners to acquire to meet the demands of the Fourth Industrial Revolution.

The National Council for Curriculum and Assessment was established following the 2007 reforms as a statutory council by the Educational Act of 2008, Act 778. The Council is responsible for the development and determination of its advice on matters relating to curriculum and assessment. In this regard, the introduction of Computer Science, Programming, and Computational Thinking to primary school curricula has been implemented in several countries and is being considered in many more.

Daniels (2002) notes that ICTs have become one of the basic building blocks of modern society within a very short time. Also, according to UNESCO (2002), Information and Communication Technology (ICT) may be regarded as the combination of Informatics Technology (IT) with other related technology, specifically communication technology. For this reason, many countries now regard understanding and mastering the basic skills of ICT, and concepts of computational skills, as part of the core of education, alongside reading, writing and numeracy.

In one of the most noteworthy changes over the past decade at the primary school level, there was a realization that primary schools presently deal with children of the digital or internet generation. That is, with children who were born into a world where digital technologies such as the internet, smartphones, mobile learning, social networks, and coding have become commonplace (Kalas, 2013). Bates (2016:13) further implies that

> educators who are exposed to the technological age where digital literacies are introduced into the curriculum to prepare learners for a digital world are taking the view that these changing external conditions give them no alternative but to accommodate these changes and to deeply rethink and reconsider existing views on schooling and the goals of education.

Furthermore, Bates (2016: 13) postulates that educational institutions were built largely for another age, based around an industrial rather than a digital era, thus teachers and instructors are faced with a massive challenge of change. According to the DBE (2018:10), this requires a transition in learning that fully harnesses the power of digital tools and resources to impact all aspects of learning including how teachers mediate learning, how learners use digital tools and content resources, and how that learning is assessed.

3.2.3 Value of ICTs and coding on learning and future global interaction

Stenger (2017) informs that basic coding courses in schools provide learners with the knowledge to develop their own websites, apps, and computer software. He further states that at its most basic, learning how to code is learning to tell machines what to do (2017: 1). This, however, requires the mastery of a problem-solving skill known as computational thinking, which involves breaking larger tasks into a logical sequence of smaller steps, diagnosing errors, and coming up with new approaches when necessary.

Prior research in early childhood settings has shown the benefits of introducing technology and engineering early for improving children's sequencing ability, design learning, executive functioning, mathematic and linguistic development, and logical reasoning (Kazakoff, 2014; Kazakoff & Bers, 2012; Kazakoff, et al., 2013). Furthermore, Serafini (2011: 145) informs that

> "I believe that Computational Thinking is nowadays essential… I, therefore, promote the idea that a computer science subject relying on computational thinking should be mandatory at every school stage, including primary school.

However, relatively little research has been conducted on coding as a learning area in itself, and which existing knowledge domains are cultivated when young children engage in coding. When children learn to code, it helps them to develop essential skills such as problem-solving, logic, and critical thinking (Stenger, 2017). Through coding, children can

learn that there is often more than one way to solve a problem and that simpler and more efficient solutions are often better. Learning to code encourages children to become creators, not just consumers, of the technology they use. Tufts (2016) in Sterling (2016:80) lists seven benefits of teaching children to code from an early age. These benefits fall loosely into three groups:

> teaching children general problem-solving and design skills – essentially the arguments for computational thinking; introducing the students to the environments they will be using in the future; and encouraging more students to take up careers in coding, with benefit to society and the workforce (Tufts, 2016).

Coders or programmers are required in every industry and, as a result, job prospects and job security are no longer as closely tied to the ups and downs of the technological sector. Programming skills are in demand across a range of industries. According to (Dishman, 2016: 2) in the Burning Glass Technologies Report (2016) half of all programming openings are in finance, health care, and other sectors outside of the digital technologies. This has increased the demand for these skills, beyond the domains usually considered technology centres, and therefore has an essential place as a curriculum subject within the school domain.

3.3 ICT and coding in the curriculum

3.3.1 Coding within the global curriculum

Since this is a comparatively recent trend in curriculum development, there is still a lot to learn about the rationale of this area of learning in a child's primary education, how best to design and integrate this area into a primary school curriculum, and how best to use these curricula in schools (NCCA, 2018:5). Garcia-Penalvo,, Reimann, Tuul, Rees, & Jormanainen (2016: 1) state that

> in a meta-analysis of 27 peer-reviewed papers on the subject of teaching computational thinking to school-aged children, it was found that only 'nine peer-reviewed intervention studies were based in K-12 settings', highlighting the gap in the research of developing computational thinking in school-aged children.

This indicates that even the academics who researched the topic realised that the scope of their work was limited. The motivation for teaching topics such as coding, specifically at the primary school level, is largely based on the value attached to exposing children to

the concepts, and developing awareness, of the technology which surrounds them in the world in which they live' (NCCA, 2018: 6).

Despite some opinion that the emphasis should not be to teach coding at all as it is only another language, Crow (2014) in (Garcia-Penalvo, et al., 2016: 3) argues that

> we should be teaching how to solve problems, how to use logic, and creativity, those transferable skills are more important than code on its own and can be applied not just to any programming language but to real-life contexts.

Martin (2016) argues that learning to code and develop computational thinking are skills that make an essential contribution in the learning process of children, helping them to face many situations they will find in life, and enabling them to effect collaboration between humans and the use of machines. Furthermore, students trained in computational thinking are significantly better prepared for the daily tasks and the professional work that awaits them in future (Basogain, Olabe, Rasmirez & Garcia, 2016). Thus, promoting an initiative to introduce coding at an early level could significantly narrow the digital divide that is currently experienced.

Though there is some debate around teaching primary school learners to code, there is also a consensus that learning languages are better done when young and since learning to code is just like learning another language, advocates of coding suggest that children can never be too young to code (Garcia-Penalvo, *et al*., 2016:6). Llorens-Largo (2015) as cited in Garcia-Penalvo, *et al*. (2016:15) further argues that

> at the same time that children learn human languages, both for speaking and writing, natural languages, encompassing all matters related to the experimental sciences (physics, chemistry, biology, etc.), and humanity languages, involving social sciences and humanities, it is also necessary they learn digital languages, in which one of the competences to be a success in the digital world is included, using coding as the way to solve problems and computational thinking as a working paradigm.

Garcia-Penalvo, *et al*. (2016:6), while learning to code in addition to learning mathematical and computational ideas, people are also learning strategies for solving problems, designing projects, and communicating ideas. He adds that these skills are useful for everyone regardless of age, background, interests, or occupation. Globally, stakeholders (educators, parents, economists, politicians and so on) are of the view that students need some computing and coding skills because they help to understand

today's digitalised society and foster innovative skills like critical thinking, problem-solving, collaboration, communication, and creativity (Ananiadou & Claro, 2009; Balanskat & Engelhardt, 2015).

The inclusion of computer science, programming, and computational thinking to primary school curricula has been achieved in several countries such as the United States & England, and is being considered in many more. The importance of coding in the curriculum is aptly described by Papert (1980:5):

> In many schools today, the phrase "computer-aided instruction" means making the computer teach the child. One might say the computer is being used to program the child. In my vision, the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, from mathematics, and the art of intellectual model building.

Furthermore, Papert (1980) argues that experience has indicated that in the LOGO setting that is a simple computer programming language used to control devices, the relationship is reversed: the child, even at a young age, is in control; the child programs the computer. Thus, in teaching the computer how to think, children embark on a journey of how they think. The experience can be heady: thinking about thinking turns the child into an epistemologist, an experience not even shared by most adults (Papert, 1985). Worldwide, there is momentum behind teaching coding and many countries are experimenting with coding in the curriculum. According to Kukul, Gökçearslan,& Günbatar (2017), coding is considered to be a 21st century skill, enhancing problem solving, critical thinking, communication, collaboration-flexibility, computational thinking, and innovative thinking skills. It is these skills that are required for future work placement.

Webb, et al. (2017) reports vignettes (table 8) from five countries where programming is in the curriculum. Much can be learned from the emerging themes of these countries.

Table 8: Emerging themes concerning curriculum. ***Source: Webb et al (2017). Education Information Technologies.***

THEME	UK	NZ	AUSTRALIA	ISRAEL	POLAND
Entitlement. Who is the CS curriculum for?	All from elementary school upwards	High school subjects for seniors. Review underway. Considering all students starting at 5 years old	New curriculum for all	Very talented students, but all must learn computing and computational thinking	All from elementary school
Starting age for CS	Early	High school (under review)	Early	High school	Early
Content balance	Across the content of IT, CS, Digital Literacy & Computational Thinking	Under review	Across the content of IT, CS, Digital Literacy & Computational Thinking	Computer Literacy for all – CS for some	Across the content of IT, CS, Digital Literacy & Computational Thinking
Teacher professional development	A major challenge	A major challenge	A major challenge	Important	A major challenge

This palpably signify the importance that many countries attach to include coding in the curriculum from an early age.

The age at which students should start to study coding was an important emerging theme from the vignettes and a key question in determining when the key knowledge elements needed to be introduced. Table 8 informs that Israel and to a lesser extent New Zealand are focused only on the high school learners whilst Israel's' focus is on the more talented learners. This creates a big vacuum between the younger learners at the primary and the learners at the high school. This categorically impacts on the continuity and flow of acquiring the necessary knowledge and skills required in this field. In this regard, New Zealand is reviewing its current stance and is seriously considering including the primary school learners as part of the CS program in the foreseeable future.

In a separate study to understand what good practice in implementing a coding or technology curriculum might look like, the NCCA selected six jurisdictions (New Zealand, Scotland, England, Finland, Northern Ireland, and the USA) for an in-depth examination. They collectively represented a range of different pedagogical approaches to implementing coding in their curricula (NCCA, 2018:4). In these countries, creating with technology, understanding technology, and using technology are all named very differently, but are all linked when children learn how to code.

According to the NCCA (2018:32), all six curricula introduce computational thinking activities and coding concepts from the first year when children attend primary school. Children develop and enhance these skills with age-appropriate tasks and resources as they progress through school. The NCCA study further states that at the start of primary school, coding and computational thinking concepts are introduced using algorithms, patterns, logic, decomposition, and debugging which are based on the concrete physical motion that children can relate to (NCCA, 2018:32). There is also a shared belief that technology is a necessity to create global citizens who can contribute to the knowledge economy amongst many societies in the Middle East and Africa (UNCTAD, 2019).

It is noteworthy to observe that all of these societies believe in the necessity to introduce ICT and internet literacy to the primary school level, as it is believed that we need to prepare students at a young age to be able to deal with technology (Hennesy, Ongoko, Harrison, Kiforo, Namalefe, Naseem, & Wamakote, 2010).

Informatics is a relatively new model of ICT, with broader goals within the information industry such as digital literacy (basic knowledge, skills and concepts of Informatics, and computers; computer literacy, working with applications; safety in a digital world), and

programming or computational thinking. This model is still rare in primary education, although, it has been implemented at this level in a few countries and is being discussed in many others (Kalaš & Mittermeir, 2011). The Russian Federation is currently implementing an informatics approach and is of the believe that

> informatics is an important part of primary school education for the 21st century. By Informatics we understand here a field of science that uses mathematically formulated notions and mathematical methods of reasoning for discrete finite objects and processes applicable to formal human reasoning as well as to electronic computing, control, and software engineering (Bulin-Sokolova, Semenov & Vardanyan, 2011).

While learning to code at the primary school level, children are encouraged to think critically and strategically to solve problems – often simple puzzles like getting an onscreen character to move around a maze. For younger children, visual blocks are often used to represent programming concepts and terminology, such as procedures, loops, and conditional instructions. Many countries have re-evaluated their curricula and have revised them or are in the process of revising them so that their curricula include coding training. The European Schoolnet's (2015) report 'Computing Our Future: Computer Programming and Coding' states that many countries have integrated coding training into their syllabi or are in the process of this addition.

3.3.2 ICT and coding within the South African curriculum

Application of innovation in learning at an early age has seldom been promoted by the South African educational authorities and we are therefore faced with a situation where there is a mismatch between employment opportunities available and the skills that our learners possess. Research done by Hove & Grobbelaar (2020: 60) informs that

> although South Africa is advanced in ICT use in sectors such as higher education and banking, the primary education sector and, in particular, public and rural primary schools may be lagging behind in technology uptake.

Also, innovative education such as CS, IT, and Coding are subjects that prepares learners for the challenges of employment, civic duty, and life in the 21st century (Saavedra & Opfer, 2013). Unfortunately, the lack of innovative subjects has also

prevented the teaching profession from employing many of the inherent skills that are perceived to enhance learning in the classroom.

In a study, Van de Oudeweetering & Voogt (2018:17) stated that:

> teachers typically indicated spending the least attention to digital literacy and innovative thinking, despite the alleged importance of these dimensions for twenty-first-century practices. This could be due to the fact that specifically the definitions and connotations of these dimensions are rather new and still the subject of discussion.

Educators have also been wary of technological innovation in their methods because they perceived that acquiring these skills would be beyond their field of expertise. Defined generally as the fear of technology, technophobia can obstruct the successful application of technology in any field (Azarfam, 2012:1) or as Fritscher (2020) indicates, is the fear or dislike of advanced technology or complex devices, especially computers.

Coding is unique in the way it brings all diverse skills together. This is one of the big advantages of teaching learners to code, as learning to programme requires computational thinking skills. Bonfiglio (2018:5) indicates that

> learning to code teaches children how to think. Computer programming isn't just about teaching how to type lines of code. It is more about teaching children how to think differently. Being able to code effectively, a programmer needs to use logical thinking. They need to be able to see a large problem and break it down into smaller pieces to solve it in an effective manner. This is called decomposition and is one of the key features of computational thinking.

Presently, coding as a curriculum subject falls within the framework of the South African National Curriculum Statement (NCS), underpinned by the Curriculum and Assessment Policy Statement (CAPS). However, according to the DBE (2019), there is no mention of coding as a subject in the document, although it is encompassed within the framework under Information Technology (IT).

3.3.3 ICT and coding within the Western Cape curriculum

It has become clear that digitalisation is transforming not only our personal lives but also our workplace as it results in the emergence of new technologies, ranging from mobile, cloud, social media and analytics, to wearable devices, 3D printing and autonomous business systems, and the full digitisation of economies (Benkert & Van Dam, 2015).

According to Mourshed, Patel & Suder (2012), common concerns of mainstream corporate employers in a recent McKinsey (2012) report was the lack of skills of entry-level applicants and graduates who were inadequately prepared for the world of work. For many of the youth, however, access to these skills is difficult, let alone acquiring a sufficient grounding in the basics of coding to move into a digital career.

Though there is currently a scarcity of coding opportunities in independent schools, and even more so within public schools, to instruct learners and train teachers, an initiative was launched in 2017 as a pilot project at four historically disadvantaged Western Cape schools to provide learners from Grade 8 to Grade 11, an opportunity to learn to write code. It is now expanding to more schools and aims to reach more than 500 greater Cape Metropole learners in 2020.

This initiative is the brainchild of Professor Rachel Jafta of Stellenbosch University's Department of Economics and aims to show those with the talent and interest the opportunities available to them if they acquired basic coding skills. She informs that too few children were learning computer coding skills for several reasons, including a scarcity of resources in public schools, especially in the areas of science, technology, engineering, and mathematics (STEM). More importantly, there is a need to move beyond the confines of STEM and teach children how to apply technology and digitalisation.

3.4 How teachers use ICTs and coding

Teaching and learning should be inseparable, in that learning is a criterion and product of effective teaching. In essence, learning is the goal of teaching (OECD, 2016: 32). Students' learning and motivation to learn are directly influenced by their teachers. While the atmosphere at school may promote or undermine student achievement, teaching practices in the classroom have an even stronger impact (Hattie, 2009).

Teaching strategies refer to a broad range of processes, from the organisation of classrooms and resources to the moment-by-moment activities teachers engage in to facilitate learning (OECD, 2010). Effective teaching strategies as proposed by Devlin and Samarawickrema (2010:113) include the following:

> Teaching and curriculum design needs to be focused on meeting students' future needs, implying the development in students of generic capabilities such as critical thinking, teamwork, and communication skills. The relevance of what is taught must be established by using real-life, current, and/or local examples and by

relating theory to practice. Student beliefs must be challenged to deal with misconceptions. A variety of learning tasks that engage students, including student discussion, need to occur so that meaningful learning takes place.

Technology changes over time, but the concepts of handling data and converting data into information are fairly constant and this is reflected in the terminology of the programme of study. Terms like ‘email’ and ‘database’ appear only as examples - the main headings are ‘finding things out’, ‘developing ideas and making things happen’, ‘exchanging and sharing information’ and ‘reviewing, modifying and evaluating work as it progresses’ (Ghavifekr & Rosdy, 2015)

The process of adoption of ICT is not a single step, but it consists of ongoing and continuous steps that fully support teaching and learning and information resources (Young, 2003). Hermans, Tondeur, Van -Braak & Valcke, (2008). propose three main stages of ICT instruction to be highly regarded by teachers: integration, enhancement, and complementary stages. These stages include the integration, enhancement, and complementary approach. Furthermore, additional evidence suggests that there is no single best way of teaching for every learner, subject, and context (OECD, 2013). Teachers can be effective using a variety of teaching techniques, tailoring them to the students and contexts in question.

Teaching theories are centred on two major parameters: a teacher-centred approach versus a student-centred approach, and high-tech material use versus low-tech material use. Taken to its most extreme interpretation, teachers are the main authority figure in a teacher-centred instruction model. Students are viewed as empty vessels who passively receive knowledge from their teachers through lectures and direct instruction, with the end goal of positive results from testing and assessment.

In teacher-centred classrooms, control is of primary importance, and ‘authority is transmitted hierarchically’ (Dollard & Christensen, 1996:133), meaning the teacher exerts control over the students. Critics of teacher-centeredness argue that in these classrooms, compliance is valued over initiative, and passive learners over active learners (Freiberg, 1999). Direct instruction and kinaesthetic learning form the core of this approach.

Within the context of a learner-centred teaching model, teachers and students play an equally active role in the learning process. Research into student-centred instruction in science, technology, engineering and mathematics (STEM), in which students take an active role in the learning process rather than being passive recipients of information from

the teacher, demonstrates outcomes consistent with developing 21st-century skills and STEM mastery (Keiler, 2018:2). Educators have used the constructivist theory to develop a variety of student-centred instructional approaches, each with its own research base and consistently positive student impacts. Research about student-centred, constructivist classrooms documents increases in students' higher-order thinking, learning, and motivation, particularly in STEM classes (Moustafa, et al*.,* 2013).

Research about specific models highlights commonalities across constructivist, student-centred STEM learning environments (Keiler, 2018). For example, inquiry-based instruction, grounded in constructivist theory, has yielded a variety of benefits for students, including learning of STEM content and process skills, increased levels of engagement, positive attitudes about science, and enhanced non-cognitive skills (Juntunen & Aksela, 2013; Odom & Bell, 2015). Project-based learning (PjBL), a similar student-centred model that extends solving a problem to completing a project, has been linked to gains in student motivation, critical thinking, and academic skills in STEM classes (Tamim & Grant, 2013).

Supporters of student-centred management propose that children 'see their acceptable, caring behaviour as vital to the maintenance of the group because they have a vested interest in the health of the group as a whole' (Bloom, Perlmutter & Burrell, 1999:134). Differentiated instruction, inquiry-based learning, expeditionary-based learning, personalised learning, and game-based learning form the essence of this approach, and except for differentiated instruction, they are all high-tech approaches to learning that aid instruction in ICT and coding.

Effective implementation of novel pedagogies requires understanding teachers' roles and responsibilities in transformed classrooms. According to Moustafa, et al. (2013,418), in constructivist classes 'the teacher's role is to encourage and accept student autonomy and create a comfortable atmosphere for student expression,' acting as guides for their students. Constructivist teachers behave in marked contrast to traditional instruction where teachers dominate the classroom and provide direct instruction focused on content knowledge acquisition.

Negotiation is an important aspect of a constructivist classroom. It unites teachers and students for a common purpose. Smith (1993:1) confirms that negotiating curriculum means 'custom-building classes every day to fit the individuals who attend'. Boomer (1992) explains that it is important when negotiating for teachers to talk openly about how new information may be learned and about constraints such as the obligatory curriculum.

3.4.1 How teachers employ ICT and coding strategies during their teaching

The teaching profession emphasised improving teaching methods to accommodate the new educational needs of a changing society. Recently, teaching has advanced into the television and computer age, which has changed the emphasis on teaching. In this regard, Rajah and Nagasubramani (2018: 33) note that thanks to technology, education has gone from passive and reactive to interactive and assertive.

Despite teacher attrition for various reasons, teaching is still a fast-growing profession, especially in inner-city and rural areas, and is expected to continue to grow for many years. The availability of teaching jobs steadily increases as both national and global populations expand. Also, educators who have the proper training and certification find that the high demand for skilled teachers is not impacted by the state of the economy or threats of budget cuts.

In one of the most noteworthy changes over the past decade at the primary school level, it was noted that we presently deal with children of the digital or net generation, that is, with children that were born into a world where digital technologies such as the internet,

smartphones, mobile learning, social networks, and programming have become commonplace. Many educators are taking the view that changing external conditions give us no alternative but to accommodate these changes and deeply rethink and reconsider existing views on schooling and the goals of education. As noted by Trilling & Fadel (2009),

> four powerful forces are converging and leading us toward new ways of learning for life in the 21st century namely knowledge work, thinking tools, digital lifestyles, and learning research. In this regard, it encompasses an increasing demand for knowledge workers and innovators that businesses need to be successful, new technology, devices and services that comprise a knowledge worker's equipment, different ways of delivering, watching, hearing, entertaining, communicating or solving everyday problems, and a better understanding of how people learn.

As Trilling and Fadel (2009: 12) put it, these four forces are simultaneously creating the need for new forms of learning, and also supplying the tools, environments, and guiding principles required to support new learning practices. Significantly, in the context of education, ICT is often perceived from two sides: technology as an information medium, and technology as a construction medium. Papert (1999, 87) points out that 'education itself has two perspectives that could also be called informational (getting information and

skills) and constructional (creating, discovering, constructing knowledge)'. Coding or programming falls within the latter perspective.

3.5 Teacher professional development

3.5.1 Classifying teacher professional development

The success of a nation depends on various aspects of which education plays a pivotal role. According to Lynch, Asavisanu, Rungroingarmcharoe, & Ye (2020), successful educational systems are contingent on the quality of its teachers, and thus, unambiguously delineated aims, organised curricula well-resourced classrooms and trained teachers to run the system. Quality of education can be achieved with quality teachers and therefore quality education requires clearly defined objectives, a well-prepared curriculum, equipped classrooms, a conducive learning environment, and skilled teachers are required to manage the educational operation.

For teachers to achieve success in the classroom, the necessary conditions and opportunities need to be created to allow their learners to achieve, and these prospects ultimately fall under the umbrella of professional development. The following discussion thus aims to ascertain how educators experience their training with specific reference to the benefits and gaps that they experienced during their training and its impact on teaching the subject in class. According to the Bill and Melinda Gates Foundation (2014:1)

> what we heard from this broad range of stakeholders was consistent: The way in which schools and districts deliver professional learning is highly fragmented and characterized by key disconnects between what decision-makers intend and the professional learning teachers actually experience.

Mizell (2010:13) indicates that 'to be effective, professional development requires thoughtful planning followed by careful implementation with feedback to ensure it responds to educators' learning needs.' District and school administrators have a similar view of what good professional development looks like. However, according to the Bill and Melinda Gates Foundation (2014), there is a real disconnect between teachers' satisfaction with the professional development they are now offered by their school or district and the areas where district leaders think they should focus more on professional learning time.

3.5.2 Elements of teacher development

Teacher development is a learning process that happens during personal, social, and professional development. The segments of teacher development discussed below are interrelated and depend on each other to benefit the learning process.

3.5.2.1 Teacher personal development

Personal development defines the individuals' strengths and qualities that assist teachers to identify and make sense of their teaching practice and themselves as individuals. Klassen & Tze (2014) completed a meta-analysis of 43 studies involving 9,216 teachers and reported that teachers' personality is significantly and positively related to teaching performance. It is also a powerful instrument to attain a healthy sense of self as a teacher, which ultimately results in positive self-esteem and self-confidence.

3.5.2.2 Teacher social development

Cultivating teachers' social skills such as listening, understanding, taking turn in communication, and communicating the intended meaning is considered as crucial in today's education. According to Huitt & Dawson (2011), teacher social competence includes being aware of one's own and others' emotions, managing impulses and behaving appropriately, communicating effectively, forming healthy and meaningful relationships, working well with others, and resolving conflict.

3.5.2.3 Professional development

Becoming professionals, as Darling-Hammond & Bransford (2005) explain, entails being 'adaptive experts' which is the intent of teachers' engagement in such a process. Teachers are reliant on professional development to transfer acquired knowledge and skills to the learners in their care. The understanding and abilities required to be a masterful teacher are not fixed, and teachers' understanding must, at all times, keep pace with change. Knowledge about the process of learning is also continually developing, requiring that teachers remain informed. Many teachers require appropriate development to assist them with continuously changing technologies (Johnson et al., 2016). We would not expect pilots to fly a modern jet without any training, yet that is exactly what expect of our teachers and instructors (Bates, 2016:36).

3.5.3 Teacher professional development in a global context

Good teachers have a major impact on student performance, both over the course of the school year (Araujo, Carneiro, Cruz-Aguayo & Schady, 2016), and into adulthood (Chetty, Friedman, & Rockoff, 2014). However, though there are many exceptions, according to the World Bank (2018) report, teachers in low- and middle-income countries often lack the skills and motivation they need to teach students effectively. Popova, Evans, David, Breeding, & Arancibia (2019:1) argue that the principal tool that countries across the income spectrum use to improve the knowledge and skills of their practising teachers is professional development (PD), which refers to on-the-job training activities ranging from formal, lecture-style training to mentoring and coaching.

Laurillard (2012:449) sees teachers as initiators defining educational challenges and the conceptualisation of their solutions. To achieve this, however, certain requirements at a teacher's place of work should already be established before this initial step can be taken. Zeichler (2010:8) holds the view that an important question that needs to be carefully considered in efforts to internationalise teacher preparation institutions and programmes is the vision of the teachers that we seek to prepare through our efforts and in this regard,

> recent publications on issues of global and international education by groups like the American Council on Education, the Longview Foundation, and the Asia Society as well as the academic literature on global education and international education include lists of global competencies for teachers that address the dispositions, attitudes, knowledge, and skills that it is felt teachers need to have to teach in globally competent ways.

Furthermore, Avalos (2011:10) indicates that

> professional development is about teachers' learning, learning how to learn, and transforming their knowledge into practice for the benefit of their students' growth. Teacher professional learning is a complex process, which requires the cognitive and emotional involvement of teachers individually and collectively, the capacity and willingness to examine where each one stands in terms of convictions and beliefs, and the perusal and enactment of appropriate alternatives for improvement or change.

3.5.4 Teacher professional development in a South African context

Among the significant areas that the South African Revised Policy on the Minimum Requirements for Teacher Education Qualifications (South Africa, 2015:64) focuses on

is that teachers should know how to teach their subject(s) and how to select and determine the sequence and pace of the content in accordance with both subject and learner needs; and to be able to reflect critically on their own practice in theoretically informed ways and in conjunction with their professional community of colleagues to constantly improve and adapt to evolving circumstances

Teacher professional development is imperative because education is an evolving, ever-shifting field. Teachers are required to become lifelong learners to teach each new group of learners. In this regard, the DHET Revised Policy on the Minimum Requirements for Teacher Education Qualifications (South Africa, 2015:58) states that

> the educator will achieve ongoing personal, academic, occupational, and professional growth, through pursuing reflective study and research in their chosen field, in broader professional and educational matters, and other related fields.

Technologies play an important role in the training programme for teachers. Advanced modes of teaching are needed to develop 21st-century teacher proficiencies, such as deep mastery of challenging content, critical thinking, complex problem-solving, effective communication and collaboration, and self-direction.

3.5.5 Significance of teacher professional development

Professional development training can help teachers to become better at planning their time and staying organised. This ultimately makes teachers more efficient and gives them extra time to focus on students rather than the paperwork. Ideally, teacher development aspires to influence their knowledge, approaches, and actions, thereby shaping learners' learning.

It has been claimed in the literature on CPD that 'well-structured CPD can lead to successful changes in teachers' practice, school improvement and improvements in pupils' achievement' (Bolam & Weindling, 2006:113). Furthermore, in their review of the world's most effective school systems, Mourshed et al. (2010) note the importance of teacher learning, by way of practice development, in bringing about school improvement.

The emergence of the information and knowledge society has brought about a change of mind-set in learning. New approaches to learning necessitate new approaches to teaching which challenge the teacher's traditional role as knowledge provider. These include teaching that emphasises higher-order thinking skills, metacognition,

constructivist approaches to learning and understanding, brain-based learning, cooperative learning strategies, multiple intelligences, and different 'habits of mind' (Cobbold & Dare, 2011:1).

According to UNESCO, the Sustainable Development Goals agreed upon in September 2015 signal that despite improvements in access to education, the right to equitable and quality 'education for all' has remained somewhat elusive (Sayed, 2018). This is especially troubling given that UNESCO estimates that 250 million children across the world are 'not learning even basic literacy and numeracy skills, let alone the further skills they need to get decent work, and lead fulfilling lives' (UNESCO, 2013:186).

Since school teachers have the potential to significantly influence the success and/or failure of their learners, they should ensure that their content and pedagogical knowledge remains recent, relevant, and that they 'play a very significant role in supplying, supporting and promoting instruction of high quality' (Razak, Darmawan & Keeves, 2009:344). For this to occur, teacher professional development should be integral to plans that aim to improve learner performance. This is precisely the primary aim of Continuing Professional Teacher Development (CPTD) which, after ensuring that teachers are familiar with changes in their profession, should seek to improve the results of learners.

To transform education in this country, South African teachers need to be appropriately equipped to meet the evolving challenges and needs of the country. The national policy framework for teacher education and development is an attempt to address the need for suitably qualified teachers in South Africa. It aims to improve the quality of education by focusing on the professional development of teachers.

3.5.6 Benefits of TPD

Numerous studies have reported on aspects of teaching practice that relate to effective classroom learning and student outcomes (Haertel & Walberg, 1993) as cited in OECD, (2013). TPD is an important part of teacher preparation programmes, especially in those aspects of teaching that are more skill-like in their conception, but there are many other important aspects of teaching that can only be nurtured through reflective strategies and experiences (Rahman, Jumani, Akhter, Chisthi & Ajmal, 2011).

Training teachers is more likely to lead to diversity in practice at all levels of instruction. According to Asu (2004) as cited by Rahman, et al. (2011) several outcome areas are

potentially affected by the teacher training programme. These include: (i) teacher knowledge, (ii) teacher attitudes and beliefs, (iii) teaching practice, (iv) school-level practice, and (v) student achievement.

Continuous teacher professional development (CTPD) are also important factors in the teachers' quality of teaching. According to Solheim (2017), effective teacher learning and professional development are important for student achievement. Teacher learning is a continuous process that promotes the teachers' teaching skills, mastery of new knowledge, and development of new proficiencies which in turn help improve students' learning. According to Ingersoll & Strong (2011) Zey's (1984) theory informs that if teachers have received effective training and induction programmes, they can implement their teaching practice effectively and be retained for their profession, and then can provide improved students' learning.

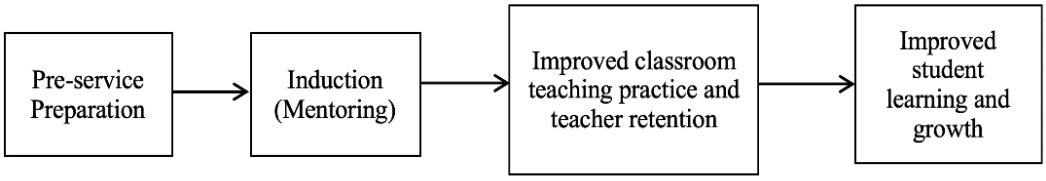


Figure 5: Zey's Theory of Teacher Development. ***Source: (Zey, 1984, cited in Ingersoll and Strong (2011)***

Typical of theory underlying induction, is Zey's (1984) Mutual Benefits model, drawn from social exchange theory. This model has based on the premise that individuals enter into and remain part of relationships to meet certain needs, for as long as the parties continue to benefit. In this regard, induction refers to an array of activities for new teacher orientation sessions, faculty collaborative periods, meetings with supervisors, developmental workshops, extra classroom assistance, reduced workloads, and, especially, mentoring. Thus, one can conclude that the success and sustainability of a coding program in South Africa lies in the effective implementation of Zey's theory of teacher development.

Furthermore, studies also suggest that mentoring appears to affect teachers' classroom management skills, as well as their ability to manage their time and workloads, Evertson & Smithey (2000) as cited by OECD (2013). OECD (2013) notes that high-quality professional development, particularly in the form of mentoring or induction, may be key to increasing the likelihood that teachers will remain in the profession (TALIS, 2013).

3.5.7 Teachers' motivations for professional development

According to Mclnerney (2019: 427) motivation, the psychological construct 'invented' to describe the mechanism by which individuals and groups choose particular behaviour and persist with it, has a history going back millennia in all cultures. Ryan & Deci (2000:54) informs that, at its most basic, motivation can be understood as a process or enactment of 'being moved, energised or activated to do something'. Motivation encompasses the reasons that trigger or inspire behaviour that is characterised by the willingness and desire to act (Lai, 2011). Motivation is thus a conduit for understanding behaviour. 'It involves a constellation of closely related beliefs, perceptions, values, interest, and actions' (Lai, 2011:2). There are various reasons for teachers to undergo teacher development that fundamentally stem from either intrinsic or extrinsic factors.

When it comes to work motivation, many theoretical strands have been put forward to explain the relationship between individual motivation, job satisfaction and performance at work. Most of the empirical studies found motivation and job satisfaction to be positively correlated, while a hostile work environment is seen as a discouraging factor in the workplace (Babalola & Nwalo, 2013; Oni-Ojo et al., 2015).

Although there are multiple definitions of motivation, a certain consensus has evolved on the main dimension that characterises motivation. Since motivation is difficult to observe directly, it has been defined by the behaviour that individuals are supposed to develop (Roussel, 2000). Vallerand & Thill (1993) summarize the concept of motivation as a 'hypothetical construct that is used to describe internal and/or external forces that generate the kick-off, the direction, the intensity, and the persistence of behaviour'.

As a result, motivation can be defined as 'a process that activates, orients, reinforces and maintains the behaviour of individuals towards the achievement of intended objectives' (Roussel, 2000:5). Ryan & Deci's (2000a:54) definition of motivation underlines this process-oriented concept: 'to be motivated means to be moved to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated'.

Dörnyei & Ushioda (2001) identified two dimensions of defining motivation on which most researchers would agree: the direction and magnitude of human behaviour. Accordingly, motivation specifies the reason why people decide to do something, how long people are willing to sustain the activity and how hard they are going to pursue the activity.

As for teacher motivation, Sinclair (2008:37) defined it in terms of attraction, retention and concentration as something that determines 'what attracts individuals to teaching, how long they remain in their initial teacher education courses and subsequently the teaching profession, and the extent to which they engage with their courses and the teaching profession'. Furthermore, Dörnyei & Ushioda (2011) highlighted the two dimensions of teacher motivation in accordance with their conceptions of motivation, namely, the motivation to teach and the motivation to remain in the profession.

Regarding in-service teachers, de Jesus & Lens (2005) indicate that the significance of in-service teacher motivation research lay in the role it played in enhancing student motivation, advance educational reform and fulfil teachers themselves. Years of studies of in-service teacher motivation have created a strong tradition in the following five research fields: influencing factors, teacher motivation and teaching effectiveness, the relationship between teacher motivation and student motivation, teacher motivation research across different disciplines, and instruments for assessing teacher motivation.

Dörnyei & Ushioda (2011, cited in Han & Yin (2016) propose four featured components of teacher motivation: prominent intrinsic motivation closely related to inherent interest in teaching; social contextual influences relating to the impact of external conditions and constraints; temporal dimension with emphasis on lifelong commitment; and demotivating factors emanating from negative influences.

Thus, given the existing characterisations of teacher motivation, the second dimension identified by Dörnyei & Ushioda (2011) is inclusive of the persistence with and effort in the teaching profession which constitutes the second and third dimensions of Sinclair's (2008) definition. Therefore, teacher motivation stems from qualities that emanate from individuals' intrinsic values to choose to teach and sustain teaching, and the intensity of teacher motivation, which is indicated by the effort expended on the profession as influenced by several contextual factors.

The literature on teacher motivations to acquire innovative skills also suggests that in recent years, school innovations have become increasingly important for worldwide reforms. In this regard internationally, educational innovations are often introduced via centrally organised in-service teacher training programmes or CPD programmes. However, in many cases, participation in these programmes is optional, and when it is compulsory there is no way of ensuring teachers' optimal engagement in these learning experiences.

As Van Eekelen, Vermunt, & Boshuizen (2006) note, teachers' will to learn must be present before their engagement in any learning activity regarding innovations. In their small scale qualitative study, they found that it was only the teachers who were eager to learn, and agreed with the new innovative views of teaching, who undertook the appropriate action to do so (Van Eekelen et al., 2006).

Also, according to Gorozidis & Papaioannou (2014:2), motivational theorists suggest that autonomous motivation to learn is instrumental for optimal learning and performance, individual adjustment and psychological functioning, greater creativity, and persistence in many different educational settings. This suggests that teachers' autonomous and subjective motivations, to be involved in new learning experiences such as in-service training programmes, should be fundamental for the success of these programmes.

Praver & Oga-Baldwin (2008) provided a list of direct motivating factors (intrinsic motivation and extrinsic motivation) and indirect motivating factors (autonomy, working relationships, self-realization and institutional support). They believed that these factors heavily influenced the maintenance of teacher motivation over their career. As intrinsic motivation has been considered a significant factor for pre-service teachers to make a career choice, extrinsic influences especially financial benefits such as salary, pension and insurance, etc., were often mentioned as extrinsic factors motivating in-service teachers.

Legault (2016:1) observes that intrinsic motivation (IM) refers to engagement in behaviour that is inherently satisfying or enjoyable. IM is non-instrumental in nature, that is, intrinsically motivated action is not contingent upon any outcome separable from the behaviour itself. In that way, intrinsic factors are drawn directly from personal motives and philosophies. Deacon (2015) postulates that intrinsic factors relate to individual motivation and beliefs; and to those which are classified as altruistic factors, which are closely linked to intrinsic factors but relate much more to the desire to do good. Concerning intrinsic motivation, several writers suggest that people are also motivated by issues of personal enjoyment, what interests them, the pleasure they derive from teaching, and the activities related to the job itself (Sayed & McDonald, 2017:3).

Conversely, Legault (2016:1) notes that extrinsic motivation (EM) refers to the performance of a behaviour that is fundamentally contingent upon the attainment of an outcome that is separable from the action itself. In other words, EM is instrumental in nature. Extrinsic factors emanate from external considerations, or according to Lai (2011), instrumental reasons attached to rewards. In this regard, Sayed & McDonald

(2017:3) hold that teachers may be motivated by what they see as the material benefits or rewards.

3.5.8 Models of teacher professional development in ICT and coding

Conceptual models of effective teacher professional development describe a cascade of influences from features of the professional development to direct impact on teacher knowledge, intermediate impact on classroom instruction, and more distal effects on student achievement (Desimone, 2009). Although a growing body of literature supports the claim that teacher professional development can improve student achievement (Blank, de las Alas, & Smith, 2007), professional development programmes differ widely in the ways they develop teachers' expertise and skills (Shulman, 2005).

Effective and successful teacher professional development must be of high quality and relevance to teachers' needs. No amount of ICT can compensate for teacher professional development that lacks these characteristics (Gaible & Burns, 2005). This is the tool by which policymakers convey broad visions, disseminate critical information, and provide guidance to teachers.

The process starts with an understanding of teachers' needs and their work environments, schools, and classrooms. It then combines a range of techniques to promote learning, provides teachers with the support they need, engages school leadership, and makes use of evaluation to increase its impact. Critical methods include mentoring, teamwork, observation, reflection, and assessment. According to Timberley, Wilson, Barrar & Fung (2007), teacher professional development programmes should engage teachers as learners, typically involving the process of modelling.

When initiating a training process, development programmes must focus not only on teachers' technical skills, but also their concerns about logistics, about how to use computers with students, and about the risks to their status in the classroom (Gaible & Burns, 2005). Successful computer-supported or computer-focused teacher development provides teachers with hands-on opportunities to build technical skills and work in teams while engaging them in activities that have a substantial bearing on their classroom practices or other aspects of the school workplace.

According to Gaible & Burns (2005), the following groups of teacher professional development are of relevance to coding instruction:

3.5.8.1 Standardised teacher professional development

This model typically represents a centralised approach, involving workshops, training sessions, and in many cases the cascade model of scaled delivery. It tends to rely on training-based approaches, in which presenters share skills and knowledge with large groups of educators via face-to-face, broadcast, or online means.

Training-based models are frequently employed to develop ICT skills such as those covered by the International Computer Drivers' License (ICDL), and sometimes to introduce the integration of computers into the curriculum. The approach mainly focuses on the exploration of an idea and the demonstration and modelling of skills. It introduces teachers to new ideas, new ways of doing things, and new colleagues. The purpose of this model is to distribute information to the largest number of teachers possible, familiarise teachers with computers, the internet, and strategies to use these tools.

3.5.8.2 Site-based teacher professional development

Teachers are exposed to this model typically in schools, resource centres, or teacher training colleges. They are expected to work with facilitators or lecturers to engage in more gradual processes of learning, and building mastery of pedagogy, content, and technology skills. Site-based TPD often focuses on the specific, situational problems that individual teachers encounter as they try to implement new techniques.

Site-based development models are inclined to bring people together to address local issues and needs over time, encourage individual initiative, and collaborative approaches to problems. It allows more flexible, sustained, and intensive development and provide ongoing opportunities for professional learning among a single set of teachers.

This model is suitable when changing instructional practices is essential or if there is a call for significant enhancement of teachers' subject knowledge or classroom teaching and learning. The objectives of this approach include ongoing growth toward overall excellence in teaching and learning. Site-based methods can also augment and provide follow-up training for standardised methods.

3.5.8.3 Self-directed professional teacher development

In self-directed professional development, teachers determine their own professional development goals and select activities that will help them attain these goals. This can involve watching video examples of classrooms, reading books on education or a field of study, keeping journals, performing case studies, taking online courses, or observing classes taught by colleagues.

Many teachers already participate in informal, self-directed development, by seeking out an experienced colleague for advice, or searching for lesson plans on the Internet. This model places all responsibility on the teacher and requires little of the school. In many cases, school leadership directs a teacher to develop expertise in a certain area without providing resources or guidance. Self-directed activities are most effective with teachers who are motivated self-starters, and who have already developed teaching skills and subject mastery. For these reasons, self-directed professional development does little to promote basic or intermediate skills, and so is of less benefit to low-skilled teachers.

3.5.9 Factors for successful TPD in ICT and coding

It is a fact that teacher training programmes play an important role to provide the necessary leadership in training pre-service and in-service teachers to deal with the current demands of society and the economy. In this regard, Agbo (2015: 71) informs that it is important for teacher trainers and policymakers to understand the factors affecting the effectiveness of successful teacher professional development in ICT. The success of the development program in teaching ICT and Computer studies is therefore not dependent on one individual factor but is determined through a dynamic process involving a set of interrelated factors and teacher traits or characteristics (Agbo, 2015).

3.5.9.1 Personal Characteristics

Personal characteristics such as educational level, age, gender, educational experience, experience with the computer for educational purpose and attitude towards computers can influence the adoption of a technology (Schiller, 2003). Teachers are urged to adopt and integrate ICT into teaching and learning

activities, but teachers' preparedness to integrate ICT into teaching determines the effectiveness of the technology, and not by its sheer existence in the classroom (Jones, 2001).

The attitudes of teachers towards technology greatly influence their adoption and integration of computers into their teaching. Therefore, an understanding of personal characteristics that influence teachers' adoption and integration of ICT into teaching is relevant.

3.5.9.2 Teacher Attitudes

To successfully initiate and implement educational technology in a school's programme depends strongly on the teachers' support and attitudes. It is believed that if teachers perceived technology programmes as neither fulfilling their needs nor their students' needs, it is likely that they will not integrate the technology into their teaching and learning. Among the factors that influence the successful integration of ICT into teaching are the teachers' attitudes and beliefs regarding technology (Hew & Brush, 2007; Keengwe & Onchwari, 2008).

3.5.9.3 ICT Competence

Computer competence is defined as being able to handle a wide range of varying computer applications for various purposes. According to Peralta & Costa (2007), teachers with more experience with computers have greater confidence in their ability to use them effectively. Jones (2004) reported that teachers' competence relates directly to confidence. Teachers' confidence also relates to their perceptions of their ability to use computers in the classroom, particular compared with their children's perceived

3.5.9.4 Teacher workload

According to Buabeng-Andoh (2012: 141), many studies have revealed that the workloads of teachers influence their acceptance of technology in classrooms. Samarawickrema & Stacey (2007) investigated factors related to the use of the learning management system in a large multi-campus urban university in Australia. They found that increased workload coupled with teaching with technology was

critical to the participants of the study. Factors reported to contribute to increased workload were course maintenance and constant upgrades, student emails, the learning of new skills, and the continuous search for sustainable strategies.

Teachers' professional development is a key factor in the successful integration of computers into classroom teaching. Sandholtz & Reilly (2004) claim that teachers' technology skills are strong determinants of ICT integration, but they are not conditions for effective use of technology in the classroom. They argue that training programmes that concentrate on ICT pedagogical training instead of technical issues and effective technical support, help teachers apply technologies in teaching and learning. Research studies have found that quality professional training programme helps teachers implement technology and transform teaching practices (Brinkerhoff, 2006; Diehl, 2005).

3.5.10 The consequence of teacher development in coding on teaching

There are many advantages to teaching computer science to children, aside from the high demand for workers in computer programming related jobs and the 21st century being heavily influenced by computing (Sáez-López, Román-González, & Vázquez-Cano, 2016). Learning to programme is the vocabulary of commands (primitives) and syntactic rules for constructing acceptable arrangements of commands. Concerning this, coding also has other advantages that can be used by learners across the curriculum. Stenger (2017: 1) notes that

> at its most basic, learning how to code is learning to tell machines what to do. But this requires the mastery of a problem-solving skill known as computational thinking, which involves breaking larger tasks into a logical sequence of smaller steps, diagnosing errors, and coming up with new approaches when necessary.

Coding education, however, can also be of benefit for learners who are not necessarily interested in pursuing computer programming as a career but would like to gain a better insight into technology and how it is shaping our world. Embedding coding experiences into other content areas leads students to think computationally. Using these practices inside the classroom allows students the opportunity to gain an understanding of how the world around them works and of strategies to solve large problems (Sáez-López *et al*., 2016).

Coding experiences, used in the mathematics classroom, bring many contributions to mathematical thinking and learning (Batista & Baptista, 2014). There is also a lot of

mathematical thinking involved when working with code. Teaching mathematics through a computing lens contributes to the understanding of the mathematics content. A study by Yadav, Stephenson, & Hong (2017) found that when computational thinking experiences were integrated into a specific mathematics classroom, the class had a much higher understanding of mathematics processes than a class that did not get the same experiences.

Furthermore, Moreno-Leon, Robles & Roman-Gonzalez (2016) found when working with coding in the classroom that middle school-aged children showed improvement in academic performance, specifically mathematics test scores related to a comparison of numbers, understanding of probability, and mathematical thinking structures.

An added benefit of coding is that it supports early literacy development. This is evident in that coding and literacy development complement each other because they are both based on a structure of communication that shares ideas and provides an experience of comprehension. Furthermore, Filipiak & Miller (2014) note that

> the integration of code into literacy education under the framework of connected learning has several important implications for education. First, previous research has demonstrated the importance of digital texts and culture in the lives of youth. Incorporating multimodal forms of texts and experience into literacy instruction offers the opportunity for teachers to make more critical connections to the lives and literacies of youth and give youth more tools to express their stories and ideas.

Undoubtedly, the advantages of learning to code extend well beyond knowing how to create an app or website, and even students who won't go on to become programmers or developers will gain valuable 21st-century skills that can be transferred to many different areas of their lives.

3.5.10.1 Benefits of TPD for the school community

Mizell (2010) notes that professional development is the strategy schools and school districts use to ensure that educators continue to strengthen their practice throughout their careers. The most effective professional development engages teams of teachers to focus on the needs of their students. They learn and problem-solve together to ensure all students achieve success. School systems use a variety of schedules to provide this collaborative learning and work time for teachers, Mizell (2010).

Institutions of higher learning cannot provide an extensive range of learning experiences necessary for graduates to become effective public school educators. According to Mizell (2010:6), educators who do not experience effective professional development do not improve their skills, and student learning suffers. As in all professions, novice teachers and newly appointed principals take years to gain the skills they need to be effective in their roles. The complexity of teaching is so great that one-third of teachers leave the profession within three years and 50% leave within five years (Ingersoll, 2003).

Even teachers with vast experience confront great challenges during their tenure due to changes in subject content, new instructional methods, advances in technology, changed laws and procedures, and student learning needs. Educators who do not experience effective professional development do not improve their skills, and student learning suffers (Mizell, 2010:6). With extra support, however, new teachers learn more effective practices to apply to daily challenges, and it assists districts to retain new teachers and set them on the path to becoming effective educators. Most importantly, research shows that new teachers who received intensive mentoring had a significant effect on student achievement after as little as two years (Strong, Fletcher, & Villar, 2004)

Positive effects of professional communities that operate beyond the school level have also been documented by several researchers. These are often organised via networks that connect teachers around subject matter or other shared educational concerns. A positive school culture is required for successful PD, otherwise precious time and resources will be spent on achieving only minor growth among teachers (Campbell 1997: 27).

For a positive school culture, a school should be humane and professionally supportive where teachers have the resources they require and the opportunities to work together and to learn from each other. Collaborating teachers utilise strengths and complement each other's knowledge and skills, thereby stimulating reflection and broadening their perspective (Somers & Sikorova, 2002:103). This creates more effective teaching and ownership of their own professional learning. According to Dymoke & Harrison (2006:80), collaborative learning is also regarded as the key to sustaining momentum.

According to Mizell (2010), within the framework of the American education system, to ensure that teachers are at all times current with the latest trends in education, various states and provinces have laws that require school districts to provide a minimum number of days of professional development, and these provinces and states provide some

funding for this purpose. States and provinces may also require periodic professional development as a condition for educators to renew their teaching license.

The South African Council for Educators (SACE), is a body established by law to uphold the teaching profession. SACE registers all professional educators, ensure that all educators conduct themselves professionally, and manages a system for the promotion of continuing professional development of all teachers in South Africa (RSA, 2013:3). Furthermore, each teacher will have a personal Professional Development Portfolio (PDP) developed according to SACE guidelines.

The PDP will provide advice and support on professional development and will provide a personal record of a teacher's professional development journey (RSA, 2013:5). Additionally, SACE will allocate professional development (PD) points to teachers' professional development activities according to a schedule of points approved by SACE. Gaining PD points is also an internationally acceptable technique which is used to recognise members' continuing professional development (Desimone et al., 2006:205).

3.6 Educator experiences of TPD during training

As a former Director of the Edna McConnell Clark Foundation that extensively researched learner achievement, Mizell (2010) indicates that although teachers have been participating in professional development for many decades, the research has shown that historically, professional development has not impacted student learning significantly. However, if professional development is implemented effectively, it has been shown to have a direct positive correlation with student performance. According to Hattie (2012:134),

> research shows that teacher quality is significantly and positively correlated with student attainment and that it is the most important within-school aspect explaining student performance. Its effects are much larger than the effects of school organisation, leadership, or financial conditions.

According to Darling-Hammond, Hyler & Gardner (2017:5), 'professional teacher development, offers teachers not only the knowledge of a new skill or strategy but the time to implement the new skill until it becomes second nature'. The length of time for professional development has to be significant and continuous to give teachers the time to learn new strategies and contend with implementation challenges.

Darling-Hammond et al. (2017:5) further state that

Teachers need support while they make attempts to implement the strategy to help them get through any challenges or frustrations they may have from changing their instructional practices. When teachers are supported during this phase, they change their teaching practices in a positive manner. Curricular models and modelling of instruction provides teachers with a clear vision of what best practices look like. Teachers may view models that include lesson plans, unit plans, sample student work, observations of peer teachers, and video or written cases of teaching.

3.6.1 Teacher Perception of TPD

There is increasing awareness that teachers must be carefully recruited and developed professionally throughout the course of their careers to be effective (Billingsley, 2004; Burns & Lawrie, 2015). Developing an effective means of supporting and retaining teachers is crucial to creating a quality learning environment for students and a supportive work environment for teachers (Evers, Van der Heijden, & Kreijns, 2016). Professional development is necessary to fill in the gaps in the skill sets of new teachers and to continue to develop the expertise of teachers (Evers et al., 2016).

Success requires teachers to be active learners and be a coherent part of other well-planned professional development activities. To improve teaching in the classroom, professional development must be collaborative, long term, and content-driven (Guskey & Yoon, 2009). Research also stresses that to be successful, teachers need professional development that is a sustained, intensive effort to improve teaching and learning (Richardson, 2003).

Teachers learn best through professional development that addresses their needs (Meissel et al., 2016). Therefore, professional development needs to include a range of activities to meet different areas of need. For example, some activities focus on students with special needs and managing the classroom. Other activities involve designing curriculum and unit planning (Pehmer, Groschner, & Seidel, 2015).

3.6.2 Features of beneficial practices during training

According to Bingimlas (2009), by identifying obstacles and barriers that stymy the effective use of ICTs in class, teachers can make significant gains in their understandings

of the roles of ICTs in teaching and learning, their personal competence with ICTs, and their confidence about using ICTs with students. In a recent study on teacher professional development in New-Zealand, Ham, Gilmore, Morrow,Moeau & Wenmoth (2002:56), found that

> some of the main benefits of the programme for them had been in personal skill development and increased classroom use of ICTs. But they also very often made reference to other benefits that they had not anticipated at the beginning of the project or had not listed as objectives in the surveys. Many of these unanticipated or emerging benefits related to the facilitators' three primary concerns of establishing collaborative networks among teachers, building teacher confidence and self-esteem, and of developing their understandings about teaching and learning with ICT.

Ghavifekr et al. (2014) further postulate that teacher professional development supports the ongoing acquisition of skills, improves teacher confidence in the use of technology, supported endeavour to integrate coding skills into other subjects of the curriculum and make teachers more committed to a constructivist style of teaching.

In terms of the effects of teacher professional development programmes on classroom teachers, the most common benefits are that the programmes allow teachers to introduce greater variety and interest in their classroom programmes. It also increases teachers' enthusiasm for teaching generally, and their sense of effectiveness as teachers.

In conclusion, the research supports the view that professional development programmes develop teachers' understanding of pedagogy in an ICT-related context, especially (but not exclusively) those in clusters that had an extensive formal component of professional reading or reflection and a strong focus on teaching and learning theory.

3.6.3 Features of shortcomings identified during training

In South Africa, coding and robotics will be introduced through an existing technology subject taught until Grade 9, or through a new subject called Digital Skills (Rivett, 2019). The curriculum is expected to provide learners with the necessary knowledge and skills to become 'inventors of new technologies to make a valuable contribution to the global community'.

According to Bargury, Muller, Haberman, Zohar, Cohen & Levi (2012), the cornerstone of implementing a new educational idea or a programme lies in the teachers. It is therefore important to focus on in-service training and evaluate the development process that the teachers are subjected to, and their feelings and attitudes. However, significant challenges identified during training were the absence of appropriate policies and an approved curriculum that could inform the teacher participants of the scope of the subject of coding needed in the various primary school grades. Furthermore, the absence of professional learning communities (PLCs) in coding amplified teachers' anxieties when faced with the challenges of teaching coding as an innovative subject.

3.6.3.1 Teacher accessibility to an approved South African curriculum in coding.

According to Gal-Ezzer & Stephenson (2010) successful implementation of a new curriculum greatly depends on the pedagogical and content knowledge of the teachers as well as their satisfaction from the ongoing training and the support offered by the curriculum's initiators. As coding training in South Africa is at the pilot stage, it requires certain foundational guidelines and aspects regarding the subject to be in place that should guide teachers and schools to prepare for effective rollout.

Teacher training, however, is expensive and currently, teachers in South Africa do not learn how to code. To develop an integrated and sustainable curriculum, it will be essential to reflect on the current requirements for teachers and to understand how they are trained. In this regard, an approved curriculum for teaching coding in South Africa has still not been officially formalised and thus add to teacher anxiety in teaching the subject.

3.6.3.2 The need for Professional Learning Communities (PLCs)

According to Kalogiannakis (2010:4), the use of ICT is becoming a part of everyday life in schools. therefore,

> the Republic of South Africa needs to determine the kind of ICT professional development interventions that are most effective for improving teaching and learning using ICT.

Professional learning communities (PLCs) play a vital role in supporting teachers during development especially during development in an innovative subject. Also, PLCs hold

potential as leverage points for affecting teacher beliefs and practices regarding technology use (Cheng, 2017). According to Heath (2017) teachers describe the ideal teacher professional development (TPD) experience as relevant to their teaching context, sustained over time, interactive, and in recent years research has highlighted the impact of teacher collaboration in improving teacher effectiveness. In particular, the area of collaboration falls within the domain of Professional Learning Communities.

Professional learning communities (PLCs) are understood as effective learning environments when they have “an impact on the professional learning and morale of the staff-teachers, school leaders and other adult workers and, most importantly, impact on student achievement” (Bolam, McMahon, Stoll, Thomas & Wallace, 2005:3). According to Whitford & Wood (2010:22) Professional Learning Communities can be defined as “small groups of educators meeting regularly to engage in systematic peer critique and support by sharing their own professional practices as well as artefacts of student learning.”

Furthermore, Windschitl & Sahl (2002:202) found that when teachers were open to innovation or innovating with technology in their teaching, “one of the most powerful settings is regular planning time with a colleague” where “sense-making opportunities are created for participants to construct meaning in connection with the use of technology”. To this end, Longfield (2018) informs on successful CPD programs based on the ‘INSPIRE’ model that entrench peer collaboration as important for successful TPD. In the absence of this assistance (as is the case observed during this research) mastering the required skills and pedagogies in ICT development can be frustrating and exasperating.

3.7 Conceptual framework

This section supplies a visual representation via a diagram of the conceptual framework that underpins the study. The conceptual framework serves as a lens for the design, analysis, and review of the data collected. It functions as the mainstay of the study and underpins the soundness and stability of the evidence accrued and referenced.

Furthermore, the conceptual framework accentuates in the simplest terms the researchers’ assumptions, informs the study’s value for education, and posits the academic basis of the constructivist view that grounds this study. Akintoye (2015) postulates that in many instances a conceptual framework is an uncomplicated way

through which a researcher presents his/her asserted remedies to the problem s/he has defined.

As indicated in Chapter 1, this study asks the question, ‘What are the professional development experiences of South African primary school teachers who teach coding as a novel subject?’ Therefore, the study examined teachers’; experiences of their professional development in coding, and was guided by TPD literature nationally, and internationally. Furthermore, it seeks to identify how teachers’ dispositions are developed or shifted, in a professional development program in coding to dispositions that are better structured and effective.

The role and functioning of schools are changing and so is what is expected of teachers. One of many reasons for teacher development is to update an individuals’ knowledge of a subject in light of recent advances in the area. In this regard, the OECD (2009: 49) defines TPD as activities that develop an individual’s skills, knowledge, expertise and other characteristics as a teacher. Also, effective professional development involves teachers both as learners and as teachers and allows them to struggle with the uncertainties that accompany each role.

TPD is a social construct, fluid in nature, provide for teachers to reflect critically on their practices and to fashion new knowledge and beliefs about content, pedagogy, and learning (Darling-Hammond & McLaughlin, 1995). Darling-Hammond & McLaughlin (1995) assert that starting with pre-service education and continuing it throughout a teacher's career, teacher development must focus on deepening teachers' understanding of the processes of teaching and learning, as well as of the students they teach.

In defining teacher professional development for this study, Darling-Hammond et al.’s (2017: v) definition is used, which describes professional development as structured professional learning that results in changes in teacher practices and improvements in student learning outcomes, as described in 6.3.2 above. Therefore, the purpose of professional development is not only to improve instruction so that learners might improve in an area of study, but also to allow for enhanced comprehension in teacher experiences of new content.

The processes refer to pedagogies presented and modelled in the TPD programme, and the pedagogies that are taught and incorporated by facilitators during the program. In the process, teachers’ existing dispositions and background knowledge are seen as having shifted based on how they experience the pedagogies, a process which in turn is based on how well facilitators incorporate, use, and teach these pedagogies. It further analyses

how teachers' prior dispositions are modified grounded on their experiences of development.

This process is thus premised upon how effective teacher trainers integrate, practice, and teach these pedagogies. The diagram (Fig: 6) that follows offers an insight into the conceptual framework utilised in the study.

CONCEPTUAL FRAMEWORK

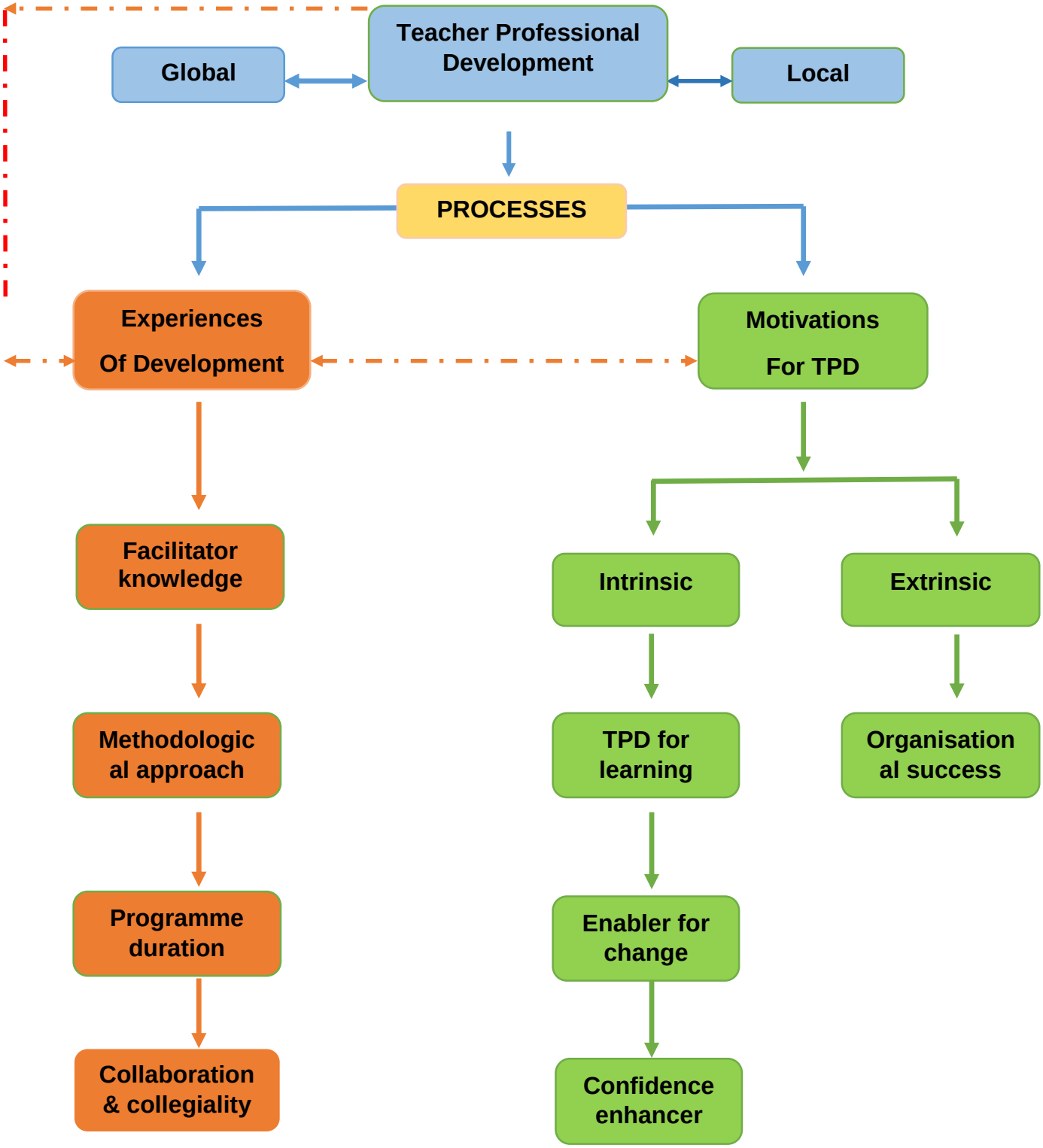


Figure: 6. Conceptual framework

3.8 Conclusion

The blueprint of the research was embodied in this chapter and presented the literature reviewed as it relates to the research question and sub-questions. The conceptual framework that underpins the philosophy on how the researcher understood and planned this research was explained in detail. As teaching is constantly evolving and new skills are required in the classroom, selecting the literature to align with the research questions required specific standards that had to be maintained.

To meet these standards, the literature reviewed was selected to elaborate on how the introduction of coding as an innovative subject could impact the South African educational landscape. Furthermore, the literature review explored teachers' motivations for undertaking professional development in coding and more broadly, how they experienced the development process.

These explorations set the foreground to determining a suitable research philosophy, an appropriate research design, and fitting methodological approaches to best support and reinforce the research. The chapter that follows explicitly elaborates on these determinations and attempts to justify in more detail how the research was conducted.

CHAPTER 4: Research design and methodology.

4.1. Introduction

This chapter discusses the research methodology of the study. The researcher aims to inform and clarify in more detail the research philosophy, the research design, and the methodology of the topic under discussion. This study is an investigation of professional development in the coding practices of teachers in selected public primary schools in the Western Cape. The purpose of the study was to investigate experiences that surfaced when primary school teachers were trained in coding and to understand and explain how they experienced the development with specific reference to best practice and gaps that are associated with the training received.

This chapter is divided into 10 sections and clarifies the research design and methodology used to obtain the required data.

Section 1 informs on the research philosophy and deliberates on the way in which data about the phenomenon was gathered, analysed and used.

Section 2 revolves around the research design. In this section the overall strategy that the researcher utilised to integrate the different components of the study to ensure that the research problem is addressed is informed upon.

Section 3 informs on the sampling method used in the research. This section explains the research selection process to determine the participants that the data was collected from.

Section 4 explains the process of data collection and the instruments used to collect the data from the participants.

Section 5 describes the data analysis process. In this section the researcher informs specifically how the data gathered from the interviews were analysed.

Section 6 deals with trustworthiness. This section discusses criteria such as credibility, transferability, dependability and confirmability.

Section 7 informs on positionality and states the stance of the researcher in relation to the social and political context of the study—the community, the organisation or the participant group.

Section 8 elaborates on the ethical consideration, informed consent, and the issue of anonymity that applies to the research and the participants.

Section 9 informs on limitations that the researcher experienced during the process of gathering data from suitable schools, suitable literature, and the Covid-19 pandemic influenced the gathering of data.

Section 10 is the concluding section in this chapter and supplies an overview of the discussions in this chapter.

The purpose of the methodology is to answer the research question ‘How are teachers prepared to teach coding as a subject in primary schools?’ as comprehensively and accurately as possible so that valid inference can be drawn.

4.2. Research Philosophy

Positioning a research project within a paradigmatic framework is a worthwhile task that will lead researchers to ‘reflect upon the broader epistemological and philosophical consequences of their perspective’ (Perren & Ram, 2004: 95). Each research paradigm has certain assumptions, strategies, methods, and limitations. A researcher must, therefore, choose the paradigm within which they will be working, understand the nature of their chosen paradigm, and document their paradigmatic choice in their writing (De Vos, Strydom, Fouché & Delport, 2011: 41).

Research philosophy deals with the source, nature, and development of knowledge (Baipai, 2011). Within the context of human action and interaction, a research methodology is needed that can effectively comprehend the complex and changing environments of our social worlds. This convolution is readily apparent in the learning environments of our schools and classrooms.

Positivist approaches cannot account for the subjective realities of individuals being studied, whereas in contrast, interpretive researchers understand ‘the world of human experience’ (Cohen & Manion, 1994:36). Interpretivism contends that knowledge is built up by and builds on our conceptual constructions, and continues to adapt to the experiential world we encounter (Cohen, Manion & Morrison, 2007). According to Willis (2007), interpretivism usually seeks to understand a particular context, and the core belief of the interpretive paradigm is that reality is socially constructed.

This interpretive study seeks to explore people’s behaviour; themes in behaviours, attitudes or trends; or relations between people’s actions. According to Yin (2014), an interpretive perspective adopts the premise that multiple realities and meanings exist,

which depend on and are co-created by the researcher. This philosophical versatility provides the researcher with the opportunity to decide the methodological orientation used in the conduct of a case study (Stewart, 2014; Yin, 2014).

Cohen, et al. (2007) state that 'the interpretive approach focuses on action. This may be thought of as behaviour with meaning; it is intentional behaviour and, as such, future-orientated.' Situations will be examined through the lens of the teachers' experiences and they will have the opportunity to talk about their actions, based on their experiences. According to Harrison, Birks, Franklin & Mills (2017) an interpretative position views reality as multiple and subjective, based on meanings and understanding. Knowledge generated from the research process is relative to the time and context of the study and the researcher is interactive and participates in the study.

The researcher posits that teachers need to reflect on their practice to apply innovative ideas to their work. Teachers should also encourage students to constantly assess how activity helps them gain understanding. This view of learning considers the student as an agent in the process of knowledge acquisition. These conceptions of learning have their historical roots in the work of Bruner (1961), Dewey (1929), Piaget (1980) & Vygotsky (1962).

The perceived benefits of this approach to learning may be particularly valuable where the teaching of complex skills, such as problem-solving or critical thinking skills, is concerned (Tam, 2000). If we accept that an interpretive constructivist evaluation is the best way to define learning, then it follows that to promote student learning it is necessary to create learning environments that directly expose the student to the material being studied. For only by experiencing the world directly can the learner or student derive meaning from it.

In the process of attempting to answer the research question, the researcher was moved by the need to interpret and construct an understanding of teacher practice and the process of teacher development in coding as an innovative subject. The research further aimed at identifying the impact of development on the teachers' training, simultaneously probing the potential benefits and possible gaps in their professional development in coding.

The position of interpretivism concerning ontology and epistemology is that interpretivists believe that reality is multiple and relative. Interpretivists avoid rigid structural frameworks such as in positivist research and adopt more personal and flexible research structures (Carson et al., 2001) which are receptive to capturing meanings in human interaction

(Black, 2006), and making sense of what is perceived as reality (Carson et al., 2001). Ontology is the nature of reality (Hudson & Ozanne, 1988) while epistemology is the relationship between the researcher and the reality or how this reality is captured or known (Carson, Gilmore, Perry, & Gronhauget, 2001).

Ontology is concerned with identifying the overall nature of the existence of a particular phenomenon. When we seek answers (reality) to our research questions, we are referring to a particular type of knowledge that exists external to the researcher. (Bryman, 2001) considers interpretivism as an ontological position in which social phenomena and their meanings are continually being changed and revised through social interaction, i.e. a researcher's accounts of the social world where nothing is definitive as the versions evolve with experience.

This study thus presents an interpretation of the participants' experiences and the meaning they make from their ways of understandings during the TPD activities. The ontological perspective of this research is structured from a relativist view as it assists in making sense of the social interaction of the study. Schwandt (2007:261) states that 'relativism is the belief that reality itself is determined by our language or conceptual scheme'.

In terms of epistemology, Stake (2006) argues that situation shapes activity, experience, and one's interpretation of the case. An epistemology is a theory of knowledge concerning beliefs about 'how phenomena [can] come to be known' (Giacomini, 2010:131); that is, how valid knowledge is produced. Pascale (2011:4) elaborates that epistemology is concerned with 'the nature, sources, and limits of knowledge,' and that it provides 'a justificatory account of the scientific production of knowledge'.

Epistemologically, the viewpoint of the interpretive paradigm is that our knowledge of reality is a social construction by human actors (Burrell & Morgan, 1979). The epistemology of this study focused on understanding the process of teacher professional development as they developed their practice, pedagogy, and skill as novice instructors of coding in primary schools.

Researchers believe that the interpretive/constructivist paradigm predominantly uses qualitative methods (Willis, 2007; Nind & Todd, 2011). According to Teherani, Martmianakis, Stenfors, Wadhwa, & Varpio (2015: 669), qualitative research starts from a fundamentally different set of beliefs – or paradigms – than those that underpin quantitative research. Quantitative research is based on *positivist* beliefs that there is a singular reality that can be discovered with the appropriate experimental methods.

Contrary to positivist research beliefs, c*onstructivist* researchers believe that there is no single reality, but that the researcher elicits participants' views of reality (Bergman et al., 2015).

As explained by Willis (2007), qualitative approaches often give rich reports that are necessary for interpretivists to fully understand contexts. Creswell (2009:4) states that ‘qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem’. Hence, in educational research, if a scholar seeks the understandings and experiences of a group of students or teachers, qualitative methods are likely to be the best-suited methods.

Qualitative research is a systematic inquiry into social phenomena in natural settings. These phenomena can include but are not limited to, how people experience aspects of their lives, how individuals and/or groups behave, how organisations function, and how interactions shape relationships. Qualitative research further refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things (Berg, 2009:3).

Researchers take note of all meanings, beliefs, symbols, and emotions aligned with events or objects and relating to research subjects in the study environment. Since they analyse the context to find and make sense of how subjects make meaning of their lives, qualitative researchers are also given to interpretation. Thus, the methodology of choice that the researcher employed was qualitative research.

4.3. Research design

A research design is a logic that links the data to be collected and the conclusions to be drawn to the initial questions of a study; it ensures coherence. According to Rowley (2002:18)

> another way of viewing a research design is to see it as an action plan for getting from the questions to conclusions. It should ensure that there is a clear view of what is to be achieved by the case study.

Research is valid when a conclusion is accurate or true and research design is, therefore, the conceptual blueprint within which research is conducted. According to Ahuja (2010), when designing research, we must recognise the type of evidence required to answer the research question reasonably. Research designs inform the planning of the methods to

be adopted for collecting the relevant data and the techniques to be used in the analysis, keeping in view the objective of the research (McNabb, 2010). This requires delineating the fundamental components of the investigation, such as research questions and propositions, appreciating how credibility and dependability can be established, and selecting a case study design.

4.3.1. Case study

Case study research has grown in reputation as an effective methodology to investigate and understand complex issues in real-world settings. Case study research as a strategy for methodological exploration, according to Flyvbjerg (2011:302) 'has been around as long as recorded history'. Contemporary case study research is said to have its origins in qualitative approaches to research in the disciplines of anthropology, history, psychology, and sociology (Simons, 2009; Stewart, 2014).

Sociologists and anthropologists investigated people's lives, experiences, and how they understood the social and cultural context of their world, intending to gain insight into how individuals interpreted and attributed meaning to their experiences and constructed their worlds (Simons, 2009). Such investigations were conducted in the natural setting of those experiences, with results presented descriptively or as a narrative (Merriam, 2009).

Yin (2009) defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. In most cases, case study research uses a variety of evidence from different sources, such as documents, artefacts, interviews, and observations, and this goes beyond the range of sources of evidence that might be available in historical study. It is also useful when a how or why question is being asked about a contemporary set of events over which the investigator has little or no control (Yin, 1994:9).

Skinner (2010: 290) states that the case study '… is valuable because of the insight it can provide into the processes occurring in a particular context'. In this research, the unit of analysis was the teacher with specific relevance to their professional development in coding. This investigation thus studied five teachers who taught coding at primary schools in different quintiles in the Western Cape. The aim was to provide information on how teacher development in coding was experienced as part of the digital literacy programme at selected schools in South Africa.

Within the context of South Africa, digital literacy has largely been neglected at the primary school level and is thus in need of attention if learners are to be prepared for the rigours and expectations of the subsequent academic phases, and future career opportunities. In this regard, the DBE states that 'consistent with the Action Plan to 2019 (DBE, 2015) the Integrated Strategic Planning Framework for Teacher Education and Development (ISPFTED) commits us to invest in digital technologies to support the delivery of the strategy'.

Though coding is currently offered only in selected independent schools and even fewer public primary schools, the subject has mostly been classified as an addition to the set curriculum. The intention of the DBE to introduce coding as a fully-fledged curriculum subject in all public primary schools in South Africa within the near future has prompted the teaching fraternity to become knowledgeable in the subject content.

The DBE has regrettably not formalised a set curriculum for the subject as yet, although it is a novice subject, and teacher development programmes have at this juncture not been initiated for the public school teaching fraternity. This has compelled the researcher to identify existing sites that offered the subject of coding and to interview teacher participants that have been trained by private corporate institutions.

Given the nature of the research question, a case study approach was considered the most suitable research strategy for this study as it provided a methodical way to gather data, analyse information, and report the results of how teachers experienced their training in coding.

4.4. Sampling

The sampling method in this research hinged on both purposive and convenience sampling methods. De Vos, Strydom, Fouche, & Delport, (2011) states that one must study the sample to gain an understanding of the population under study. The procedure most often used in qualitative research is purposive sampling, the goal of which is to choose places, people, or objects yielding the fullest and most intricately detailed information available in answer to the research questions (Lodico, Spaulding & Voegtle, 2011).

According to Maree (2010), participants are selected by the purposive sampling method in which their defining traits make them the holders of the sought-after data required for

the study. Amongst others, Walsh & Downe (2005) regard the key participant selection principles as follows: small numbers are studied intensively, and participants are chosen purposefully. Furthermore, in educational research, a group of people having specific characteristics become the population of interest to the researcher.

Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard, 2002). It is typically used in qualitative research to identify and select information-rich cases for the most proper utilisation of available resources (Patton, 2002). This involves the identification and selection of individuals or groups of individuals who are proficient and well-informed in a phenomenon of interest (Cresswell & Plano, 2011).

Of the 14 138 public and 657 independent primary schools in South Africa, only 941 public schools and 100 independent schools are situated in the Western Cape (DBE, 2016:17), of which less than 2% offer coding as a subject. For this study, the schools were selected purposively as they were all primary schools in different quintiles that offered coding as an additional subject and were in reasonable proximity to each other. In this regard, it allowed the researcher the opportunity to objectively determine how coding is implemented at schools that are resourced differently. To this extent, it is worth noting that one school was classified as a no-fee school in quintile 2 while the other two were fee-paying schools in quintile 5.

As there were only a few schools scattered over the Western Cape that offered coding and due to the vast distances between these schools, the researcher was compelled to also employ convenience sampling for travelling purposes in addition to purposive sampling to accrue the required data. The study thus utilised convenience sampling in conjunction with purposive sampling at three differently resourced public primary schools in the Western Cape which were close to each other. All three schools follow the Curriculum Assessment Policy Statement (CAPS) of the Department of Education in South Africa. Information Technology (IT), including coding, forms part of their core curriculum, and the schools have suitably trained instructors within the field of programming or coding and information technology.

The necessary consent for the research was acquired from all the relevant departments and role-players that included the WCED (Appendix A), the principals (Appendix B), and the educators (Appendix C). The following table informs on the context of the schools identified for the data collection.

Table: 9. School context.

NAME	LEARNER TOTALS	CLASS TOTAL	AVE LEARNERS PER CLASS	ECONOMIC DISPOSITION	RACIAL CLASSIFICATION
Spartans Primary Quintile 2	249	7	35,57	Mostly underprivileged learners. No-fee school	Mostly black & coloured learners.
Trojans Primary Quintile 5	473	14	34,71	Learners from middle/upper-income families. Fee-paying school	Mostly white learners and privileged black & coloured learners.
Athenians Primary Quintile 5	694	18	38,56	Learners from middle income families. Fee-paying school	Mostly privileged learners of diverse colour.

The population from which this sample was drawn is representative of five diverse individuals who has been trained as coding instructors, coming from three schools with diverse resources in the Western Cape. The teachers in the study were all in a similar age bracket (the late 20s to mid-30s) as the subject being researched dealt with 21st-century skills coding, and as a fairly new subject in the South African curriculum, appealed mostly to the younger generation of teachers. In the table below, teacher participants' (pseudonyms used) details are indicated:

Table: 10 Participants and schools' pseudonyms.

Pseudonym	Race	Sex	Age	Teaching experience	Qualification	Subjects	School
Taryn Peters	Coloured	F	34	9	BEd Hons	Code/ Eng / Afr	Spartans Primary No-fee Quintile 2
Abbey Davids	Coloured	F	29	6	ECD	Code/CS	Trojans Primary Fee-paying Quintile 5
Tania Roberts	White	F	28	6	Higher Certificate in Information Systems	Code/CS	Athenians Primary Fee-paying Quintile 5
Mervyn Adams	Coloured	M	29	3	IT Management Diploma	Code/CS	Athenians Primary Fee-paying Quintile 5
Ashley Newman	Coloured	M	35	13	BEd	NS/PE/ Code	Athenians Primary Fee-paying Quintile 5

4.5. Data collection

Data collection methods in educational research are used to gather the relevant information that is then analysed and interpreted. As such, data collection is a very important step in conducting research and can influence results significantly. Once the research question and sources of data are identified, appropriate methods of data collection are determined. Data collection includes a broad range of more specific techniques.

In research, there are various data collection instruments to gather information, but ultimately the instruments used are determined by the research questions and the context of the actual research. For this research, the flexibility of the instruments was of the essence coupled with the fact that no face to face interaction between the researcher and the researched was possible due to social distancing requirements and lockdown implementations during the COVID-19 pandemic. The most appropriate cause of action was thus for the researcher to utilise interviews via a digital format.

4.5.1. Interviews

Interviews are used to collect facts and seek to elicit information about attitudes and opinions, perspectives, and meanings, the stuff of much of psychology and sociology. They are widely used because they are a powerful means of both obtaining information and gaining insights. We use them because they give us an idea of how people think, of the personality, and the motivations of the interviewee. According to Oakley (1998), a qualitative interview is a type of framework in which the practices and standards are not only recorded but also achieved, challenged and reinforced.

The researcher used the interviews to investigate motivations for undertaking development in teaching coding, their experiences of their training, and to identify possible gaps in their training received. It is for this reason that most of the questions used in this study allowed the interviewees to talk at length about their experiences. The intention of the interview questions was thus designed to facilitate intense discussion on the research questions.

Furthermore, to gather empirical evidence, interviews had to be structured in a manner that allowed participants to supply as much detail of the topic under discussion. This required the researcher to ask questions and follow-up questions for the participants to further elaborate on previous responses. The purpose was to successfully extract

comprehensive sets of data from the respondents to formulate an educated and substantiated opinion of the topics under discussion.

Careful and meticulous planning of the interview questions was done before the actual interviews that measured not only theoretical evidence but also evidence gathered through actual observed experiences. Special attention was given to respondents' voice tone and pauses when responding to questions as this indicated an area that had to be explored further. The researcher had a choice of three variants of interviews to employ in gathering the required data, namely:

4.5.1.1. Unstructured interviews

This is a relatively formless interview style that researchers use to establish rapport and comfort with the participant, and is extremely helpful when researchers are discussing sensitive topics. Selecting this interview-style might require several rounds of interviews with participants to gather all the information needed.

Legard, Keegan & Ward (2003:138) describe the unstructured interview as a 'conversation with a purpose' as it is intended to allow researchers to collect in-depth information. This is a view also shared by Morse & Corbin (2003) who describe the unstructured interview as a shared experience 'in which researchers and interviewees come together to create a context of conversational intimacy in which participants feel comfortable telling their story'. However, since one does not use a standard interview protocol, participants' narratives sometimes manoeuvre the conversation away from other aspects of the research topic to be explored.

4.5.1.2. Structured Interviews

These are interviews that strictly adhere to the use of an interview protocol to guide the researcher. Though this method can be advantageous when researchers have a comprehensive list of interview questions, since it helps target the specific phenomenon or experience that the researcher is investigating, the structured interview is by its very nature a very rigid instrument.

In the view of Gill et al. (2008), the structured interview is defined as a 'verbally administered questionnaire' which does not use prompts and provides very little scope for follow-up questions to investigate responses that warrant more depth and detail.

4.5.1.3. Semi-structured Interviews

Gill, Stewart, Treasure, & Chadwick (2008) define this approach as an interview that has several key questions that help to define the areas to be explored. It also allows the researcher the flexibility to pursue an idea in response in more detail. It does maintain some structure (hence the name semi-structured), but it also provides the researcher with the ability to probe the participant for additional details.

According to Adams (2015:493), semi-structured interviews are time-consuming and labour-intensive and require interviewer sophistication. Interviewers need to be smart, sensitive, poised, and nimble, as well as knowledgeable about the relevant substantive issues. Furthermore, the process of preparing for the interviews, setting up the interviews, conducting the interviews, and analysing the interviews is not nearly as quick and easy as one might think (Adams, 2015:493). It does require a considerable amount of time and effort to conclude.

Despite the disadvantages, semi-structured interviews offer various advantages that suited this study. Adamson (2015:494) states that this includes the following:

- If the researcher needs to ask probing, open-ended questions and want to know the independent thoughts of each individual in a group;
- If the researcher needs to ask probing, open-ended questions on topics that your respondents might not be candid about if sitting with peers;
- If the researcher is examining uncharted territory with unknown but potentially momentous issues and the interviewers need maximum latitude to spot useful leads and pursue them.

Ultimately, each interview type has its advantages and its disadvantages as briefly outlined above, but the researcher selected in-depth semi-structured interviews as it would best address the research questions and had the means of both obtaining information and gaining insights into the phenomenon.

4.5.2. Interview method of choice

According to Gray (2009:370), an interview ‘is a powerful tool for eliciting rich data on people’s views, attitudes and the meanings that underpin their lives and behaviours’, and it was for this reason that semi-structured interviews were chosen. These interviews afforded the researcher the opportunity not only to capture views, understandings, dispositions, and contradictions with regards to their development in coding but to delve deeper by asking the participant to clarify and expand on their answers (Gray, 2009:373; Maree, 2010:87).

According to Weller, Vickers, Bernard, Blackburn, Borgatti, Gravlee, & Johnson (2018: 1) open-ended questions are used alone or in combination with other interviewing techniques to explore topics in-depth, to understand processes, and to identify potential causes of observed correlations. Also, open-ended questions allow respondents to include feelings, attitudes, and understanding of the subject. This allows researchers to better access the respondents' true feelings on an issue.

Seidman (2006) further notes that the interview exists solely to gain inside information and thereby some comprehension of the lived experiences of others, together with the meaning attached to such experiences. Thus, in-depth interviews (2 x 60-minute sessions) with audio records and field notes of five coding teachers at the schools (later changed to Skype because of the Covid lockdown) were conducted with teachers and were administered rotationally according to their availability. In-depth interviews enabled the researcher to communicate directly with the teachers and allowed them to articulate their emotions freely. Furthermore, in-depth interviews were employed to determine how teacher development affected teacher assimilation, incorporation, and experiences of their training in coding as a primary school subject.

An initial in-depth semi-structured interview (Appendix C) was conducted with the five teachers’ to determine the teachers’ background and, their motivations for undertaking professional development in teaching coding. This discussion formed the backbone of the initial interview and related directly to the question, ‘What are teachers’ motivations for undertaking professional development to teach coding? Teachers were further prompted to delineate the types of motivations that were deemed important for developing them in a subject geared towards the Fourth Industrial Revolution.

Initial interviews with two participants were held at their school during their class period for a period of approximately one hour. This initial personal interviews could unfortunately not be done with the other three participants as the country-wide lockdown due to COVID-

19 prevented any personal interaction at the school level. All subsequent interviews were thus scheduled via Skype, Google Meet and Zoom. When responses were not clearly formulated, participants were asked follow-up questions to clarify any uncertainties.

The initial interviews were subsequently followed by secondary in-depth interviews (Appendix E) to determine the teachers' experiences concerning the training received. Determination of positive aspects and gaps perceived during their training was probed. These questions were related to this one: 'What are primary school teachers' understandings of the training they received in teaching coding?', and allowed for data gathering to establish how the training impacted their perceived expectations of the training.

Though Maree (2010:87) notes that a disadvantage of using semi-structured interviews is that the participant could easily be 'swayed by trivial aspects that are not related to the study', the researcher prevented this from occurring by directing the interviewees back on track in the most amenable way possible.

4.5.3. Field notes

Historically, "scratch notes" or field notes have been a central component of qualitative research since the early 1900s, originating in the field of ethnographic anthropology (Emerson, Fretz, & Shaw, 2011). Initially, field notes were researchers' private, personal thoughts, ideas, and queries regarding their research observations and interviews (Phillippi & Lauderdale, 2018:381).

Though field notes were originally thought of as not very reliable, it is currently understood that qualitative field notes are an essential component of rigorous qualitative research (Phillippi & Lauderdale, 2018). Creswell (2013) informs that the majority of qualitative research methods encourage researchers to take field notes to enhance data and provide rich context for analysis.

Field notes serve a multitude of functions. Principally, they assist in constructing thick, rich descriptions of the study context, encounter and document's valuable contextual data. Additionally, field notes can be useful in subsequent analyses including secondary analyses and meta-synthesis (Phillippi & Lauderdale, 2018).

Before initiating the data collection process, the researcher designed a field note strategy in-line with the conceptual framework and the methodological approach. Mulhall (2003)

informs that the theoretical framework and methodological approach help to define the nature of knowledge, which directs the line of inquiry and the value placed on different sources of information. All the necessary ethical considerations were taken into account before, during, and after the gathering of the field notes via Skype and Google Meet.

4.6. Data Analysis

This study employed an inductive approach for data analysis. What makes a study qualitative is that it usually relies on inductive reasoning processes to interpret and structure the meanings that can be derived from data. Generally, inductive reasoning uses the data to generate ideas (hypothesis-generating), whereas deductive reasoning begins with the idea and uses the data to confirm or negate the idea (hypothesis-testing). According to Thomas (2003:2), the primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies.

For this study, it was important for the researcher to engage with the research material on a variety of levels, micro- to macro-view, and over a period of time to become familiarised with the data. This required the researcher to immerse himself in the data by transcribing the data from the recordings, make analytical notes, dividing the text into smaller parts, and reading through the transcripts repeatedly. This is further substantiated by Erlingsson & Brysiewicz (2017) who postulate that an important initial phase in the data analysis process is to read and re-read the transcribed interview while keeping the aim in focus. Finally, the researcher labelled condensed meaning units by formulating codes and then grouping these codes into categories.

In this research, data accrued from teacher interviews and field notes were analysed using the thematic analysis method. According to Braun & Clark (2006), thematic analysis is widely used in qualitative research and has been rarely appreciated in the same way as grounded theory, ethnography, or phenomenology. Braun & Clarke (2006) further argued that thematic analysis should be a foundational method for qualitative analysis, as it provides core skills for conducting many other forms of qualitative analysis. Nowell, Norris, White & Moules (2017) postulate that thematic analysis is a qualitative research method that can be widely used across a range of epistemologies and research questions. It is a method for identifying, analysing, organizing, describing, and reporting themes found within a data set (Braun & Clarke, 2006)

Through its theoretical freedom, thematic analysis provides a highly flexible approach that can be modified for the needs of many studies, providing a rich and detailed, yet complex account of data (Braun & Clarke, 2006; King, 2004). As thematic analysis does not require the detailed theoretical and technological knowledge of other qualitative approaches, it offers a more accessible form of analysis, particularly for those early in their research career (Braun & Clarke, 2006).

4.6.1. Analysing the interview data

In conducting the study, in-depth semi-structured interviews were selected as the most suitable data collection method. Kvale (2007:7) defines interviewing as a 'professional interaction,' which takes place to get participants to talk about their experiences and perspectives and to capture their language and concepts concerning a topic that has been determined. This study used an interview guide that consisted of general questions/broad areas to use during the interview sessions, which could be later adjusted and reorganised as necessary.

While there can be many different ways of analysing qualitative data, Braun & Clarke (2013:174) indicate that 'some sort of "thematic" coding is common across many qualitative methods within the social sciences.' While there are various ways that one can approach thematic analysis (Javadi & Zarea, 2016), in this study, the data collected through interviews was analysed based on the guidelines recommended by Braun & Clarke (2006) referred to as the Six steps of Thematic analysis.

In this study, interview questions (below are some examples) helped the researcher focus on the research objectives:

1. What is your perception of teacher professional development?
2. Why is teacher professional development necessary?
3. Where and when did you receive your training as a coding instructor?
4. Would you care to inform me of the duration of the training programme, and what is your opinion of the duration of the training received?

The questions were used flexibly, allowing both the researcher and the participant to change course as necessary during the interviewing process. The interviews were all audio recorded and lasted between 55 and 70 minutes.

Transcribing the data then ensued. Regarding transcribing, Braun & Clarke (2013:161) recommend transcribing audio data – that is, 'play a recording in very short bursts and

type up what you heard'. Transcriptions were verbatim, taking note of not only what was said but also how it was said. Transcribing the data ensued directly after every interview.

The structure and research procedures of the interviews were conducted in four stages.

- The first stage was an assessment and analysis of literature relating to teacher professional development and coding instruction locally, nationally, and internationally.
- The second stage was the design and administration of the interviews to formulate questions on teachers' motivations for professional development.
- The third stage was initiated with theoretical sampling. Pilot interviews were conducted at the researcher's own school to test the interview leads and questions and to attend to issues of trustworthiness.
- The final stage incorporated the physical interviews with the participants using the finalised interview instruments. As the questions were open-ended, teachers were prompted to elaborate further on areas that were unclear during the interviews.

The transcribed data was then analysed to familiarise the researcher with the input of the respondents. Braun & Clarke (2013) advise that familiarising oneself with the data must be done while consciously and actively thinking about what the data really means, reading transcripts several times to become truly immersed in it, and in turn, identifying points of interest. Field notes acquired during the process of data gathering were also cross-checked with the data of the interviews at this stage. This step required the researcher to consciously and analytically reflect on how the conversation between the participant and the researcher related to the research questions.

This was followed by generating initial 'codes' of the transcribed data. Braun & Clarke (2013) identify a code as a word or brief phrase that captures the essence of some useful data. Codes can be data-derived/semantic – i.e., provide a crisp summary of what is directly given in the data, or researcher-derived/latent – i.e., go beyond the directly given data and use the researcher's conceptual or theoretical frameworks to identify implicit meanings within the data.

For the purpose of this study, the researcher employed the semantic method of coding. As an example of identifying initial codes, (Table 11) below show excerpts taken from two interviews conducted with two coding teachers. The first column shows the interview extracts and the second column shows the codes that are developed. A colour coding system has been used to easily match the data extract with the generated code.

Recurring codes were identified from the initial codes, and similar codes were then grouped into themes. Braun & Clarke (2006:82) state that a theme 'captures something important about the data concerning the research question.' This was followed by control of data for quality by referring back to the coded data (Table 11) and uncoded data to see whether the themes generated fit the data, along with how well it captured the research questions. Final revisions were done to label the themes with appropriate names that helped connect the reader with the research question.

The following is a framework of how data were coded:

Table: 11 Coded data

Interview 1 Female teacher at Trojans Primary	Initial Code
Interviewer: Would you care to inform me of the length of your training? **Interviewee**: So.....I suppose.... I can describe it as a crash course, basically...the training we received.... like... it wasn't even that long... so.... basically we received links sent with .... different lessons for different programs.... like it has the SCRATCH programme... so.... it has the lesson... so (pause) ... you're learning as you are teaching. So we got 17 lessons, and (pause) the one lesson will tell you what to do .... and how to do it.... and then you're teaching the kids.	crash course wasn't even that long received links

4.7. Trustworthiness

Trustworthiness or rigour of a study refers to the degree of confidence in data, interpretation, and methods used to ensure the quality of a study (Politt & Beck, 2014). In each study, researchers should establish the protocols and procedures necessary for a study to be considered worthy of consideration by readers (Amankwaa, 2016).

Establishing the trustworthiness of data gathered in this investigation required the researcher to evaluate the concepts and beliefs held by quantitative and qualitative approaches to apply the criteria established in the literature. According to Guba (1981), there are four trustworthiness concerns that any researcher needs to address irrespective of his/her research paradigm.

According to Lincoln & Guba (1985), positivist researchers have developed a set of criteria to fit the ontological and epistemological assumptions of the positivist perspective. The positivist criteria include internal validity, external validity, reliability, and objectivity, but these are not relevant for assessing the rigour of naturalistic inquiry because it makes different ontological and epistemological assumptions (Lincoln & Guba, 1985; Wallendorf

& Belk, 1989). Furthermore, quantitative research hinges on positivist inquiry that assumes a single reality and inquiry findings are based on a single reality, while naturalists consider multiple realities as an alternative explanation for social reality.

Assessing the rigour of qualitative inquiry requires different criteria for answering the four questions proposed by Lincoln & Guba (1985), and this resulted in Guba & Lincoln (1989) proposing that 'internal validity should be replaced by that of credibility, external validity by transferability, reliability by dependability and objectivity by confirmability'. Schwandt (2007:299) states that 'trustworthiness was defined as that quality of an investigation (and its findings) that made it noteworthy to audiences'. A qualitative researcher must persistently record the processes on which category decisions are to be taken. This was realised through credibility, transferability, dependability, and confirmability. This section therefore briefly discusses each of the suggested qualitative research trustworthiness criteria and how it was applied during research.

4.7.1. Credibility

According to Hammarberg, Kirkman & de Lacy (2016:500), a qualitative study is credible when its results, presented with adequate descriptions of context, are recognizable to people who share the experience and those who care for or treat them. Lincoln & Guba (1985) argue that ensuring credibility is one of the most important factors in establishing trustworthiness. Polit & Beck (2014) further support this view and notify that the credibility of the study, or the confidence in the truth of the study and therefore the findings, is the most important criterion. This concept is analogous to internal validity in quantitative research.

Lincoln & Guba (1985) describe a series of techniques that can be used to conduct qualitative research that achieves credibility in an area of research. In this study, the researcher employed two of Lincoln & Guba's techniques and thus, credibility was achieved through prolonged engagement and member-checking. Furthermore, Onwuegbuzie & Leech (2007) advise that the researcher's extended time in the field improves the trust of the respondents and provides a greater understanding of participants' culture and context.

To ensure this ideal the researcher established early familiarity with the culture of participating organisations before the first data collection dialogues took place. This was achieved via consultation of appropriate documents and preliminary visits and prior

telephonic communication with the organisations and interviewees themselves. Forero et al., (2018) inform that this process allowed the investigators to check their personal perspectives and predispositions, and enhance their familiarity with the study setting. This strategy also allowed participants to become familiar with the project and the researcher.

The process of member-checking was employed to ensure and validate that data, analytic categories, interpretations and conclusions were tested with members from whom the data were originally obtained. Lincoln & Guba (1985) posit that this is the most crucial technique for establishing credibility. Also, Onwuegbuzie & Byers (2014) note in this regard that member-checking is the most crucial technique of all for establishing credibility by allowing the participants to verify the credibility and accuracy of the researchers' interpretation of their experiences.

The researcher facilitated this process by initiating checks relating to the accuracy of the data during and after the data collection dialogues, including a post-debriefing session with all the participants to ratify the data accrued from the research.

Finally, the line of questioning pursued in the data gathering sessions and the methods of data analysis was derived from those that had been successfully utilised in previous comparable projects. Before the interviews, all participants were afforded the opportunity to refuse participation in the project. Cohen et al., (2013) stress that privacy is much more than confidentiality as it pertains to the right of the participant not take part in any or all of the research study. Therefore, the onus is on the researcher to inform participants of their right to refuse, as well as obtain permission to take part. This ensured that the data collection sessions involved only those who were genuinely willing to take part and prepared to offer data freely.

Participants were encouraged to be frank from the outset of each session, with the researcher aiming to establish a rapport in the opening session by indicating that there were no ‘right’ answers to the questions posed. Participants could, therefore, talk about their experiences without fear of losing credibility in the eyes of their own organisation or the researcher.

4.7.2. Transferability

Transferability refers to the degree to which the results of qualitative research can be transferred to other contexts with other respondents – it is the interpretive equivalent of generalizability (Bitsch, 2005). Thick description is described by Lincoln and Guba (1985)

as a way of achieving a type of external validity. By describing a phenomenon in sufficient detail one can begin to evaluate the extent to which the conclusions drawn are transferable to other times, settings, situations, and people.

Furthermore, thick description refers to the detailed account of field experiences in which the researcher makes explicit the patterns of cultural and social relationships and puts them in context (Holloway, 1997). To achieve this aim, a sufficiently detailed description of the phenomenon under investigation must be provided. This means that when the researcher provides a detailed description of the enquiry and participants were selected purposively, it facilitates transferability of the inquiry (Anney, 2014:278).

Since the findings of a qualitative project are specific to a small number of particular environments and individuals, it is impossible to demonstrate that the findings and conclusions apply to other situations and populations. Transferability in this research should be seen as a baseline understanding of a phenomenon with which the results of subsequent work can be compared. As Pitts (1994) in Shenton (2004) has acknowledged, understanding of a phenomenon is gained gradually through several studies, rather than one major project conducted in isolation.

4.7.3. Dependability

Dependability is important to trustworthiness because it establishes the research study's findings as consistent and repeatable. Researchers aim to verify that their findings are consistent with the raw data they collect as they want to ensure that if other researchers were to look over the data, they would arrive at similar findings, interpretations, and conclusions about the data and that the researcher was unbiased in his position during the process of gathering the data. Reflexivity, i.e., a self-assessment of subjectivity, can reduce bias (when appropriate to do so) and increase dependability by increasing transparency of the research process (Guba 1981, Tong, Sainsbury & Craig, 2007).

Dependability is linked to both credibility and confirmability (Lincoln & Guba, 1985). According to Shenton (2004:71), a researcher can establish dependability 'if the work were repeated, in the same context, with the same methods and with the same participants, similar results would be obtained'. Likewise, the positivist employs techniques to show that, if the work were repeated in the same context, with the same methods, and with the same participants, similar results would be obtained (Pandey &

Patnaik, 2014:5750). Therefore, each stage of the study should be informed by research on similar studies.

As reliability of the instruments is of great importance too, repeating the use of the instruments in the research should ensure that the methods are reliable (Leedy & Ellis-Ormrod, 2005). This testing of replication should be feasible and may allow for the reliability of the methods. To achieve this objective in this research, multiple participants from varied schools were used and more than one interview per participant was employed to gather the data. Also, the repetition of phases is encouraged in investigation of 'all reasonable areas' to ensure that early closure does not occur, thus reducing the impact of researcher bias (Lincoln & Guba, 1985).

Also, dependability refers to the consistency and reliability of the research findings and the degree to which research procedures are documented, allowing someone outside the research to follow, audit, and critique the research process (Polit et al., 2006). Lincoln and Guba (1985) emphasise "inquiry audit" as one measure which may enhance the dependability of qualitative research. It involves having a researcher not involved in the research process to examine both the process and product of the research study (Hoepfl, 1997).

In this research, dependability was achieved through transparency and reflexivity to reduce bias and increase dependability by increasing transparency of the research process.

4.7.4. Confirmability

Arguably, stating one's philosophical position is the most important requirement of social research: it defines the relationship between the researcher and their subject/s (Moon et al., 2016:8). Knowing the position of the researcher is essential in confirming the extent to which research findings are intended to be a function of the subjects or the researcher themselves (Guba 1981).

According to Pandey & Patnaik (2014: 5751), the concept of conformability in the qualitative paradigm is comparable to the concern of objectivity in quantitative research. Confirmability is there to verify that the findings are shaped by participants more than they are shaped by a qualitative researcher. Here steps must be taken to help ensure as far as possible that the work's findings are the result of the experiences and ideas of the informants, rather than the characteristics and preferences of the researcher.

Pandey & Patnaik (2014:5751) further postulate that

> steps must be taken by the investigator to ensure as far as possible that the findings are the result of the experiences and ideas of the informants and the participants, rather than the characteristics and preferences of the ' researcher. This will eliminate biases and favours from the findings obtained.

Furthermore, the researcher utilised an audit trail to ensure conformability as it documented the procedures for checking and rechecking the data throughout the study. This method was useful when writing up the results chapter.

In this research, the details of the process of data collection, data analysis, and interpretation of the data were recorded. This provided a record of the topics that were unique and interesting during the data collection and provided a rationale for why the researcher merged codes.

4.8. Positionality

As indicated earlier, in educational research a group of people having specific characteristics become the population of interest to the researcher. As stated by Merriam (2009) the emic perspective typically represents the internal language and meanings of a defined culture. The scope of said culture can be quite broad—for example, a researcher may study the culture of an entire school system or just one building or one particular classroom or a small group of individuals who share a common characteristic. Regardless of how a culture's scope is defined, "an emic perspective attempts to capture participants' indigenous meanings of real-world events" (Yin, 2010:11) and "looks at things through the eyes of members of the culture being studied" (Willis, 2007:100).

According to Olive (2014) in contrast, the etic perspective encompasses an external view on a culture, language, meaning associations and real-world events. Most often, in social behaviour research, the etic perspective is associated with that of the researcher since it comprises the "structures and criteria developed outside the culture as a framework for studying the culture" (Willis, 2007:100). When a researcher takes an etic approach to his or her study, he or she uses pre-existing theories, hypotheses, and perspectives as constructs to see if they apply to an alternate setting or culture (Olive, 2014). However, Olive (2014) stipulates that

within qualitative research, there are a number of methodologies that significantly favour the emic over the etic and visa-versa. Regardless of the methodology being employed, many researchers of social behaviour reside within the tension between the two extremes. Given the inescapable subjectivity that every researcher brings to a study through his or her past experiences, ideas and perspectives, a solely emic perspective are impossible to achieve. Conversely, if a researcher takes a purely etic perspective or approach to a study, he or she risks the possibility of overlooking the hidden nuances, meanings and concepts within a culture that can only be gleaned through interviews and observations.

As the researcher prepared to conduct interviews with in-service teachers about their experiences with and perceptions of professional development in coding, he expected that his position as a fellow educator would aid him in connecting with the participants. Such expectations would seem reasonable and were at least in some part grounded in logic, based on works that suggest that people tend to gravitate toward those with whom they share some level of commonality (Chang, 2002; Fries-Britt & Turner, 2002).

The researcher, however, identified apprehension from some of the participants, as they viewed him as a more senior, authoritative figure within the profession. Becoming aware of these apprehensions, the researcher attempted to put them at ease by reminding them of the ethical considerations of the study where they would remain anonymous regarding their responses to the interviews. This assisted greatly in those participants being more at ease during the data collecting process.

‘Positionality is thus determined by where one stands in relation to “the other”’ (Merriam et al., 2001:411). Who am I in the context of researching issues of difference? The researcher chose to be an insider (emic approach) with all of the participants as both the researcher and the researched shared a common bond: that of determining good practice in teaching learners’ innovative subjects at the primary school level.

4.9 Ethical Considerations, Informed consent and Anonymity

Integrity is about ethics, and ethics is about professional regulations and codes of conduct that guide the researcher in his dealings with participants (Denzin & Lincoln, 2005:96). It is critical to the success or failure of an educational research study. Researchers must ‘do no harm’ (Berg & Howard, 2012:61) as they collect data from someone and report findings to someone. Research studies involving humans can cause physical and

psychological harm. In this regard, the treatment of research participants is the most important and fundamental issue that researchers confront (Johnson & Christensen, 2012:103).

In our modern ethical conception, all research conducted on humans must be pre-emptively accepted by the subjects themselves through the procedure known as informed consent (ICH, 2016; Manti & Licari, 2018). Clearance to conduct research was required from the Cape Peninsula University of Technology (CPUT) and the Western Cape Education Department, as the schools earmarked for the study, as well as the principals of the schools, fell within the jurisdiction of WCED.

A letter of intent to conduct research as well as consent forms were forwarded to the teachers and school managers concerned and only on acceptance of the terms by all parties did actual research commence. Participation in the study was voluntary and participants were able to withdraw from the research at their discretion.

The researcher was sensitive to ethical issues by ensuring confidentiality and anonymity throughout the interviews. According to Saunders, Kitzinger & Kitzinger (2015:617),

> 'confidentiality' is a generic term that refers to *all* information that is kept hidden from everyone except the primary research team. Anonymity is one form of confidentiality – that of keeping participants' identities secret. However, confidentiality also includes keeping private what is said by the participants, something only achievable through researchers choosing not to share parts of the data.

To ensure anonymity, only pseudonyms were used and schools used as research sites were given fictitious names. Participants were treated with dignity, respect, and fairness. Those being studied understood the workings of the tape recorder and were free to reject its use if they wished. If they accepted them, the results obtained were to be in harmony with their right to welfare, dignity, and privacy.

4.10. Limitations

Theofaniodis & Fantouki (2018:156) note that limitations of any particular study concern potential weaknesses that are usually out of the researcher's control, and are closely associated with the chosen research design, statistical model constraints, funding constraints, or other factors. One of the limitations of this research was the dearth of

suitable sites to gather the required data from, and this directly affected the sample size. Though areas relating to programming are done in the Further Education and Training (FET) phase in the South African schools, this limitation was due to the subject under research being a novice subject in the primary school curriculum. Limited primary schools introduced the subject recently, but it was done as an additional subject when the school governing bodies mooted it. The researcher was thus obliged to identify the schools initiating coding as a subject within reasonable proximity from each other.

A second limitation was the limited literature on teaching coding globally and nationally. Much of the subject under research was only recently introduced, and in most cases, it was still in the process of being introduced in the South African primary schools. Though the researcher explored available literature on IT and CS to gain insight into the South African coding context, the literature on coding was unfortunately grouped in an array of technology areas with different weightings within the areas of the curriculums. Coding was also grouped in an array of technology areas with different weightings within the areas of the curriculums.

As informed upon in the abstract, the outcomes do not fully reflect the intended ideals and thus, there is a need for a more suitable development program. In this regard there is a definite need for a more participatory program such as design based research that includes teachers of coding in the design of professional development mediation. Also, opportunities for collegial support amongst teachers were notably absent during the development process.

A final limitation in the research was the onset of the COVID-19 pandemic that prevented the researcher from employing additional data collection instruments such as observations to achieve reliable triangulation of the research data, as well as the limited time that COVID-19 afforded the researcher to examine the teacher participants' classroom implementation of the training received. While the research could accommodate the interviews with the various participants using the Skype and Google Meet platforms, the same method could not be used for the planned class observations as schools were under lockdown for a prolonged period.

4.11. Conclusion

This chapter discussed the philosophy, research design, and methodological approach of the study. This research employed a qualitative inquiry with a case study approach to

comprehend and illustrate the practices and proficiencies of the participants in the process of receiving professional development in coding for implementation at the primary school level. It also aimed to elaborate on their experiences of the training received.

The research used transcribed semi-structured interviews of teachers' encounters during their training to define their perspectives and experiences. The process of collecting the required data using both purposive and convenience sampling methods was further explained in detail. The data collection instrument of choice was semi-structured interviews that were administered via a personal and digital platform to five primary school teachers at various stages of the research.

Before the research process, informed consent was acquired from the WCED, participating schools and the participants to participate in the study. Furthermore, all participants were assured of anonymity as only pseudonyms were used to protect their identities.

CHAPTER 5: Presentation of findings

5.1. Introduction

This chapter presents the findings based on the research methodologies detailed in Chapter 4 and expounds on key themes emerging from the research findings. The study sought to gain insight into teachers' experiences of the process of teacher professional development in teaching coding at the primary school level. The presentation in this chapter hinges upon data obtained from written reflections, audio transcriptions, and field notes from in-depth semi-structured interviews. Appendix A and B lists the interview questions which were directed by the following research sub-questions:

- What are primary school teachers' motivations for undertaking professional development to teach coding?
- What are primary school teachers' understandings of the training they received in teaching coding?

This chapter answers the research questions that aim to understand teachers' experiences during training and their motivations for undertaking professional development in coding. Additionally, the research further seeks to comprehend the teacher participants' impressions and sentiments regarding the training they received.

This chapter is thus structured in the following sections that inform and report the findings on primary school teachers' experiences in coding development at selected primary schools in the Western Cape. The chapter then concludes with a summary of how the outcomes discussed in the various sections impact the study.

In the first section, the interview questions initially set the backdrop to research question one by presenting the findings that emerged from the data collected on the participants' motivations for embarking on the process of professional development in coding. Within this framework, the participants' motivations are examined under distinct headings that inform exclusively on the intrinsic reasons for undertaking the training. Discussion in Section 1 is thus subdivided and discussed under sub-headings or themes that examine the importance of professional development for teaching and learning, teacher development as an enabler to adjust to changes in a field of work and, professional development as a confidence enhancer.

Section 2 presents teachers' extrinsic motivations for assuming professional development for teaching coding at the primary school. The data that surfaced from

research question 1 reports on a single extrinsic factor as a reason for the training and is discussed under the theme of professional development for organisational success.

The third section offers an overview /summary of the findings that are directly related to research question 1 of the study. In this section, the researcher elaborates on the findings of both intrinsic and extrinsic motivations for undertaking the study.

Section 4 reports on teachers' experiences of the training they received. The themes that emerged from the data speak to the facilitators' planning of the training and how it impacted the teachers' understandings and expectations of the training process. The themes initially consider the trainers subject content knowledge and then seeks to probe the methodology used for introducing an innovative subject into the curriculum. Encompassed in this section, the data from the interview questions further reports on the facilitators' insight into the requirements for training teachers with limited background knowledge of a subject to be introduced as an innovative addition to the primary school curriculum, as this ultimately determines the success or failure of any development programme.

The data further speaks to the facilitators' methodological approach used and then further elaborates on the duration of the training in an effort to appraise either the realisation or the inability of the facilitation to achieve the anticipated outcomes of the programme. This ultimately set the background to the final theme that verbalised explicitly the teacher participants' opinions on the promotion of peer collaboration and collegiality during the training programmes.

The fifth section offers an overview/summary of the findings that are directly related to research question 2 of the study.

The final section supplies a short but overarching synopsis of the data accrued during the interviews with the teacher participants relevant to the two research questions that guide this research.

5.2. Presentation and discussion of Sub-Research Question 1:

The data that emerged from interview questions relating to research question 1 are detailed and discussed in depth under various headings/sections that relate to the themes that surfaced. The interviews required the participants to speak about their general understanding of professional development with prominence to their motivations or views

on the relevance of continuous training for teachers. This line of questioning afforded the researcher insight into the participants' understanding of the development and allowed the researcher to set the background to the subsequent section and questions.

The themes that surfaced provide information explicitly on various motivations that underscored the participants' interpretations of the professional development received. As reflected in the literature discussed in Chapter 3, motivation is apportioned into two categories, i.e. intrinsic motivation and extrinsic motivation. The literature on these categories of motivations suggests that

> in general, intrinsic motivation (IM) could be defined as an engagement in behaviour that is inherently satisfying or enjoyable…Meanwhile, extrinsic motivation (EM) is a performance influenced by an achievement separated from the action itself (Legault, 2016:1).

Past empirical studies on teacher motivation show a positive impact on teacher performance as a result of highly motivated teachers, both intrinsically and extrinsically, in schools (Jang, Kim & Reeve, 2012). A motivated teacher can thus shape the future of a child, as teachers make the first impact on learners in early childhood, so the teacher should be motivated both intrinsically and extrinsically.

From the data that emerged from the interviews the sections below (5.2.1. and 5.2.2.) report on the intrinsic and extrinsic motivations identified by the teacher participants. From research question 1, intrinsic motivations are viewed as a predominant factor in teacher participants' reasons for the development and are primarily informed upon in section 5.2.1. and then further categorised under theme headings, as these motivations are not contingent upon any outcome separable from the behaviour itself.

In the following section, the data that emerged under research question 1 further reports on an additional theme that was extrinsically motivated. This theme was categorised under the heading labelled 5.2.2 as the teacher participants' motivating factor for identifying this theme was primarily instrumental in nature, as it aimed to attain a different outcome.

5.2.1. Intrinsic motivations

Intrinsic motivation in its most simplistic form is the act of doing something without any obvious external reward. In this regard, according to OECD (2009), professional

development is defined as activities that develop an individual's skills, knowledge, expertise, and other characteristics as a teacher. In this last case, development can be provided through collaborative planning and teaching, and the sharing of good practices. The OECD (2009) further states that

> effective professional development is ongoing, includes training, practice, and feedback, and provides adequate time and follow-up support. Successful programmes involve teachers in learning activities that are similar to ones they will use with their students and encourage the development of teachers' learning communities.

Intrinsic motivation is posited to have more effect on the individual compared to extrinsic motivation. Furthermore, intrinsic motivation can be articulated as an activity where people are engaged in tasks for the sole reason of accomplishing the outcomes, without expecting any incentive for the act (Wong, 2014). The supporting strategies for intrinsic motivations are thus the preferences for work and interest in work especially in the teaching profession (Urhahne, 2015).

In response to the interview questions on teachers' motivations for professional development the data reports on the following interrelated intrinsic motives or themes that surfaced, and is discussed under the following headings:

5.2.1.1. Importance of TPD for learning

Teachers' professional development can lead to improvements in their teaching practice and the development of their pedagogical thinking about student learning and development. According to Hauge (2019:1), research in the field of pedagogy in 2018 found that many factors impacted and influenced the professional development of teachers, and thus collective processes in professional learning communities (PLCs) in an environment dominated by trust between the participants are important. Moreover, Hauge (2019) further noted the importance of teachers having an influence on the planning and initiation of teachers' professional development, and that external support has an impact on teachers' professional development (Hauge, 2019).

Mizell (2010:10) postulates that effective professional development enables educators to develop the knowledge and skills they need to address students' learning challenges. Furthermore, to be effective, professional development requires

> thoughtful planning followed by careful implementation with feedback to ensure it responds to educators' learning needs. Educators who participate in professional development then must put their new knowledge and skills to work. Professional development is not effective unless it causes teachers to improve their instruction or causes administrators to become better school leaders (Mizell, 2010)

Regrettably, many trainers or facilitators tasked with planning and managing professional development have had no formal education or training in how to do so. The learning experiences they create for others are similar to their own experiences, many of which were neither appropriate, positive nor effective.

When probed about the importance of TPD, respondents were, without exception, of the opinion that it was a necessary tool for any individual to acquire knowledge and skills in an area of study. As the data that emerged from the interviews were generally consistent, only selected responses are used to substantiate the respondents' views:

The following extract relates teacher Adams' input about the importance of professional development:

> Definitely an important part of any training in whatever type of work you do.

When prompted to explain what he meant, he responded in the following manner.

> …, because it creates a platform for personal growth, and widens your horizons.

The response from teacher Adams was instantaneous as he further remarked that when he was trained in his previous field, he realised how important his development was working with computers. He continued that a computer was only a tool that was dependent on his acumen and knowledge to carry out the correct instructions. He further indicated that it made him a better teacher.

The next extract further emphasises the value that the participants attached to development:

> It is a fact that good preparation leads to great results. It is thus important for people to be open to development. (teacher Ashley Newman)

Teacher Newman, describing his response to his experiences in the UK, noted that the training he received whilst studying to become a teacher in South Africa had prepared him very well for the challenges that he faced when teaching abroad. He further indicated that

> Our training system in South Africa prepares teachers more than adequately for the challenges of teaching globally. (teacher Newman)

This response speaks to the literature that indicates that teachers require effective training to develop their practice so that their learners can accomplish, achieve, and succeed. Ultimately, that support falls under the auspices of professional development.

Another response is teacher Tarryn Peters' view:

> I believe that development and continuous development supports learning in all fields, i.e. the teacher as well as the learner.

Her response was immediate and she was convinced that effective training was an effective tool to bring the best out of teachers in the area of training and that it would ensure effective transferal of knowledge to the learners. In this regard, the literature confirms that effective teachers' professional development refers to teachers' learning, how they learn and how they apply their newly acquired knowledge in practice (Avalos, 2011). The definition corresponds to Pedder & Opfer (2011), who state that teachers' professional development and learning is about the growth and development of their expertise that lead to changes in their practice to enhance the learning outcome of students. These sentiments are directly in line with teacher Peters' further comment:

> Teacher development helps them to grow into more effective teachers in their area of teaching.

This is corroborated by Evans (2010), who defines changes in teachers' practise as changes in knowledge, understanding, skills, behaviour, attitudes, values and convictions.

Research further indicates that when teachers' professional development is contextualized to practice and when opportunities for collective development are created, this is a good approach that can support teachers' professional development and create improvements in their teaching practice (Darling-Hammond & Richardson, 2009). Darling-Hammond & Richardson (2009) also state that when schools support teachers with well-designed, engaging and meaningful professional development opportunities, the teachers will be more able to create the same opportunities for learning and development for their students. The following input of teacher Newman speaks to this statement:

> The benefits of my development became tangible as I experienced how it affected my teaching and the learners understanding of the work.

When asked to explain how it benefitted his teaching the educator stated that

> My content knowledge was broadened…., and it provided additional skills and methods that I could apply in class.

In education, the term professional development may be used in reference to a wide variety of specialised training, formal education, or advanced professional learning intended to help administrators, teachers, and other educators improve their professional knowledge, competence, skill, and effectiveness. In practice, professional development for educators encompasses an extremely broad range of topics and formats. In a nutshell, teacher professional development is considered to be the primary mechanism that schools can use to help teachers continuously learn and improve their skills over time.

According to Kamamia, Ngugi, & Thinguri (2014:646), the inability to effectively master a subject one is teaching results in failure to deliver curricula and also does not allow insight into the types of alignment that exist between teacher training, practice, and national curriculum objectives. In this regard, in theory, professional development programmes seek to help teachers gain subject-specific knowledge (Dadds, 2001), use appropriate pedagogical practices (Schifter, Russell, & Bastable1999), develop positive attitudes towards teaching, and ultimately improve the learning of students (Villegas-Reimers, 2003).

Teacher professional development may range from a one-day conference to a two-week workshop to a multiyear advanced-degree programme. It may also be delivered in person or online, during the school day or outside of normal school hours, and through one-on-one interactions or in group situations. Furthermore, it may be led and facilitated by educators within a school or provided by outside consultants or organisations hired by a school or district.

Also, teacher professional development enables teachers to acquire a broader view of a knowledge area. It allows the teacher to obtain proficiencies in learning new scientific theories, expanding knowledge of different historical periods, or learning how to teach subject-area content and concepts more effectively. Furthermore, teachers are exposed to learning new technological skills and improving fundamental teaching techniques.

Teacher Davids was especially vocal regarding this area and said,

> Initially, I had limited knowledge of coding, but the training afforded me to have a deeper understanding of the subject.

When asked to explain her response, she replied:

I think it was because I had a knowledgeable person to guide me.

According to Glatthorn (1995:41), 'teacher development is the professional growth a teacher achieves as a result of gaining increased experience and examining his or her teaching systematically'. This implies that if knowledge is power, then professional development is an act of learning that provides new perspectives and increased expertise in one's field. The goal of most staff development activities, if not all, is to teach how to do something better. By mastering new skills, efficiencies are realised. Furthermore, by using the knowledge learned with the confidence and credibility gained, the ability to influence and lead becomes less subjective. These opportunities provide a tool for more meaningful contributions to the team.

Regarding the educational framework in the United States, Darling-Hammond et al. (2009) in Blank & de las Alas (2009) observe that

> in the present education policy environment, a high priority has been placed on improving teacher quality and teaching effectiveness in U.S. schools. Standards-based educational improvement requires teachers to have deep knowledge of their subject and the pedagogy that is most effective for teaching the subject.

Blank & de las Allas (2009) informs that to realise the above-mentioned goal, the Council of Chief State School Officers (CCSSO) in the United States was awarded a grant from the National Science Foundation (NSF) to conduct a meta-analysis study to provide state and local education leaders with scientifically based evidence regarding the effects of teacher professional development on improving student learning. The CCSSO meta-analysis of studies that were based on scientific research designs reported significant effects of teacher development on improving student achievement (Blank & de las Allas, 2009).

Furthermore, the importance of professional development is further supported by empirical evidence from developed countries. This is substantiated in a review of experimental evaluations of professional development programmes in developed countries, where Yoon, Duncan, Teresa, Wen-Yu, Scarloss, & Shapley (2007) found that the academic achievement of students whose teachers participated in professional development programmes increased by 0.54 standard deviations compared to students whose teachers did not participate in professional development.

There are fewer studies of teacher quality in developing countries, but those available confirm that differences in teacher quality can significantly impact student achievement.

One such study found that in Peru, teachers with high achievement in mathematics increased student achievement on standardised mathematics tests by about 9% of a standard deviation (Metzler & Woessmann, 2012).

5.2.1.2 CPTD as an enabler to adjust to changes in a field of work

Issues of teacher change are fundamental to any discussion of technology or technology integration. Citing the topic of technology, Fullan & Stiegelbauer (1991) postulate in this regard that,

> in general, when teachers are asked to use technology to facilitate learning, some degree of change is required along any or all of the following dimensions: (a) beliefs, attitudes, or pedagogical ideologies; (b) content knowledge; (c) pedagogical knowledge of instructional practices, strategies, methods, or approaches; and (d) novel or altered instructional resources, technology, or materials.

Furthermore, when thinking about technology as an innovation, Fisher (2006) cautioned against viewing technology as an agent of change. Rather, he argued that teachers must assume this role.

Shen (2008:73) states that there are almost as many conceptions of the change process as there are writers on the subject, but despite this, there are some broad areas of agreement on it. Robbins & DeCenzo (2001:230) define change as ‘an alteration of an organisation’s environment structure, technology or people’. Fullan (1992:22) claims that ‘change is a process of learning new ideas and things. It is learning to do and learning to understand something new’.

Also, professional development is necessary to fill in the gaps in the skill sets of new teachers and to continue to develop the expertise of teachers (Evers, Van der Heijden, & Kreijns, 2016). Professional development is necessary to keep the teacher up to date with continuously changing practices and student needs.

People require change to improve their work or improve their existing skills and knowledge. Robbins & DeCenzo (2001:231) point out that factors that drive change are both external and internal forces. These forces also bring about the need for change. In educational institutions, changes are imposed from outside or motivated by internal

pressure. The ultimate goal of change is to expand an individual's knowledge base and make practice better or more effective in the work.

As the teacher participants' viewed professional development as an important component for learning, they were subsequently probed about the need for continuous development within an innovative area of study or teaching. This prompted useful data that guided the researcher to formulate the following theme that emerged from the interviews. The data accrued spoke directly to the participants' dependence on development to guide and assist them in an area of teaching that was geared to future-orientated subject content. This was especially important as almost without exception, the participants had very little knowledge and experience in teaching coding.

Though each teacher worded their responses differently, the core message that surfaced was that they deemed continuous professional development (CPTD) to be an enabler for them to cope with changes or new ideas in their field of teaching, and thus enable them to empower learners with contemporary and innovative skills to equip them for the challenges of the Fourth Industrial Revolution.

When prompted about continuous professional development, their responses were as follows:

> Teachers should be life-long learners. They have to keep tread with career demands and new developments. (teacher Abbey Davids)

This response by teacher Davids referred to her initial choice of working in the motor industry and her subsequent decision to expand her horizons by persevering to finally become an ECD teacher. Teacher Newman was extremely animated about the significance of continuous development and said,

> Our children are experiencing a world totally different from what their parents experienced a few years ago. New information obliges us to reconsider existing methods. Being in the teaching profession, we need to be knowledgeable and set the standard through constant development...

The interview questions that enquired about continuous professional development overwhelmingly prompted positive responses from the participants. The participants unanimously concurred that teachers should avail themselves of any opportunity to be informed of new developments that occur within the profession.

Furthermore, respondents believed that learners currently have access to global information at their fingertips (referring to cell phones and social media) and that

innovative teaching required teachers to constantly be informed about new developments. The respondents further informed that professional development in coding was a necessary tool to assist them with empowering learners with the necessary skills for innovative areas of future employment.

In Tarryn Peter's view,

> Children must be trained for the future. Technology and computer skills are major requirements for future job opportunities. There should be emphasis placed in schools for subjects to prepare our learners, and teachers must be trained in these areas to assist the learners.

Teacher Tarryn supported her view by referring to her decision as an HoD to take the initiative in heading the IT department at her school even though she had very little knowledge of the subject. She thought that teachers had to be proactive and recommended that continuous development should be an ongoing practice within all the curriculum subjects.

She remarked that the job market was saturated with certain professions and that it was up to the teachers to guide their students when it came to career choices in 21st-century skills. This guidance, however, depended on teachers possessing the required knowledge.

Teacher Newman responded in the following manner:

> If teachers are not knowledgeable in the area of innovative technology skills, then our learners will not be adequately prepared for future employment. It starts with teacher development. (teacher Ashley Newman)

An important comment was made by teacher Adams who commented on the importance of teacher knowledge and skills required at the primary school level:

> It is expected that primary school teachers need to be versatile in the subject areas that they teach… High school teachers are seen as subject specialists, which is not the case at primary schools.

A similar comment was made by teacher Newman when he referred to teacher skills at the primary schools:

> Primary school teachers are expected to teach all or any subjects when requested to do so, and I suppose that the Education Department will expect existing staff members to teach any new curriculum subject instead of employing additional teachers.

The above-mentioned comments refer to the expected flexibility of primary school teachers to be able to teach any subject that forms part of the primary school curriculum. This suggests strongly that the onus would be on primary school teachers to be empowered to transfer the knowledge and skills of any innovative subject to the learners at this level.

Being continuously updated and informed on an area of teaching such as coding was generally accepted by all respondents as an important criterion for effective teaching. Respondents were of the view that continuous development improved their knowledge, and confidence in the subject, or any other subject for that matter, and they could thus be more effective within the classrooms.

Teaching methods are continually developing, and CPTD allows teachers to learn new techniques and strategies which enable them to keep up with colleagues who have more recently finished training. Additionally, CPTD gives teachers the chance to reinforce existing skills, as well as learning new ones that were not covered during their teacher training. Further training can allow teachers to build on their interaction skills and learn strategies for helping pupils to achieve their full potential.

According to Kloosterman (2016), the benefits of CPTD mean that well-crafted and delivered continuing professional development is important because it delivers benefits to the individuals, their profession, and society at large. It further ensures that teachers and their knowledge remain relevant and up to date. Teachers become more aware of the changing trends and directions in their profession. The pace of change is probably faster than it has ever been – and this is a feature of the new normal that we live and work in. Teachers who stagnate will get left behind, as the currency of their knowledge and skills becomes outdated. This was substantiated by teacher Adams:

> Technology is ever-changing and to keep abreast of new developments, I had to conform and adjust through additional training.

When asked to supply examples of additional training, Mr Adams replied,

> This can include self-learning, availing yourself for workshops in your subjects or other subjects, etc…

Within the South African context, CPTD or CPD refers to any activities aimed at enhancing the knowledge and skills of teachers through orientation, training and, support (Coetzer, 2001:78). The development is also likely to affect attitudes and approaches and

may therefore contribute to the improvement of the quality of the learning and teaching process (Bolam in Early & Bubb, 2004:4; Day & Sachs, 2004:3).

Numerous sources note that effective CPD should firstly be aware of and address the specific needs of teachers (Bredeson, 2003:9). Once these needs have been identified, activities need to be properly planned to support teachers in applying the knowledge and teaching methodology creatively and confidently (Anderson, 2001:1). Collinson (2000:125) states that the best results are obtained if s programme is formally and systematically planned and presented with the focus on the enhancement of personal and professional growth by broadening knowledge, skills and positive attitudes.

The importance of continuing professional development should not be underestimated. It is a career-long obligation for practising professionals. Sometimes it is mandated by professional organisations or required by codes of conduct or codes of ethics. But at its core, it is a personal responsibility of professionals to keep their knowledge and skills current so that they can deliver the highest quality of service. Within the context of teaching, continuous professional development is the strategy schools and school districts use to ensure that teachers continue to strengthen their practice throughout their careers.

Respondents thought that CPTD helped them to stay interested and interesting, and if CPTD was focused, then it opened them up to new possibilities, new knowledge, and new skill areas. However, they also felt that CPTD should instil a deeper understanding of what it means to be a professional, along with a greater appreciation of the implications and impacts of their work. This area, in particular, was absent in their training of coding instruction

Globally, the literature promotes continuous development and ensures that teachers are at all times current with the latest trends in education; various states and provinces have laws that require school districts to provide teachers with a minimum number of days of professional development. Within the South African context, the South African Council for Educators (SACE) is responsible for managing the CPTD system.

Within the parameters of this system, all useful teacher development activities are recognised by approving quality and credible development providers, endorsing relevant and good quality professional development activities and programmes, and by allocating professional development (PD) points to such activities. This ensures that all teachers registered with SACE earn professional development points by selecting approved professional development activities that meet their development needs (SACE, 2007:20).

5.2.1.3 TPD as a confidence enhancer in teaching different subjects.

The literature on teaching a broad range of subjects indicates the importance of teacher confidence, particularly the aspect of self-efficacy, in successful teaching (Czerniak & Schriver, 1994; Ginns & Watters, 1996). Their basic message is that teachers need the confidence to communicate their own understanding successfully. Many have looked at teachers' understanding of scientific concepts (Smith & Peacock, 1992; Summers & Kruger, 1993) and often found understanding to be inadequate. Others have looked at the interaction of confidence and understanding but in the context of fairly specific scientific concepts (Harlen, Holroyd & Byrne, 1995).

Improving teacher quality is at the core of any education departments' efforts to achieve excellence in the classroom. This comes at a time when the very structure of education is going through a profound change. The National Research Council (2001:87) states that with knowledge all around us, available anytime and anywhere, the role of the teacher is going to be fundamentally transformed in the 21st-century. The challenge of the modern classroom is its increasing diversity and the skills that this diversity requires of teachers. For this reason, it is necessary to apply new thinking in the teaching profession.

Gaining confidence in their teaching skills and developing their teaching ability, in general, are not just the concern of teachers who are new to the profession, but also of experienced teachers when they meet new challenges which seem to threaten their long-standing values and beliefs about learning and teaching, especially if these may change to their teaching practices or a different area of teaching.

Self-confidence and developing ones' teaching ability are closely associated, and developing a specific area leads to improvement on the other. The more individuals develop their teaching ability, the more confident they will become in their teaching. In the same way, the more confident they become in their teaching skills, the better prepared they are to move on to the next level, i.e. deepen their understanding of learning and teaching. Furthermore, it allows them to find out about the latest learning and teaching theories, and try out new teaching practices, thus developing their teaching ability.

Teacher Peters commented on how the development assisted her in becoming more confident in her teaching abilities in her other subjects:

> My development in coding strengthened my perception and knowledge in many areas that I could use in teaching my language classes.

Teacher Newman's response to the interview questions that asked about possible gains of the programme indicated:

> The development had positive spinoffs that applied to my subject of NS as well as…. it taught them … the kids, and me …. to be more critical in our thinking…. as well as …… motivated them and me to become better problem-solvers.

Both teachers referred to the many concepts that are vital in teaching coding successfully, and the positive impact it had on their Literacy and NS (Natural Sciences) classes they had to teach as well.

Teacher Peters stated that many of the concepts such as problem-solving skills, critical thinking skills, persistence, and logical thinking that coding requires assisted her in transforming her language classes to the benefit of the learners in her care. The skills and confidence she gained allowed her to teach in a more relaxed manner, supply learners with appropriate strategies to overcome adversities not only in coding, but in Literacy as well, and positioned her in a much better space to answer the many questions that the learners posed.

Teacher Newman added that the learners in the Natural Sciences classes gained from his teaching because he could inform and apply problem-solving and critical thinking skills in the lessons that he taught. This not only boosted his confidence in his teaching but assisted the learners to become more proficient and productive in the area of Natural Science.

Teacher Adams stated that though he was quite confident with technology use and ICT as school subjects, these subjects were mostly taught at a level where the full potential of the subjects could not be realised. In this regard, the training received in coding opened a whole new world of possibilities to steer technology and ICT teaching into the area of 21^{st-} century skills and preparing the learners and himself for the rigours and possibilities required for the Fourth Industrial Revolution and possible work placement. Teacher Adams further indicated that,

> Even though I am not fully confident in the subject content as yet, this training has inspired me and has given me renewed confidence to take my teaching to the next level.

His comment had a direct bearing on his becoming more effective and confident through the training in coding. Teacher Adams further mentioned in this regard that

> The training has allowed me to explore areas that I thought was beyond my comprehension.

The literature supports this view in that as with other professionals, teachers are expected to use technology in ways that extend and increase their effectiveness. Ertmer & Ottenbreit-Leftwich (2010:257) indicate that it is no longer appropriate to suggest that teachers' low-level uses of technology are adequate to meet the needs of the 21st century learner. Furthermore, using technology simply to support lecture-based instruction falls far short of recommended best practice (Lawless & Pellegrino, 2007).

Lai (2008) indicates that to achieve the kinds of technology uses required for 21st-century teaching and learning, teachers should be helped to understand how to use technology to facilitate meaningful learning, defined as that which enables students to construct deep and connected knowledge which can be applied to real situations. Although 'technology can make it quicker or easier to teach the same things in routine ways,' it makes it possible to 'adopt new and arguably better approaches to instruction and/or change the content or context of learning, instruction, and assessment' (Lawless & Pellegrino, 2007:581).

The TALIS (2008) Technical Report (OECD, 201) which indicated practices that increase teachers' feeling of confidence in the classroom and, in turn, improve children's learning, stated that a key objective of the survey was to discover what school and individual characteristics are associated with teachers who have confidence in their teaching abilities. While cultural characteristics influence the strength with which patterns appear in different countries, three findings stand out. Two of these findings have a direct bearing on this research.

Firstly, teachers who report they teach well are often found in school settings characterised by a greater variety of teaching practices in the classroom. Teachers who make use of diverse teaching practices are more-able to adapt them to different learning situations and student needs. Secondly, teachers who report confidence in their teaching also participate in professional learning communities. Two of the six components of professional learning communities were particularly important: cooperation through joint teaching, which requires a higher level of coordination and reflection than just the exchange of pedagogical material; and openness, as measured by the frequency with which teachers observe the classes of their colleagues. Teacher Davids referred to her progression from the motor industry to Foundation Phase teacher, indicating that

> My journey from the motor industry to teaching learners in the Early Childhood section and ultimately teaching coding to Foundation Phase learners [is] all due to the value of my continuous training.

Within the context of the primary school, improving one's subject knowledge across the curriculum is especially relevant and important. In this regard, considerable demands are placed on teachers to acquire subject knowledge across the primary curriculum, not least in requiring them to understand how pupils learn in different subjects and what pupils need to know by the time they complete the primary phase.

According to Ofsted (2009:4), Literacy and Numeracy, quite rightly, have been the focus of extensive national training, but with notable exceptions, there has been relatively little opportunity for primary teachers to identify and remedy weaknesses in subject knowledge beyond Literacy and Numeracy. Professional development in coding has the potential to develop teachers to the extent that it can promote excellence, understanding, and enjoyment across the curriculum, and is thus worthy to pursue.

5.2.2 Extrinsic Motivations

Extrinsic motivation can be described as reward-driven behaviour, for example, the use of rewards or other external incentives for specific activities. Chow (2013) observes that extrinsic motivation stimulates an individual to work in return for rewards or to avoid punishment. Additionally, extrinsic motivation is also necessary to enhance and develop an interest in an activity. In this regard, tangible rewards and other forms of incentives motivate an individual extrinsically (Jang, Reeve & Deci, 2012).

According to Jang, Kim and Reeve (2012), the controlling strategies of extrinsic motivation are the deadlines for an assignment, directives, the consequences and rewards of work in incentives and benefits that make an individual more motivated towards work. Moreover, Ryan & Deci (2000b:71) explicitly indicate that extrinsic motivation regulates behaviour 'in order to attain a separable outcome'.

Regarding research question 1 that speaks to teacher professional development in coding, a solitary extrinsic motivation was identified when the data emerged. This factor is discussed under the following theme.

5.2.2.1. Importance of TPD for organisational success

Few would argue against the view that the most vital resource that any school has is its staff, and thus attention, therefore, needs to be given to staff development. Isaac (1975:21) implies that teachers play the key role in the functioning of a school and it follows that any effort towards improving their contribution is of great importance. Precedence must be given to staff development generally but especially in times when economic factors restrict any improvements in buildings and facilities. The more difficult the situation the more vital is the need for teachers of a high calibre working to high standards (Isaac, 1975).

Professional development presents a prime opportunity to expand the knowledge base of all employees, but many employers find the development opportunities challenging due to cost or loss of work hours. Despite the potential drawbacks, training and development provide both the organisation as a whole and the individual employees with benefits that make the cost and time a worthwhile investment. A well-structured development programme allows schools to strengthen those skills that each teacher needs to improve and brings all participants to a higher level so they all have similar skills and knowledge. Additionally, a structured training and development programme ensures that teacher participants have a consistent experience and background knowledge as consistency is particularly relevant for the schools' basic policies and procedures.

The final theme that emerged during this section of the interviews indicated that development was essential for preparing individuals to cope within the working environment. In this regard, the following extract bears testament to many of the participants' responses:

> I believe that your development should prepare you for the job at hand. So…it is of the utmost importance. (teacher Tania Roberts)

When probed on how it prepared her, teacher Roberts replied:

> …the training afforded me with the skills and knowledge needed.

Teacher Roberts explained that her training in Information Systems required her to be knowledgeable in her area of work as she headed a department at her previous employment. As a leader, she had to be strong and needed to be focused and responsive as her team depended on her for guidance when they experienced problems. This extract alludes to her personal development and is reinforced by the literature that suggests that development also defines the individuals' personal strengths and qualities that assist

them to identify and make sense of their work-related practice and themselves as individuals.

The following responses from teachers Peters and Newman further support the notion that professional development is of significance for success in the workplace:

> Nothing compares to good training or development in any field of work. If you want to achieve excellence, then your training is important. (teacher Tarryn Peters)
>
> I think it is a necessity in any area of work because it guides you to be the best that you could possibly be within that area. (teacher Newman)

The participants thus unanimously agreed that professional development in any area of work was a necessary requirement and that it contributed to the success within the work environment. Within the teaching profession, respondents believed that professional development assisted teachers to understand the content and become familiar with pedagogies of the subject.

Employee training and development is a term often used interchangeably across sectors and encompasses various employee learning practices. More specifically, training involves programmes that enable employees to learn precise skills or knowledge to improve performance. Development programmes involve a more expansive employee growth plan, for future performance rather than immediate career role improvement. As new markets emerge, so will new technologies; both having a profound impact on education and development. Recognising new skills and ways of learning will help a company evolve and innovate for the future.

Professional development is important for organisational success because research indicates that career prospects and learning opportunities are influencing factors when potential employees choose between job offers (Barbeite & Maurer, 2002). Also, employees who perceive their employer to provide career growth opportunities show a greater commitment to their organisations (Mikkelsen, Saksvik, Eriksen, & Ursin, 1999). Teacher Adams hinted at this:

> My school manager is always open to the staff improving their skills and knowledge-base. This was a determining factor in remaining at the school.

Employees who participate in required training courses and work-based development activities during work time also reported higher job satisfaction and organisational commitment (Birdi, Allan, & Warr, 1997). These findings can be explained by social

exchange theory, which posits that employees will remain with and work harder for an organisation if the organisation shows it values the employees by taking on the responsibility of shaping their careers (Aguinis & Kraiger, 2009). This is echoed by teacher Peters:

> My principal was eager to allow me to do the training and was my support base throughout the process.

When asked why she thought her school manager was eager for her to do the training, she said,

> I am sure that…our manager was looking at my personal interest….. as well as … the promotion of the school by having well-trained teachers.

Furthermore, employers can also increase productivity and financial returns by investing in their employees via career development. Perceived growth opportunities offered by an employer have been linked to higher job performance and lower turnover (Kraimer, Seibert, Wayne, Liden, & Bravo, 2011), which contributes to higher quality products and prevents monetary loss due to turnover. Moreover, evidence suggests a positive relationship between financial performance and organisations that encourage and

support continuous knowledge acquisition and dissemination (Ellinger, Ellinger, Yang, & Howton, 2002).

The literature on teacher professional development suggests that it is an important part of teacher preparation programmes, especially in those aspects of teaching that are more skill-like in their conception. It further indicates that there are many other important aspects of teaching that can only be nurtured through reflective strategies and experiences (Rahman, Jumani, Akhter, Chisthi & Ajmal, 2011).

Joyce & Showers (2002:4) identify several specific behaviours which, they suggest, staff developers can incorporate into their training and support for teachers and principals. They can:

> help schools and teams of teachers to redesign their workplaces instead of just recommending schools provide time for collaborative working, ensure that peer coaching study teams are formed on the first day of training, to give them opportunities to experiment with productive ways of working together, and provide examples of structures or formats for collaborative planning, for example by offering a structure or scaffold for a sample planning activity.

Though the respondents acknowledged that professional development was important in developing skills for future work placement in any area of work, strangely, none of them referred to how their development impacted their social competences. Developing social skills is considered a vital component in any teachers' arsenal. Huitt & Dawson (2011) indicates that teacher social competence requires being aware of one's own and others' emotions, behaving appropriately, communicating effectively, working well with others, and resolving conflict.

Furthermore, teachers who receive the necessary training are more-able to perform well in their job. Training will grant teachers a greater understanding of their responsibilities within their role, and in turn, build their confidence. This confidence will enhance their overall performance and this can only benefit the school. Teachers who are competent and on top of changing professional standards help their schools hold a station as a leader and strong competitor within the education profession, especially during these times when parents are becoming more selective in where they enrol their children.

5.2.3 Summary of Sub-Research Question 1

This section brings to a close a report on the findings for research question one and describes the extraction of key themes that emerged from the first interview session with the participants. The data that emerged from the interview questions informed that the themes that emerged were overwhelmingly intrinsically motivated and that only a single theme was extrinsically motivated for primary school teacher participants to undergo teacher professional development in coding.

Several themes emerged from research question 1. The feature that was most dominant in the teachers' motivation for professional development in coding was that it is an important tool to enhance their knowledge and skills in an area of learning and teaching. Continuous professional development also afforded opportunities for teachers to remain current with the latest trends in education and allowed them a suitable platform to review current strategies in a rapidly changing society.

Additionally, the data that surfaced from research question 1 revealed how the programme acted as an enabler for the participants to adjust to changes in their field of study or work, and ultimately the data identified and spoke to how the programme assisted, or not, teacher participants in acquiring confidence in teaching diverse or innovative subjects.

Finally, the data showed an extrinsic motivation that allowed teachers to contribute to the organisational success of their schools as it added to the knowledge base of teachers and learners, and thus placed their schools and immediate society from which they source learners in a niche of institutions with knowledge of innovative skills learning that is geared towards future needs and employment.

Research (Omar, 2014) on teacher motivations for professional development indicates that the design of any training programme needs to be closely related to its intended outcomes, which in this case was achieved successfully in all aspects if one is to reflect on the themes discussed above.

5.3 Presentation and discussion of Sub-Research Question 2.

The data that emerged from interview questions relating to research question 2 are detailed and discussed in depth under various headings/sections that relate to the themes that surfaced. The interviews required the participants to speak about their general understanding or perceptions of the training they received in coding as a subject to be taught in the curriculum. The interview questions relating their perceptions of the development in coding revealed interesting but to a large extent concerning information about the training methods and format used to empower the teachers with the skills and knowledge of the subject.

The Department of Basic Education describes coding as the writing of instructions for computation using a programming language to achieve a specific goal or to solve a problem. In simple terms, coding refers to using a language that a computer understands to implement computer programmes, mobile applications and websites. Coding is therefore similar to introducing a new language in the school curriculum.

In this regard, as noted above, the Department of Education is training a group of teachers to learn how to code and how to teach coding. The subject supposed to have started in the 2020 academic year and piloted at 1 000 schools across five provinces, can thus be classified as a novel subject in the curriculum that requires intense and sufficient training of teachers.

To implement the DBE proposal to introduce coding as an innovative subject into the primary school curriculum and to train teachers to do it, teachers must be afforded the necessary time and opportunities to thoroughly familiarise themselves with all the components and skills required to teach the subject successfully. The dynamics of the

training thus gave impetus to the following themes that surfaced from data that speaks to research question 2.

5.3.1. Knowledge of the facilitator on introducing a novel subject

According to Wildova (2013:1112), significant attention is paid in Europe to training primary school teachers, as primary schools have undergone a vast transformation recently. As a part of this transformation, training primary school teachers is being reconfigured in terms of current trends emerging in other European countries. This is in line with the notion that continuous training of teachers should transform them into proficient individuals who will in turn transform their teaching and enable the learners in their care to become more skilful and capable in the classroom and beyond.

To transform education in this country, South African teachers need to be appropriately equipped to meet the evolving challenges and needs of the country (Stein, 2008: 15). Introducing innovative subjects such as coding to the curriculum can transform teachers into proficient educators as the subject holds many benefits for learners and learning if teachers are adequately trained. However, to successfully facilitate this transformation, the intended training should be considerate of the primary background knowledge that the trainee brings to the table. In this regard Vaillant & Marcelo (2015) state that

> the success of the transformations that are carried out in the educational centres is necessarily due to the cognitive and affective involvement of the teaching staff, who from their personal and professional characteristics can design and execute positive change actions within the framework of their pedagogical practice, but this can be achieved through the professional development of teachers that contributes to school improvement.

According to Cserti (2019), to guide individuals or a group of people to a successful outcome, facilitators need to be clear on the end goal and the milestones to be achieved along the way. Facilitators create the conditions for success by evaluating whether the time allotted is realistic for achieving the goal, ensuring that there is insight into the trainees' content background knowledge, and providing the necessary materials for the work to be done. Having a clear goal from the beginning serves the dual purpose of giving the facilitator more confidence for tackling the task at hand, and that confidence trickles down to the trainees, giving them the courage to navigate the unknowns of complex problem-solving (Ferguson, 2019).

This theme speaks directly to the facilitators' inability to consider the participants' dearth of contextual subject knowledge. The data that emerged from this section shows that despite their interest in the subject, none of the participants had previously received training in the subject of coding. Coding as a subject was thus a novel area. One educator indicated how his interest in coding started.

> I had no experience in teaching the subject before this. I was always involved with computers, but while teaching in the UK, I was exposed to coding at school, and it was there that I developed an interest in the subject. … (teacher Ashley Newman)

A second teacher stated that her affiliation with coding was when a need arose at school for someone to take charge of the subject:

> Even though I had no background in the subject content, as one of the HoDs, I took the initiative to steer and teach the subject at school. (teacher Taryn Peters)

The third teacher remarked the following regarding her experience in coding:

> Nobody at our school had any experience with coding when the Governing Body decided to introduce it as an additional subject, and that is when I decided to avail myself to teach coding. (teacher Abbey Davids)

When reflecting on the respondents' input on being novices in coding, the data shows that almost without exception the respondents alluded to the fact that they were unfamiliar with coding concepts. Teacher Davids' further stated that nobody at her school had any experience with coding and that it was unfortunate that nobody could assist her at the school level. This statement referred indirectly to the need for additional support.

Though two of the participants had no official training as teachers they had experience in working with computers and were suitably trained in the area of IT and CS. They were thus employed at their schools to manage the computer labs. Teacher Adams commented about teaching coding at school as follows:

> As the head of the CS department, it seemed natural for me to take charge of the Coding section when it was introduced last year. My knowledge of code was extremely limited at that stage. (teacher Mervyn Adams)

The interviews further highlighted that none of the participants was initially employed as a coding teacher at the schools where they are teaching and that coding as a subject was

very new to them. Their understanding of teaching coding had thus been framed by and based on their initial area of study and the higher institutions of learning they attended.

The data that emerged from this theme then shows the facilitator's knowledge on introducing an innovative subject into the primary school curriculum. As discussed in this section it became clear that the participants had extremely limited background knowledge of the subject of coding. This was in stark contrast to the facilitator who had a wealth of information on the subject. It became evident, however, that though the facilitator was extremely knowledgeable in the subject of coding, the facilitating programme failed to inspire the participants with confidence in their own abilities to master the concepts and skills of the subject. This became apparent when the participants gave the following input regarding their perception of the facilitator and the perceived success of the facilitation process:

> The facilitator was very knowledgeable in the subject content but failed to enthuse me with confidence as he seemed oblivious… (might be too strong a term) to the fact that everything he tried to convey, was actually very new to me. (teacher Peters)

This comment of teacher Peters referred to the facilitators' inability to take into account that the subject content was in essence a new curriculum subject that required a measure of patience and empathy with the trainees' quest to comprehend the subject content.

These comments were likewise echoed by teacher Newman who proclaimed:

> Acquiring the skills to teach a new subject requires adequate preparation and time to familiarise oneself with the subject content and skills. I am of the opinion that the facilitator did not satisfy this vital need.

It has become apparent that the introduction of an innovative learning area in schools, such as technology, is problematic. In a study on introducing technology subjects in New Zealand, Jones (2016:281) found that 'teachers' existing subcultures in terms of teaching and learning, subject area and school, in association with their concepts of technology, influence the development of classroom environment and strategies, and consequent student activities'. This implies that to introduce technology into the classroom, it is important not only to have a developed concept of technology but also awareness and understanding of technological practice. Teacher Peters referred to this issue in stating that,

> I found it extremely daunting to teach coding initially as my understanding of the subject was almost non-existent.

According to the literature, this deficiency experienced by teacher Peters, and many others before her, has resulted in teacher development programmes based on a model that emphasises the importance of teachers developing an understanding of both technological practice and technology education being developed to enhance teachers' understanding of this new area (Compton & Jones, 1998).

According to Hermans, Sloep & Kreijns (2017), the literature on acquiring skills in a new subject further states that

> in order to implement a new pedagogy successfully it is of the essence to take into account how teachers learn and what motivates them to adapt and change their way of teaching. Teachers need time to test and adapt a teaching design to fit the needs of their classroom practice and the students' needs.

Darling-Hammond, Hyler & Gardner (2017: v) further postulate that 'PD that focuses on teaching strategies associated with specific curriculum content supports teacher learning within teachers' classroom contexts'. Furthermore, effective PD provides teachers with adequate time to learn, practice, implement and reflect upon new strategies that facilitate changes in their practise (Darling-Hammond, et al., 2017).

Also, the teaching literature makes it clear that, for most teachers, a room full of bright students is an ideal situation. Unless, of course, teachers try to teach a subject outside their area of expertise, then it can be a nightmare. Teaching unfamiliar material is difficult work for anyone. Data that surfaced from the participants further suggests that as a novice within a subject they feel like imposters, and worried that their students would challenge them because of their dearth of content knowledge. Bruff (2019), classifies a 'content novice' as someone who has little or no specialised knowledge in a topic. It's different from being a novice teacher; even a seasoned instructor could be a content novice in certain classes.

The data accrued thus indicates that, though the facilitator came to the programme with a wealth of knowledge, the facilitation process did not meet the demands required to successfully support the teacher participants with the content knowledge and skills to transfer the information effectively and confidently to the learners.

5.3.2 Facilitators' teaching approach during the programme.

Method, according to Azeb (1984:90), is an arranged and deliberate improvement headed for the given or corresponding scheme of ideologies for the presentation or custom of implementation. Method allows the teacher to select appropriate learning experiences, to form sufficient settings, and calculate and estimate improvements. Hence, it can be concluded in the context of education that a method of teaching is a pathway by which the content of subjects is interconnected in such a way that it could accomplish the planned and scheduled consequences or objectives.

Ramsden (2003), says that the selection of teaching methods depends upon the diversity of elements or features. Therefore, the elements of particular teaching methods include age and mental level of learners, students' previous knowledge, and the particular needs of the students. Borich (1988) specifies that

> before selecting a specific type of teaching method an instructor should keep in mind the following decisive factors; educational objectives, subject matter, teachers' characteristics, the specific condition of the instruction, e.g. time, class size, resources provided for the instructional process.

So, depending upon what knowledge or skills a teacher wants to achieve in students,

there are many types of teaching methods. According to Aslam, Abdul & Awan (2019:43),

> when a teacher takes a decision about his teaching method, they are required to be flexible and show willingness towards the adjustment of their teaching styles according to the learners and the content to be taught. Therefore, student's success is highly dependent on the effective teaching method.

According to Newcomb, et al. (1986:26), the following three principles speak directly to the teaching methods and approaches that teachers (trainers) use during their lessons and indicates that,

> (1) When the subject matter to be learned possesses meaning, organization, and structure that is clear to students learning, it proceeds more rapidly and is retained longer; (2) Readiness is a prerequisite for learning. Subject matter and learning experiences must be provided that begin where the learner is; (3) To maximize learning, students should 'inquire into' rather than 'be instructed in' the subject matter.

These principles constitute the foundation for all phases of the instructional process, the organisation and structure of subject matter, motivation of students, appropriate use of reinforcement, and the selection of teaching techniques.

The second theme that came to light was the methods (pedagogies) used during their training. Having a well thought out pedagogy can improve the quality of teaching and the way students learn, helping them gain a deeper grasp of fundamental material. Persaud (2019) argues that the proper approach helps students move beyond simple forms of thinking as defined in Bloom's taxonomy pyramid, like basic memorisation and comprehension, to complex learning processes like analysis, evaluation, and creation.

The responses of the participants regarding training methods used during the training programme were:

> The assistance and presence of the trainer was predominant throughout the training sessions... (Ashley Newman)

> The format of my training was basically that the trainer did a concept and I had to follow. (Tania Roberts)

> The facilitator was central in the training as he explained and I had to follow his lead. (Tarryn Peters)

The above extracts indicate that the development was predominantly facilitator-orientated and teachers basically had to follow the facilitators' instructions and were thus deemed as empty vessels to be filled.

When learning a new skill, the available literature indicates that teaching and learning should be inseparable, in that learning is a criterion and product of effective teaching. In essence, learning is the goal of teaching (OECD, 2016:32). Someone has not taught unless someone else has learned. Students' learning and motivation to learn are directly influenced by their teachers or facilitators. This ideal is subject to the approach that the facilitator employs in his attempts to transfer knowledge. In this regard, teacher Peters described her experience of the facilitation:

> I feel confident that the trainer should have used the training methods used during our initial development as teachers or as we were trained as in-service teachers at CTLI. [Cape Teaching and Leadership Institute]. (teacher Peters')

This response was concerning previous training she received that was sanctioned by the WCED and was student-centred. Instructors understood the importance of being sensitive to the needs of their students, especially in an area of development within a new concept or innovative subject.

The data that emerged from the interviews suggests that the learning process between the teachers (recipient of knowledge) and facilitator (presenter of knowledge) was facilitator-centred. Freiberg (1999) critiques this approach by stating that in these classrooms, compliance is valued over initiative, and passive learning over active learning. Within the context of teacher development in coding as a novel subject, the data showed that the approach that the facilitator used, together with the limited training period, contributed largely to the inability of the participants to grasp more comprehensively the concepts taught.

In direct contrast to the approach used by the facilitator during the training, research about student-centred, constructivist classrooms documents increases in students' higher-order thinking, learning, and motivation, particularly in STEM classes (Moustafa, et al., 2013). Furthermore, Keiler (2018:2) notes that research about student-centred instruction in STEM, in which students take an active role in the learning process rather than being passive recipients of information from the teacher, demonstrates outcomes consistent with developing 21st-century skills and STEM mastery.

Successful computer-supported or computer-focused teacher development provides teachers with hands-on opportunities to build technical skills and work in teams while engaging them in activities that have a substantial bearing on their classroom practices or other aspects of the school workplace. Though the facilitator employed the site-based approach discussed in the literature in a previous chapter, the outcomes were not achieved, because of the very short duration of the training process. It is directly because this method of training was used that the teachers had to employ self-directed learning as an additional strategy to enhance their coding knowledge at the initial stage of their training.

In contrast, it would have been more suited for the facilitator to use the standardised teacher professional development approach as this model typically represents a centralised approach, involving workshops, training sessions, and in many cases the cascade model of scaled delivery. It tends to rely on training-based approaches, in which presenters share skills and knowledge with large groups of educators via face-to-face, broadcast, or online means. The approach mainly focuses on the exploration of an idea

and the demonstration and modelling of skills. It introduces teachers to new ideas, new ways of doing things, and new colleagues.

Teachers Newman and Peters both referred to this possibility when they proclaimed that

> I would have preferred to receive the training with other teachers in order to share ideas. (teacher Newman)
>
> Personal (face-to-face) training would have allowed for meaningful interaction. (teacher Peters)

As coding was a novel subject to all the respondents, this model would have been more suited as it would have allowed for more contact time with the facilitator and exposed the participants to a wider group of teachers and could have created a platform of shared or common problems and issues regarding the training or subject content.

5.3.3 Impact of the training programme duration on teachers' understanding.

What impacted even more on teacher participants' abilities to fully grasp the concepts and skills of coding was the limited training period that the programme offered. Almost without exception, respondents referred to their period of training as being inadequate. The respondents unanimously reported that the duration of their training impacted their understanding of the concepts of code and this affected their confidence when having to prepare and teach the content to the learners in their care.

Proper management of logistical issues in teacher education programmes tends to promote the quality of preparation of school teachers. According to Baskan & Ayda (2018:2),

> to achieve quality in teacher training, the teacher training program should be implemented step-by-step. Within these steps, both candidates and those within the profession need to be trained in a qualified way.

These steps encompass topics such as the selection of teacher candidates, their education within a specific time and programme, their activities in practice schools and their duration, the selection of teacher candidates by public administration, and in-service training of teacher candidates

The following extracts speak to the respondents' input in this regard:

Teacher Peters commented on her initial training as a teacher and compared her training in coding in the following manner:

> I can confirm that training as a teacher, we were submitted to years of training in the subject of choice. The development in coding was way too short and very impersonal. (teacher Taryn Peters)

Teacher Davids' who was trained in IT and had no formal training as a teacher shared the same concerns and responded:

> A facilitator sat with me for approximately three hours in my own classroom. And that was it…. No further face to face training. (Abbey Davids)

Teacher Adams was also critical about the training and responded in the following manner:

> My limited training was done in the school computer lab. My session lasted about two and a half hours and after that session, all follow-up sessions were done via links that were sent to me. (Mervyn Adams)

Notably, it emerged that the training was done over an extremely short period at the participants' place of work with only one personal session between the facilitator and the participants. The participants thus had to steer their way through the rest of their learning phase on their own, while depending greatly on the links that were forwarded to them by the facilitator.

Furthermore, interview questions posed to cross-reference the duration of their coding training with the development received when they did their teacher's training or when participants were trained in IT or CS, prompted the following responses:

> My training as an ECD teacher was much longer and it was more intense. (teacher Abbey Davids)

Teacher Davids commented that it was very difficult for her to grasp the concepts during the short session spent with the facilitator. Her concerns were that the subject was very new to her and that additional personal support would have been appreciated. She further commented that if coding was to become part of the curriculum then the DoE would have to arrange for more intensive workshops to ensure that teachers were trained properly.

Teacher Roberts' response was:

> My course in IT was done over a period of months and this way I felt confident in mastering the content and methods explained to us.

Teacher Roberts commented that though she had a solid foundation in Information Technology and was comfortable with computers, she struggled with the more advanced concepts such as Python. The foundation phase exercises she could comfortably deal with, but she was responsible for intermediate phase classes which required her to have a deeper understanding of the more advanced concepts of coding.

The abovementioned extracts indicate that due to the short period of training that the development programme offered, teachers were placed at a distinct disadvantage as they required an extended period of training to ensure that they would be knowledgeable in the subject content. Many of the respondents commented that their confidence levels were negatively affected because they felt unprepared to teach content that they had not mastered as yet.

They were unanimous in stating that more sessions with the facilitator would have been appreciated. One notable comment when they compared their former training in teaching or IT training to the development they received in coding, was that extended development sessions would have been more effective and would have contributed to their being more confident and more proficient in the subject of coding.

Within the context of the duration of training in a subject, Evans, et al. (2008) found that,

> despite having a graduate and, in some cases, a master's degree, 37 out of 40 trainees said that their knowledge prior to their training was 'not enough' to enable them to teach with confidence.

The participants in the study identified schemes of work as the driver for enhancing subject knowledge. This is particularly evident when trainees were teaching aspects of a syllabus in which they lacked subject knowledge. Reflecting on the findings of Evans et al. (2008), the fact that the respondents in this study of coding instruction only received one contact session with the facilitator during training supports their claim that their confidence levels for teaching coding were negatively affected.

Moreover, considering the duration of a development programme, Gallagher, et al. (2017) state that in effective PD programmes, the practices of generating feedback and supporting reflection often include opportunities to share both positive and constructive reactions to authentic instances of teacher practice, such as lesson plans, demonstration lessons, or videos of instruction. These activities are frequently undertaken in the context of a coaching session or a group workshop facilitated by an expert.

Providing PD that exhibits the aforementioned characteristics and results in meaningful professional learning requires time and quality implementation. Though research has not yet identified a clear threshold for the duration of effective PD models, it does indicate that meaningful professional learning that translates to changes in practice cannot be accomplished in short, one-off workshops, (Desimone, 2009). Professional development that is sustained, offering multiple opportunities for teachers to engage in learning around a single set of concepts or practices, has a greater chance of transforming teaching practices and student learning.

Besides, in a review of literature, Yoon, et al. (2007) identified nine studies of PD using experimental or quasi-experimental designs and found that the effective PD models examined in these studies offered an average of 49 hours of development per year, with an associated average boost in student achievement of 21 percentile points. This is in direct contradiction to the training received by the respondents who were exposed on average to only 3 hours of formal development between themselves and the facilitator.

The abstracts above capture the participants' fears, and apprehensions regarding the length of their training. They were unanimous in stating that their training was too short and that more sessions with the facilitator would have been appreciated. Furthermore, the literature suggests that the process of adoption of ICT or ICT-related subjects is not a single step, but should consist of ongoing and continuous steps that fully support teaching and learning and information resources (Young, 2003).

Reflecting on the above processes or stages, the data that emerged from this section suggests that the length of the training programme has not supported the adoption of these stages and thus contributed to the teacher participants' frustrations concerning successfully comprehending the subject content and grasping the skills required to teach the subject of coding with confidence.

5.3.4 Absence of a professional learning community (PLC) to support teachers.

The final theme that surfaced during this section of the research speaks to the absence of peers and colleagues to interact and support the participants during the training programme. Teacher participants were fairly vocal and consistent regarding their input and comments about the absence of fellow teachers during their training.

Self-efficacy refers to an individual's belief in his or her capacity to execute behaviours necessary to produce specific performance attainments (Bandura,1997). Armor, et al.,

(1976) in Tschannen-Moran & Hoy (2001:783) defined teacher self-efficacy as "... a judgment about his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated".

Like self-efficacy, teacher self-efficacy is derived from four sources: mastery experiences, physiological and emotional arousal, vicarious experiences, and social persuasion (Bandura, 1994). Studies have indicated that amongst others, factors such as the interpersonal support received from colleagues affects the levels of self-efficacy of teachers within a novice subject more than their more experienced colleagues, while mastery experience seems to play a greater role in the higher levels of self-efficacy of experienced teachers.

Research also suggests that self-efficacy beliefs can enhance a teacher's ability to respond effectively to stressful and challenging situations. For example, research has indicated that teachers with strong, positive efficacy beliefs about their teaching ability are more likely to take risks and use new techniques (Guskey, 1988), and to experiment and persist with challenging strategies that may have a positive effect on student achievement (Hani, Czerniak, & Lumpe, 1996). They treat less familiar learning areas as a source of their own development, and demonstrate resilience, viewing setbacks as temporary stumbling blocks. It is imperative that the professional learning offered to teachers as learners are positive, supportive, collaborative, and trusting to maximise their risk-taking opportunities within the learning.

According to Darling-Hammond & McLaughlin (1995), collaboration and collegiality have come to be viewed as a critical feature of effective development efforts. Indeed, as Little (1990b:509) has noted, collegiality advocates 'have imbued it with a sense of virtue – the expectation that any interaction that breaks the isolation of teachers will contribute in some fashion to the knowledge, skill, judgment, or commitment that individuals bring to their work, and will enhance the collective capacity of groups or institutions'.

Teacher Taryn Peters lamented in this regard that:

> It would have been so much more productive if I had a knowledgeable partner or colleague to assist me with the subject content and skills. I presume the understanding would have been so much better.

Her comments were consistent with the other participants who felt that knowledgeable assistance and support during and post-development would have contributed greatly to a more comprehensive understanding of coding content and skills.

Also, when teaching an unfamiliar topic, collegial support is expected and valued. The literature on teaching a novel subject according to Vygotsky (1994) supports the assistance of a more knowledgeable other to assist in gaining a deeper insight of the subject content, and reinforcing the necessary methodology, and skills and of the new area of knowledge (Siyepu, 2013).

Furthermore, Longfield (2018) note that when one learns a new teaching strategy or approach, it is usually a fairly complex process to successfully implement it in practice. Throughout the process of development, regular support and feedback from teaching colleagues, peers and other experts are crucial. This peer collaboration should be a key component of any professional development programme.

Additionally, Sparks (2002)) postulates that

> effective peer collaboration – that of teachers with other teachers – has been reported to be amongst the highest indicators of effectiveness in teachers' development. It allows one to learn from one's colleagues, transfer that knowledge to one's classroom practice, and be reflective about what one has learnt.

Teacher Newman voiced the following response when asked about possible limitations experienced in his training:

> I always strive to be knowledgeable in my subject to ensure quality teaching…I would have appreciated the input of other teachers at the training, similar to the teacher workshops at CTLI and those held within the various circuits with subject advisors.

Teacher Davids and Peters raised similar concerns when they responded to questions concerning inadequacies in their training. Teacher Davids remarked:

> I felt so unprepared… alone… and…vulnerable during my training session… There was no support from other teachers whom I could share my insecurities and questions about the programme with…. It was very different to our normal workshops with our clusters.

Teacher Peters indicated:

> I missed the company of other teachers that I could relate my concerns with… There were times that I thought…maybe I'm the only one who doesn't grasp the concepts… (teacher Peters)

She further commented:

> Yes…perhaps other teachers didn't have the same issues I had. I think…I needed a support-base with other teachers to share my many questions I had with the subject content. (teacher Peters)

According to Longfield (2018:7), the process of teacher learning for transferability – i.e. learning a new strategy or approach to implement it in practice to enable impactful student learning – is not just long, but also complex. Throughout this process, regular support and feedback from colleagues and experts is crucial, and should therefore be a key component of a CPD programme.

Furthermore, Sparks (2002) states that effective peer collaboration has been reported to be amongst the highest indicators of effectiveness in CPD, as it is conducive to the co-construction of contextual knowledge which is beneficial to individual teachers, specific groups of teachers and the organisation. In the *Cambridge Papers in English Language Teaching (ELT)* research paper, Longfield (2018) set out basic principles that provide the foundation for successful CPD programmes. These principles form the acronym 'INSPIRE' that entrench peer collaboration as one of the vital components of successful teacher professional development.

The following diagram reflects these principles:

(Figure 7) Peer-collaboration in teacher development programmes *Source: Longfield – 2018.*

Furthermore, Tondeur, et al, (2012) emphasise that learning from peers and collegial collaboration are productive ways for pre-service teachers to learn how to implement ICT in their teaching practice. Recent research indicates that teachers want to learn about

ICT together with other teachers (Bacigagulpo & Catchia, 2011) and participate in training activities related to authentic classroom settings (Balanskat et al., 2006).

One way to interpret these research findings is that collegial collaboration provides informal opportunities for teachers to learn about ICT together with other teachers to foster ICT self-efficacy and understand how to use ICT for educational purposes. This notion is also supported by previous research, which has shown that teachers' professional self-efficacy is positively affected by interpersonal support and collegial collaboration (Goddard, et al., 2007) collective work, cooperation and exchanges amongst teachers (Grangeat & Gray, 2008)

Also, Caspersen & Raaen (2014) identify both collegial and superiors' support as influential in terms of teachers' perceived mastery of teaching. Finally, previous research indicates that collegial collaboration is of importance when it comes to teachers' actual teaching practice and students' achievements (Goddard, et al., 2007).

Thus, taken together, these findings indicate that contextual factors like collegial collaboration are positively associated with teachers' ICT self-efficacy for instructional purposes.

5.3.5 Summary of Sub-Research Question 2

This section brings to a close a report on the findings for research question two and describes the key themes and sub-themes that emerged from the second interview session with the participants. Four main themes emerged from research question 2. The most significant feature that the data showed was the teacher participants' perceptions of the training received that was discussed in detail under various themes.

The data that emerged from the various themes in this section reports on the facilitators' subject knowledge related to introducing a novel subject into the curriculum and initially highlights the facilitators' inability to comprehend that the participants were new to the subject of coding. This inability on the part of the facilitator was the impetus that gave rise to the challenges reported in the subsequent themes that speak to the participants' struggles experienced during the training and eventually affected the teachers' abilities to confidently teach the subject to the learners.

Reflecting on the responses recorded about coding as a curriculum subject coupled with the participants' initial background knowledge, it became apparent that with some

exceptions, the majority of teacher participants had very little knowledge of digital technology, IT or CS, and this impacted on their ability in some way to grasp the skills associated with coding. The limited training received further compounded teacher participants' struggles to prepare themselves adequately to teach the subject to the learners in their care. The processes required, as referred to in the relevant literature, was thus compromised to the detriment of the teacher participants.

Teacher participants were also subjected to facilitator-centred pedagogies that limited their participation in the training to allow for meaningful interaction between the participant and the facilitator. This inability to communicate more effectively during the training has impacted negatively on teacher participants understanding of the skills and concepts of coding as an innovative subject in the curriculum. Though self-learning was a positive consequence of the facilitation approach, the mode of training was deemed unsuccessful by the teachers as they preferred a more student-centred method.

Finally, as coding is seen as a novel subject in the South African curriculum, the teacher participants were unanimous in their view that they required additional support in the form of collegial support during the training sessions to share similar concerns and to assist each other in entrenching the content knowledge and skills of coding.

5.4 Synopses of the data relating to the two research questions

This section provides an overarching summary of the data that surfaced from the two sets of in-depth interviews held with the teacher participants at the various primary school sites. The comments that emanated from the teacher participants speak to their motivations as well as their perceptions of the training received in teaching coding as a novel subject in the South African curriculum and are directly related to the research questions that guide this research.

The data that emerged from research question one reflects several intrinsic motivations and a solitary extrinsic motivation that teachers signposted for undertaking training in coding. The participants were unanimous in their opinion that the training programme met their expectations as discussed under the various headings that speak to research question 1, and contributed greatly to enriching their personal knowledge as well as affording them a platform to enhance and expand their career opportunities.

The data that surfaced from research question 2 speaks exclusively on teacher participants' perceptions of the training in coding received and is deliberated upon under

four captions that examine logistical shortcomings of the training programme. The failure of the development programme to recognise that incorporating a novel subject into the curriculum, one which the teachers had no substantial background knowledge of the subject content, contributed to the many struggles and trials that the participant teachers experienced during the training.

It can thus be concluded that, though aspects of teachers' motivations for training in teaching coding reflected positively on the facilitating process, there were many areas of concern regarding teachers' perceptions of the training that will have to be addressed if future professional development programmes are to meet the expectations of teachers who require training in teaching coding at the primary school level. Recommendations in this regard are discussed in the following chapter.

CHAPTER 6: Study Synthesis

6.1. Introduction

In further developing the discussion of the findings in Chapter 5, the framework of the study as clarified in Chapter 3 is revisited. In this chapter, teacher professional development incorporating teacher motivations for, and experiences of the development program are understood as processes that ultimately inform teachers' experiences of the ensuing shifts in dispositions of professional development in their training to teach coding. This chapter is thus divided into three main sections that informs on the research questions, that relate to teacher professional development, the processes, and the themes that emerged during the study. Section 2 and 3 is further sub-divided into sub-sections.

Section 1 provides an overview of teacher professional development in teaching coding.

Section 2 discusses the various processes and is sub-divided into two sub-sections that informs on the participants' motivations and their experiences of TPD under a number of headings.

Section 3 informs on the themes identified during TPD and is further sub-divided into two sub-sections that is discussed under various headings. The first sub-section notifies on teacher participants motivational dispositions and shifts for development. The second sub-section informs on teacher-participants disposition and shifts relating to their experiences of the development.

6.2. Teacher professional development for teaching coding

As indicated in the literature contained in Chapter 3, quality education is achieved by having good teachers, who are enabled by good teaching and learning processes and facilitated by a conducive learning environment. To accommodate this ideal, teachers require assistance to develop their practice so that their learners can accomplish, achieve, and succeed. Ultimately, that support falls under the auspices of professional development, especially in the area of innovative subjects such as technology and coding.

As noted by the DBE in its Teacher Professional Development Master Plan Document: 2017-2022 (2017:43), it aimed to embark on consultative workshops with stakeholders to prepare for the adoption of a framework for digital learning, which will assist teachers to identify their ICT development needs. This process was in preparation for the

implementation of teacher development programmes for digital learning aligned to the framework as one of its objectives. It further aspired to provide on-site support to teachers in the integration of learning with technologies for effective learning and to build capacity to support professional development in digital learning within the schools.

However, the reality is that the DoE does not currently have a suitable programme to introduce innovative ICT subjects such as coding to teachers at the primary school level. This situation is further amplified as many teachers do not possess the ideal background knowledge to master the proposed development programme as envisaged by the Department of Basic Education. This is mainly because, in the past, the education system in South Africa did not place sufficient emphasis on the importance of innovative subjects that would prepare the learners for the rigours of the Fourth Industrial Revolution. This conundrum has come about because, though, teachers were adequately trained in diverse academic subjects, only some of them received training in subjects related to digital technology or innovative subjects. This is especially true of teachers at the primary school level.

The available literature on TPD supports the view that becoming professionals, or as Darling-Hammond & Bransford (2005) explain, entails being 'adaptive experts' which is the intent of teachers' engagement in such a process. Furthermore, the understanding and abilities required to be a masterful teacher are not fixed and teachers' understanding must, at all times, keep pace with changes. In this regard, however, many teachers' currently lack adequate insight, content knowledge, and training to deal with rapidly changing technologies.

Globally, researchers who have been analysing evidence accumulated since the 1970s have suggested that teaching is arguably the strongest school-level determinant of student achievement (Gauthier & Dembélé, 2004). According to Schwille & Dembélé (2007:25), heightened interest in and concern about teacher quality worldwide, as well as interest in and criticism levelled against teacher education systems, can be attributed to such evidence. Furthermore, the formulation of policy and design of teacher preparation and continuing professional development programmes optimally takes into account

> the whole spectrum of teacher learning, that is, teachers' opportunities to learn from the beginning of their own prior schooling and throughout their teaching careers. This perspective is what has become known as the continuum of teacher learning, a comprehensive framework for organizing and understanding how

professional educators acquire and improve their capability to teach (Schwille & Dembélé, 2007:29).

Within the South African context, one of the important areas that the South African Revised Policy on the Minimum Requirements for Teacher Education Qualifications (South Africa, 2015:64) focusses on is that teachers should know how to teach their subject(s). The data that emerged from this research indicates that teachers represented in this study were unanimous in their views regarding the value of TPD and CPTD. Their opinions were in line and harmonised with the available literature on the many positive impacts that teacher development holds for the teacher, the learner and the profession.

An important aspect that surfaced, however, was a disconnect between what the literature intimates and what the participants experienced during their training. This disconnect hinges on a misalignment in the mode of how the development process was initiated, and how it affected the processes of the development programme as discussed in the next section. Moreover, the data that emerged from this research indicate that the required platform to facilitate a process in advanced modes of teaching within innovative subjects such as coding is urgently required to develop teacher proficiencies, such as deep mastery of challenging content, critical thinking, complex problem-solving skills, and the necessary collaboration opportunities to facilitate a truly successful development programme.

This situation has been magnified because the current body of teachers includes mostly novices in the area of teaching ICTs who have to contend with acquiring knowledge and skills in coding as an innovative subject in the South African primary school curriculum with no, or very little, formal training in the subject.

6.3. Processes

Teacher professional development motivations and their understandings of the development programme are understood as processes during the development process in teaching coding. These processes are discussed under various headings and lay the pathway to the anticipated outcomes of the development process. Reflecting on the conceptual framework of the study as informed upon in Chapter 3, motivations are discussed in terms of intrinsic and extrinsic reasons for undertaking the study. This aligns with literature that notes that teachers are driven by intrinsic motivation, without expecting

recompense in any form for the act, or to the contrary, results in personal gain, reward or gratification.

6.3.1. Teacher motivations for participation in the TPD programme.

The significance of teacher motivation research is self-evident as it is a crucial factor closely related to several variables in education such as student motivation, educational reform, teaching practice and teachers' psychological fulfilment and well-being. In this regard, Han & Yin (2016:1) state that a significant step forward in literature within the area of teacher motivation research was the release of a special issue on motivation for teaching by the journal *Learning and Instruction* in 2008. This issue's specific emphasis was on relating the then-current motivational theories to the domain of teaching, which was called a 'Zeitgeist of interest' by Watt & Richardson (2008). This work was an important impetus for setting the agenda for future teacher motivation research.

Furthermore, Richardson & Watt (2010) conducted a review of teacher motivation research with a focus on their 'FIT-Choice' (Factors Influencing Teaching Choice) programme with student teachers. The FIT-Choice programme of research began in 2001, prompted by two questions that had been forming for Richardson over the period of a decade: why do people from demanding, high status and financially rewarding careers want to switch to teaching? And what motivates people to do teaching at all? To fully comprehend these reasons, it is of significance to understand and review the motivations of pre-service teachers as well as in-service teachers.

Available literature shows that teachers are moved to undertake TPD for various reasons. The literature further indicates that motivations for development can be categorised according to these reasons or needs for undertaking development in areas of interest. In this regard, to identify motivation factors and the change in pre-service (or in-service) teachers' motivation, Sinclair (2008) distributed the Motivational Orientations to Teach Survey (MOT-S) twice with 186 student teachers at the beginning and the end of their first semester of teacher education. He proposed a hierarchy of pre-service teachers' motivation to teach. Specifically, pre-service teachers were significantly motivated by higher intrinsic motivation than extrinsic motivation. The strongest intrinsic motivation factors were working with children, intellectual stimulation and self-evaluation, whereas the strongest extrinsic motivations included the nature of teaching work, working conditions and life-fit.

Further, an increase over time was found in five motivating factors, including self-evaluation, authority and leadership, life-fit, the influence of others and career change. Sinclair (2008) classified all determinants into ten categories, including calling, altruism, intellectual stimulation, the influence of others, perceived benefits or convenience of teaching, the nature of teaching work, a desire for a career change, the ease of entry into teacher education, and the status of teaching.

The data emerging from this research resonates clearly with the literature in that the themes that were identified during this section of the research correlated with the literature on teacher motivations, be they in-service or pre-service teachers undertaking the training. Furthermore, this research identified that teachers had intrinsic and extrinsic motivations for undergoing TPD that are briefly discussed under the following headings.

6.3.1.1. Intrinsic motivations for TPD

Intrinsic motivation tends to lead to more engagement with the learning environment, more active pursuit of learning interests, and more effort, which is necessary for the development of skills and abilities (Reeve, 2001). In summary, intrinsic motivation results in high-quality learning and creativity (Ryan & Deci, 2000a), both amongst students and teachers.

The themes that emerged from the data indicate that the overwhelming reasons for development were ascribed to intrinsic motivations. This tendency aligned with the literature on teachers' intrinsic reasons for development, as the themes that emerged spoke to development as an important tool to enhance teacher knowledge and skills in an area of learning and teaching, affording them opportunities to remain current with the latest trends in education and allowing them a suitable platform to review current strategies in a rapidly changing society. Furthermore, it also acted as an enabler for the participants to adjust to changes in their field of study or work, and ultimately assisted teachers to acquire confidence in teaching diverse or innovative subjects.

Teachers were unanimous in their views that the intrinsic motivations mentioned above were important to ensure that they remained updated with the latest trends in education. It also afforded them a personal comfort zone or space in which they became and felt comfortable and confident with the content knowledge and skill of a subject.

6.3.1.2. Extrinsic reasons for TPD

Ryan & Deci, leading experts in motivation, define extrinsic motivation as 'doing something because it leads to a separable outcome' (Ryan & Deci, 2000:55). There are many sources of extrinsic motivation for engaging in an activity. For example, people do many activities, even things they deeply detest, for monetary gain, or the respect or admiration of others.

In this research, the data from the interviews revealed a solitary extrinsic motivation for TPD resonating with the literature, that enthused teacher participants to assume training in the area of teaching coding. The overwhelming evidence that came to light during the interviews was that TPD in coding allowed teachers to contribute to the organisational success of their schools by adding to the knowledge base of teachers and learners. This placed their schools and immediate society from which the school source learners in a niche of institutions with the knowledge of innovative skills learning, geared towards future student needs and employment. It also afforded the school a wider base of learners for enrolment selection as potential parent communities would be drawn to institutions offering a wider curriculum subject choice.

6.3.2. Teachers experiences of the development

As indicated in the literature reviewed in Chapter 3, student performance hinges on the quality of instruction. This leads to the assumption that to improve the quality of instruction, teachers need to be sufficiently trained. Therefore, supporting the continual development of teachers is important to improve the quality of teachers and the quality of their teaching (Seferoglu, 2001:117).

The findings of this research signposted areas such as adequate time allocation, appropriate pedagogies used during the facilitation as well as opportunities for peer collaboration and collegiality that the development programme had to address. The literature, according to Borich (1988), specifies that,

> before selecting a specific type of teaching method an instructor should keep in mind the following decisive factors; educational objectives, subject matter, teachers' characteristics, the specific condition of the instruction e.g. time, class size, resources provided for the instructional process.

Moreover, according to Aslam, Abdul & Awan (2019:43), when a teacher takes a decision about his teaching method, they are required to be flexible and show willingness towards the adjustment of their teaching styles according to the learners and the content to be taught. The data informs directly on conflicts that emerged regarding teacher-centred vs student-centred learning during the programme.

The importance of peer support can never be underestimated during development, and this is underscored by the data that surfaced during the research. In this regard, Darling-Hammond & McLaughlin (1995) indicate that collaboration and collegiality have come to be viewed as a critical feature of effective development efforts. Furthermore, Little (1990b: 509) has noted that advocates of collegiality 'have imbued it with a sense of virtue – the expectation that any interaction that breaks the isolation of teachers will contribute in some fashion to the knowledge, skill, judgment, or commitment that individuals bring to their work'.

6.4. Discussion of themes identified during the development process

This section discusses themes and concerns that relate to how the teacher professional development programme in teaching coding was experienced by teachers and how it influenced their practices based on their dispositions during the programme.

6.4.1. Motivational dispositions and shifts for development

This study identifies specific dispositions on teacher motivations for undertaking professional development in coding which are briefly deliberated upon under the various themes that surfaced from the teacher interviews. The findings from research question one revealed that though the overwhelming opinion of the training received by the participants was positive, their perspectives on the value of the development differed in some ways.

6.4.1.1. Importance of TPD for learning

Mizzel (2010: 10) comments that effective professional development enables educators to develop the knowledge and skills they need to address students' learning challenges. Moreover, it can lead to improvements in teaching and development of teachers' pedagogical thinking about students learning and development.

In the current research, professional development in coding exposed teachers to new knowledge and skills to facilitate their understanding and teaching coding. Though teachers were unanimous in their views about the value of TPD, there was some disquiet regarding their initial struggles to master the concepts, skills and knowledge of coding due to their limited initial background knowledge.

Though all teachers identified the training as essential for personal growth, the teachers all indicated specific strengths that the programme afforded them on an individual level. Many of the teachers distinguished the problem-solving and critical thinking skills that the training enhanced as vital components for successful learning. These skills were acquired as an accidental consequence of the training and were identified as a fundamental component that might not have received the necessary emphasis during their former pre-service training.

6.4.1.2. TPD as an enabler of adjustment to change

Fullan (1992: 22) claims that 'change is a process of learning new ideas and things. It is learning to do and learning to understand something new'. The literature further indicates that professional development is important to improve existing skills and knowledge or to broaden ones' knowledge in a new or innovative area of work. Teacher participants referred to dispositions that applied to their personal circumstances as well as the effect

TPD had on the learners. Personal growth was identified by individuals within their own working experiences and how it enabled them to broaden their marketability in the area of job placement other than teaching. Furthermore, teachers believed that learners were positively affected by the development in terms of exposure to much-needed technology skills as well as by preparing them for the kind of work placements required for the Fourth Industrial Revolution.

6.4.1.3. Confidence enhancer in teaching new subjects

Professional development is a primary factor toward helping teachers become adept in learning the knowledge and skills required of them when teaching subject content. The effective preparation of teachers to teach is recognized as a vital factor for students' academic success. CPD refers to any activities aimed at enhancing the knowledge and skills of teachers by means of orientation, training and support (Coetzer, 2001: 78). The

development is also likely to affect attitudes and approaches and may therefore contribute to the improvement of the quality of the learning and teaching process (Day & Sachs, 2004: 3).

In support of the literature, many of the research participants reported the positive influences that professional development in coding had on their abilities to procure insight and confidence to teach subjects that they have not specialised in. This is particularly true in primary schools.

Participants reported that the skills acquired in coding development such as problem-solving skills assisted both teacher and learners in other areas of the curriculum. The application of critical thinking skills, persistence, and logical thinking that coding requires assisted teachers to transform their abilities and approach in other subjects such as Literacy, Natural Sciences, and Mathematics to the benefit of the learners in their care. The skills and confidence they gained allowed them to teach in a more relaxed manner, and approach learners with appropriate strategies to overcome adversities. In short, it placed them in a much better space to teach effectively.

6.4.1.4. Importance of TPD for organisational success

Organisations and educational institutions recognise that professional development presents a prime opportunity for their institutions to expand the knowledge base and skills of their employees. Well-trained employees contribute to organisational success and ensure prestige and recognition within the framework of employment and the society within which it exists.

In this regard, the participants were unanimous in their belief that professional development contributed not only to the success of the individual but added to the value of the organisation and enticed the community to make use of the services of an organisation that they deemed proactive and results-driven.

6.4.2. Dispositions and shifts of teacher experiences of the development

In this research, primary school teachers' exposure to diverse backgrounds in teaching practice and curriculum subjects was identified to varying extents to have led to shifts in their dispositions. However, these shifts were in many cases slightly dissimilar as not all teacher participants experienced shifts to the same degree. Moreover, shifts in teacher

participants' dispositions occurred at distinctive times that corresponded with their understandings of the subject matter that they brought to the development programme.

With the increase of technology initiatives in K-12 education, stakeholders expect teachers to integrate technology effectively and prepare students with essential digital literacy skills for their future careers (U.S. DOE, 2016). Effective teacher PD should help teachers adopt and integrate technology to change their teaching practices and further support student learning (Lawless & Pellegrino, 2007).

Though each of the teachers was viewed as fully-fledged primary school teachers, they were still viewed as individuals who brought to the training programme their unique background knowledge with varied personal expectations of the programme. The data accrued from this question shows that their individualism and personal knowledge background indeed impacted their perception of the value that the training afforded them as individuals. The themes that surfaced during this research related to teacher perceptions of the training received in teaching coding are briefly elaborated on under the following headings.

6.4.2.1. Facilitator aptitude for development in an innovative subject

Available literature according to Thornton (1992) suggests that facilitators should be accommodating to trainee needs in resolving any hindrances that could prevent them from assimilating the required skills during a training programme. Rees (1991: 86) describe skills needed for effective facilitation as a trainer that listens actively, encourages participation, manages group processes, builds consensus, organises and records group ideas, and provides content when needed.

A concern that conflicts with the available literature on introducing a new subject emanated from this section. Participants commented that the facilitator did not have the necessary acumen to introduce an innovative subject to students who were novices in the area of technology and specifically coding. Though the facilitator was extremely knowledgeable in the subject, most of the teachers struggled to get to grips with the content because of their limited background knowledge of digital technology. Due to the facilitators' inexperience in delivering a new subject to students with limited background knowledge of it, the participants were unable to keep abreast of the instructor during the short development programme.

6.4.2.2. Pedagogies used during facilitation programme

Due to the importance of ICTs in society as well as in the future of education, identifying possible challenges to integrating these technologies in schools would be an important step in improving the quality of teaching and learning. Balanskat, Blamire, and Kefala (2006) argue that although teachers appear to acknowledge the value of ICT in schools, they continue to encounter obstacles during the processes of adapting these technologies into their teaching and learning.

According to Becta (2004) the issue of training is certainly complex because it is important to consider several components to ensure training effectiveness. Research by Gomes (2005) relating to various subjects concluded that lack of training in digital literacy, lack of pedagogic and didactic training in how to use ICT in the classroom and lack of training concerning technology use in specific subject areas were obstacles to using new technologies in classroom practice. The lack of pedagogical training, or rather, effective pedagogical and didactical training in how to use ICTs such as coding lies at the heart of this theme that emerged.

Teachers in this study particularly commented on the teacher approach of the programme facilitator. This method was frowned upon as the teachers were not able to engage the facilitator in a manner that facilitated the absorption of the new content knowledge. As reported by Al Zube (2013:24), the teacher-centred approach portrays students as basically passive while the teachers are active since teachers are the main focus in this approach; this is considered sensible since the teachers are familiar with the language which the students are not. In this case, the students were less than optimally engaged during the learning process.

Furthermore, within the context of coding as a new subject, teachers felt that to acquire the skills of a subject that requires constant practical interaction between student and facilitator, the student-centred approach utilised during their initial training as teachers would have been preferred and would have resulted in a deeper understanding of the skills needed in coding instruction.

6.4.2.3. Programme duration

Having sufficient time for teachers to collaborate and learn is essential to enhancing their professional development. The literature on allotting time in communities of practice suggests that teachers have sufficient time to engage in collaborative learning activities

(Akinyemi et al., 2019). This issue was single-handedly one of the greatest concerns of the teacher participants. Without exception, the participants believed that the contact time allocated for development in coding as a new curriculum subject was too little to make a meaningful impact on their abilities to comprehend the skills and subject content of coding.

Teachers reported that it was very difficult for them to comprehend the concepts during the short session spent with the facilitator. Their concerns were premised on the fact that the subject was very new to them and that additional personal support would have been appreciated. Further recommendations were that if coding was to become part of the curriculum, then the DBE would have to arrange for more intensive workshops to ensure that teachers are trained properly. Teachers argued that the format needed to be in line with the two-week in-service refresher courses instituted by the DBE that is periodically done at CTLI.

6.4.2.4. Opportunities for collaboration and collegiality

Collegiality is one of the most important factors in determining the quality of a school. The literature, according to Shah (2012: 1243) informs that collegiality is seen as a key aspect of teacher professional development and a vehicle to increase teacher knowledge. Moreover, regular and fixed time should be allocated for communities of practice to give teachers enough time to collaborate.

Teacher participants reported that knowledgeable assistance and support during and after development would have contributed greatly to a more comprehensive understanding of coding content and skills. Also, when teaching an unfamiliar topic, collegial support is expected and valued. The fact that the development programme was held with individuals and then were expected to teach unfamiliar content without any collegial support conflicted greatly with the above-mentioned literature.

CHAPTER 7: Study summary and recommendations

This chapter brings the study to a close, by affording a final synopsis of the research as well as recommendations based on the findings. This is followed by a concise outline of the contributions the researcher considers the study to have made to the field of teacher education, teacher professional development research and policymaking arena. Finally, the researcher's reflections and suggestions on the research voyage are shared. This chapter is thus divided into five main sections.

Section 1 provides a summary of the study and is divided into three sub-sections that notifies on Research Question 1 and 2, as well as a synopsis of the research questions.

Section 2 informs on the recommendations for future study and is sub-divided into two sub-sections that inform on development in innovative subjects and the facilitation of the development process.

Section 3 relates to the recommendations for policy and practice and is sub-divided into three sub-sections that notify on policy-makers, practice, and teacher-education providers.

Section 4 informs on the contributions of the study.

Section 5 supplies concluding remarks.

7.1. Study Summary

In this study, the research centred explicitly on the experiences of teachers and the associated elements that refers to teacher motivations and teachers' understandings of the development programme in coding. Though the research sample are relatively small as a consequence of the limitations that Covid-19 placed on the sample size, the contradictions that surfaced from the data indicate that there are significant areas of paradoxes that some teachers face and will have to surmount to ensure that the effective development results in effective transferal of coding knowledge to the learners in their care.

Relating to research question 1, this study identified four main motivational features that emerged. Three of the features were related to intrinsic motivation, and one feature was directly related to extrinsic motivation. As to research question 2, four features surfaced that related to teachers' understandings of the development received.

7.1.1.Sub- Research Question 1 Summary

The study found that primary school teachers' motivation to undergo TDP precedes the training, but manifested as a subsequent result of the training. The research further focused on how these motivations for development in teaching coding and its realisation shifted, or did not shift, teachers' perceptions and expectations on how the training impacted them as discussed and reviewed under research question 2.

The research initially appraised teacher motivations for undertaking professional development in coding as a new curriculum subject and examined various motives for teachers for initiating the development. The findings resonated with the literature promulgated by, amongst others, Van Eekelen, Vermunt & Boshuizen (2006) who underlined that teachers' will to learn must be present before their engagement in any learning activity regarding innovations. In their small scale qualitative study, they found that it was only teachers who were eager to learn, and agreed with innovative views of teaching who undertook the appropriate action to do so (Van Eekelen et al., 2006).

Also, previous research has suggested that autonomous goal motivation leads to greater goal progress by allowing individuals to exert more effort, experience less conflict, and feel a greater sense of readiness to change their behaviour (Koestner, 2007). Therefore, to ensure the success of any developmental programme, teachers autonomous and subjective motivations should be involved in new learning experiences.

7.1.2. Sub-Research Question 2 Summary

This research further quantified the data that emerged from the interview questions reflecting research question 2, and that referred to teacher participants' understandings of the training received in teaching the subject and how it resonated with the available literature on teacher professional development. The inability of the training program to adequately address the teachers' expectations found by research question 2 could be ascribed to the absence of appropriate methodology, peer support, and sufficient training opportunities during the program. Some teachers highlighted the value of the training programme as a means of cultivating organisational success, whilst others viewed the programme as an enabler to adjust to changes within a field of work.

Because each participant was different and brought to the program their individualised background knowledge and perceptions, the training program outcomes had varying effects on their understandings. The teacher participants also experienced the

development program differently from how they understood their experiences as teachers in training. The pedagogies used in the coding training program could therefore be seen to have provided almost all of those teachers interviewed with personal turning points to enhance their understandings of the possibilities that the training program afforded.

Amongst the augmentations distinctly identified, the data from research question 1 indicates that participants identified some enhancement in their understanding of learning and organisational success, saw the training as an enabler to adjust to changes in an area of work, and recognized the personal value and advantages that the development held for the individual.

Research question 2 further focused on the quality of the facilitation, the justification being that the researcher aimed to determine the level of sophistication of the facilitator within the context of effective transferal of content knowledge and skills. The question thus focused on how the facilitation influenced teachers' understandings of effective development. An understanding on the part of the researcher of how the teachers perceived the quality of the facilitation was crucial to gain a clear understanding of how the level of facilitation did, or did not, impact the successful understanding of the development process.

7.1.3. Synopses of Sub-Research Question 1 & Sub-Research Question 2 findings

The study found that, though there were areas of the program that related to teacher motivations for development aligned with the literature, numerous issues of concern arose during the teacher interviews, primarily vocalising their apprehensions about the pedagogy used by the facilitator and how it failed to meet their expectations of training in a new subject area.

Many comparisons were made with the development regime that teachers undergo during training with the WCED, and how the facilitation during these programmes yielded much better results. In summary, the findings of research question 1 to some extent, but in particular research question 2, revealed that the teachers who participated in the study felt disengaged from the coding facilitation as their understanding of facilitation and training were crafted from the perspective of their prior pre-service and in-service training experiences.

7.2. Recommendations for future study

Recommendations for further research are outlined in an attempt to help inform on possible pathways to accommodate the implementation of coding as an innovative subject or any other novel subject for that matter into the curriculum. Furthermore, recommendations are suggested to try and resolve some of the contradictions and disjuncture's revealed in the previous chapter.

As indicated in an earlier section, this research does not seek to resolve the comprehension of teaching the subject of coding in its entirety but is solely geared towards the comprehension of teachers training in an innovative subject. Future research could be initiated to inform on how coding fits into the curriculum and how it informs on areas of assistance in technology or other content subjects. Moreover, another area of future study could be focussed on how the training in coding can be mediated into practice.

According to the data that emerged during this research, it became apparent that attempts to introduce the subject of coding into the primary school curriculum require deep reflection and consideration to ensure the success of the development programmes. The data further suggests that the attempts of the educational authorities to prepare teachers for the rigours of teaching an innovative subject such as coding was performed in extreme haste. This impacted the development capacity of the programme to fully engage teachers with the necessary knowledge and skills to master the concepts for teaching coding.

The data accrued further aligns with the available literature that indicates that successful development requires meticulous planning to ensure that teachers are trained effectively, which in this case was not achieved in the actual development programme. It has thus become apparent that the purpose of initiating the development did not fully meet the expected results, and thus the following recommendations should be considered for future development.

7.2.1. Development in innovative subjects

- It appears that there is a significant need in South Africa for teacher development in the area of innovative subjects and the benefits that it holds for the South African teacher, the learner, and the economy.

- Urgent research into industry requirements for the Fourth Industrial Revolution, and preparing a future workforce for the rigours of these demands is of the essence. This is in line with the South African government and DBE's vision of becoming one of the leading African countries in innovation. The recent announcement of introducing innovative subjects such as coding and robotics into the primary school curriculum is a positive move, but research indicates that the necessary spadework in developmental prerequisites is required to prepare for future implementation.

7.2.2. Facilitation of the development process

- Research should be done in determining a conducive period in which development in innovative subjects should be conducted. Facilitation sessions should not be done in an ad hoc manner. There is a need for sufficient training time for participants to become familiar with the content and skills of the new subject content. This was a definite shortcoming identified in the training programme.
- Future research should consider using quantitative methods such as relevant surveys to determine teachers' needs for effective implementation of technological subjects such as coding. This should include the required infrastructure and resources for effective teaching.

7.3. Recommendations for policy and practice

Recommendations are provided for the various stakeholders and role-players involved in TPD and CPTD who can contribute to the successful incorporation of development in both teacher training institutes and schools. The stakeholders comprise policymakers, education practitioners, and teacher education providers.

7.3.1. Policymakers

- Based on the data that surfaced from the interviews there seem to be a disconnect between what the policymakers in education expect of the programme and what the teachers experience during the development process. One of the areas that will have to be addressed is within the space of mentorship for teachers in the area of technology. Policymakers should allow for appropriate policies that will foster the ideas of collaboration and collegiality through design-based research This will

allow for support from peers when teachers require assistance in the subject. Also, consider including teachers of coding in the design of PD interventions.

- A further recommendation is for policymakers to consider devising a policy on instituting a database of knowledgeable teachers who can act as possible mentors to teachers who have difficulty in mastering the skills and concepts of the new subject. This would assist in making mentors available to newly-trained in-service teachers during this crucial process. Furthermore, this policy should ensure that pre-service teachers' pedagogies are aligned with both policy and programmes of the various teacher training institutions.

7.3.2. Practice

- Recommendations to ensure the necessary capacity for all teachers to be trained in coding within the foreseeable future are of the essence. As coding will be implemented as a compulsory curriculum subject shortly, policy designers should fast-track policies for teacher development in this innovative subject.
- Recommendations on identifying the most appropriate institutions for developing primary school teachers in technology ought to be initiated as a matter of urgency. These institutions should be resource-rich, to assist teachers to acquire the necessary skills in the area of training.
- Recommendations to provide trainers with the necessary acumen in the area of training should be high on the policymakers' list. Training individuals emanating from the private sector with appropriate background knowledge in CS or IT is different from training teachers with limited background knowledge in these areas. Consideration is important when selecting facilitators to steer the development process, especially for primary school teachers; they should have the required insight into suitable methodological practices that will support development in an innovative subject. Student-centred approaches are valued above facilitator-centred approaches in the development of any new or innovative area of teaching as teacher participants' needs should be valued during the process of development.

7.3.3. Teacher education providers

- There is a need for teacher training facilities and providers to identify the needs that are required for opportunities to comply with standards and requirements for

work placement in the Fourth Industrial Revolution. This requires opportunities for teachers to be trained in the required disciplines as appropriate facilitators in coding. These requirements should be supported by the incorporation of suitable subjects within the identified institutions' faculties and promoted with suitable bursaries.

- Finally, there is a need for teacher education providers to pay more attention to the design and position in the programme of key pedagogies to create opportunities for pre-service teachers and in-service teachers to engage in knowledge relevant to innovation and future needs, and to ensure that these teachers have optimal opportunities to shift their existing dispositions.

7.4. Contribution of the study

The sections above have considered the policy and practice recommendations emanating from this study, and have also outlined recommendations for future study. In this section, the researcher specifically considers the contributions this study makes to knowledge and understanding related to its area of enquiry.

Many reform initiatives have focused on the teacher as the key to improving learner performance (Desimone, et al., 2006:178). It is believed that teachers have the most direct, sustained contact with students, as well as considerable control over what is taught and the climate of learning. It is reasonably assumed that improving teachers' knowledge, skills and dispositions are one of the most critical steps to improving student achievement. (King & Newman, 2001:8). This explains why teachers are pressurised to be competent in their classrooms. It also justifies the urgent need for the professional development of teachers. By emphasising learning and the development of teachers, schools can ensure that learning processes contribute to the attainment of goals and the enhancement of quality and learner performance in schools (Browell, 2000:57).

Furthermore, models for continuing professional teacher development (CPTD) are much debated, but two key themes include that CPTD programmes must be grounded in valid and rigorous research that can account for the specificity of local contexts (Steyn, 2009), while homogenizing approaches are profoundly ineffective (Watson, 2013).

This study provides a comprehensive and in-depth account of a group of teachers' motivations, understandings and expectations in relation to teacher professional development in teaching coding at primary school level as gathered through qualitative

research methods. This can be considered to provide a unique aspect of teacher development as the study examines teachers' dispositions and experiences of the innovative subject of coding to be introduced as a fully-fledged subject at the primary school level.

This study has contributed directly to TPD and highlights the following aspects that are viewed as contributing factors to the study and existing literature in the field of teacher development in innovative subjects:

- It has identified teachers' motivations for undertaking TPD in an innovative subject and has found through the data that emerged that teachers are moved both intrinsically and extrinsically when they undertake development. The research has identified that in most cases, motivation has been guided by intrinsic reasons.
- TPD programmes should not take for granted that teacher development is a blanket initiative. Teachers come to the programme with different dispositions, and this should be taken into account by facilitators.
- The research also found that facilitators should have the necessary acumen in their pedagogical approaches to facilitate a programme successfully.
- Finally, this research has identified that teachers' understandings of the programme should meet their expectations for the programme to be deemed a success.

By illuminating a range of different interrelationships between the above-mentioned issues, this study has been able to offer insights into teachers' rationales at diverse primary school in the Western Cape for undertaking professional development in teaching coding, and their perceptions of the training as experienced during this programme of development. This research thus reveals how these experiences have impacted teachers concerning their training, and how the training has both aligned and miscarried in meeting their expectations.

7.5. Concluding comments

This study provided an overview of the extent of how TPD in teaching coding as an innovative subject is experienced by primary school teachers at three primary schools in the Western Cape in South Africa. This study is related to the South African Government and the Department of Education's intention to implement coding as a curriculum subject in the near future. In investigating this phenomenon, this research focused on teacher

motivations and their understandings (perceptions) of what the programme offered and how it operated.

The OECD (2009:49) signposts that a significant area of teacher training is that teachers are expected to make more effective use of information and communication technologies for teaching. This is especially relevant in preparing learners to engage successfully in the 4IR. In this regard, Sayed & Bulgrin (2020: i)) postulate that curriculum delivery, particularly in cases where curriculum undergoes major revision, requires effective and meaningful involvement and rigorous participation of teachers. Furthermore, successful curriculum delivery requires teachers who are capable, committed, motivated, and supported (Sayed & Bulgrin, 2020: iii). This applies to mastering all subjects taught, including innovative subjects in, or added to the curriculum.

This research has placed the researcher on a journey of discovery and the realisation of the value of TPD and the impact it has on acquiring skills and knowledge in an innovative subject in the primary school classroom. Therefore, this research initially explored teachers' motivations for embarking on development in an innovative area in the curriculum. Furthermore, this research has endeavoured to identify good practice during the process of receiving training but has also distinguished areas of scarcities during the development program that requires further research and evaluation.

Finally, the researcher suggests recommendations for further research that will aspire towards the expected ideals and outcomes of TPD in innovative subjects. The ultimate aim of this research is to add to and supplement existing literature in the field of TPD, more specifically within the context of the ground-braking area of teacher development in coding implementation at South African primary schools as a formal curriculum subject.

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APPENDICES

Appendix A: Ethics application

FACULTY OF EDUCATION

RESEARCH ETHICS APPLICATION FORM

This form is to be completed by students, staff members and other researchers intending to undertake research in the Faculty. It is to be completed for any piece of research the aim of which is to make an original contribution to the public body of knowledge.

Please note:

- Complete the application form and submit as a PDF document – no handwritten forms will be accepted.
- All attachments requested in the application form are to be included in this document – your email submission should include **one PDF** attachment of the application form and **one Word** attachment of the accompanying certificate template with part 1 completed by the applicant.
- Your surname must appear at the beginning of the file name, e.g. SMITH Ethics application

1 Applicant and project details

Name(s) of applicant(s):	*ZAINOE-DIEN PETERSEN*		
Project/study Title:	***Primary school teachers' experiences of professional development in teaching Coding.***		
Is this a staff research project, i.e. not for degree purposes?	*NO*		
If for degree purposes the degree is indicated:	*MASTERS IN EDUCATION (M.Ed.)*		
If for degree purposes, has the proposal been approved by the FRC?	*YES*		
Funding sources:	*NRF*		

2 Abstract of study

STUDENT: Z. Petersen **Student no: 207155721**

ABSTRACT

This is a qualitative study that centres on the exploration of teachers' motivations to undergo development and their experiences of the development process to teach Coding as an innovative subject in the South African primary school curriculum. It further seeks to determine how the development program is experienced by teachers in a professional development program in three public primary schools in the Western Cape.

The research uses in-depth semi-structured interviews to determine and understand teachers' thinking in initiating professional development in a novel subject such as Coding and focuses explicitly on their experiences of the program in relation to their expectations of development.

A constructivist perspective guided by a conceptual framework is employed to develop and support this study. It further employs an interpretive paradigm as it taps into teachers' experiences to construct and interpret the data gathered. Findings suggests that teacher motivations and their perceptions of the training received in teaching Coding contributes widely to successful implementation of the subject.

Concerning this study, the outcomes does not fully reflect the intended ideals and thus recommendations are suggested to facilitate a more suitable development program. This study further contributes to a deeper understanding of teacher motivations and perceptions of their training and how it contributes to future implementation of an innovative subject into the primary school curriculum.

Keywords:

Teacher professional development, teacher motivations, Coding, teacher experiences, expectations, innovative, qualitative, case study.

3 Ethical considerations specific to the intended study/project

Provide explicit and concise answers to the following questions:

3.1 Sampling: How will you recruit participants? Is there any possibility that participants might feel coerced to take part and if so how can you manage this issue?

A purposive sample will be employed. Teachers engaged in the process of receiving development in Coding content knowledge at the primary school will be recruited by means of a consent letter to participate in the study (refer Appendix B). Participants will have the right to refuse participation and or withdraw at any time during the process of the study.

3.2 How will participants be made aware of what is involved in the research [prior to, during and after data collection]?

All participants will be fully informed of the process and reason for the study in the consent letter (Appendix A). Participants will also be informed of the methods used to collect the data, the specific time periods for the planned interviews as well as a report-back on the findings.

3.3 How will you ensure that participants really do understand their rights?

A letter of consent will clarify their rights. They will also have the option to accept or reject the terms of the letter. In addition, they would further have the option to withdraw from the research at any time and at their discretion without prejudice. They will also be free to enquire about any other concerns before or during the process of collecting the data.

3.4 How will you collect data?

Semi-structured interviews will be used to collect the relevant data as attached in Appendix C and D.

3.5 Is there a risk of harm to participants, to the participants' community, to the researcher/s, to the research community or to the University? If so how will these risks be managed?

There is no possibility of any harm to the participants or institution chosen.

3.6 What plans do you have for managing the confidentiality and anonymity of participants in this study?

No names of any participant will be used, and all participants will be allocated with a pseudonym instead. All data will be stored confidentially on a password protected computer and folder. All hard copies of my data such as interview transcripts will be securely stored in a locked filing cabinet. Access to all data will also be limited to my supervisors.

3.7 Are there any potential conflicts of interest for you in undertaking this study?

There will be no conflict of interest as there are no personal relationship with the school and teachers who comprise my study.

3.8 How will the findings be used on completion of the study?

The findings will be used for the purpose of my M.Ed. study and for the submission of an article to an accredited journal as required per the guidelines of CPUT.

3.9 Does this work raise any other ethical issues and if so, how will you manage these?

No other ethical issues.

3.10 What training or experience do you bring to the project that will enable you to recognize and manage the potential ethical issues mentioned above?

As a manager of a school, I have been subjected to many occasions when ethical considerations were required, especially where confidential issues were concerned or the names of individuals had to remain anonymous.

4 Research Ethics Checklist

Ethical considerations:	**Yes**	**No**
4.1 Does the study involve participants who are unable to give informed consent? Examples include children, people with learning disabilities, or your own students. Animals?		√
4.2 Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? Examples include students at school, members of self-help groups, residents of nursing homes — anyone who is under the legal care of another.		√
4.3 Will it be necessary for participants to participate in the study without their knowledge and consent at the time — for example, covert observation of people in non-public places?		√
4.4 Will the study with the research subject involve discussion of sensitive topics? Examples would include questions on sexual activity or drug use.		√
4.5 Will the study involve invasive, intrusive, or potentially harmful procedures of any kind (e.g. drugs, placebos or other substances to be administered to the study participants)?		√
4.6 Will the study involve prolonged or repetitive testing on sentient subjects?		√
4.7 Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		√
4.8 Does your research involve environmental studies which could be contentious or use materials or processes that could damage the environment? Particularly the outcome of your research?		√

5 Attachment checklist

Please Tick:
The following documents have to be included at the end of this document:

Attachment	**√**
5.1 Consent form	√
5.2 Data collection instrument(s)	√
5.3 Other relevant documentation (Please specify) *NRF Accepted Proposal*	√

Signatures:

Researcher/Applicant:		Supervisor or Senior investigator (if applicable):	

Date:	*10 March 2020*	Date:	

Please note that in signing this form, supervisors are indicating that they are satisfied that the ethical issues raised by this work have been adequately identified and that the proposal includes appropriate plans for their effective management.

Appendix B

LETTER OF CONSENT

02 May 2020

Dear Potential Participant

I am a Master of Education student with the Centre for International Teacher Education (CITE) based at the Education Faculty of CPUT in Mowbray. As part of my studies, I am required to conduct a research project to complete this degree. The Topic of my research is The topic of my research is:
'***Primary school teachers' perceptions of Professional Development in teaching Coding'.*** The purpose of the study is to explore how teachers are prepared for teaching Coding as a subject in primary schools.

.

I would like to invite you to participate in an individual semi-structured interview, by sharing your experience and views about your development in Coding Instruction. Data collection will take place via (SKYPE or Google Chat) for approximately 60 minutes (interview x 2) in the month of June and/or early July 2020. Data from these sessions will be audio recorded. There are no potential benefits derived from participating, other than adding new knowledge to the existing body of knowledge regarding teacher development and pedagogies used in Coding development and instruction.

Participation in this research is voluntary and you are free to withdraw from the study at any time, without explanation and negative or undesired impact by doing so. Participants' responses will be recorded and their identity will not be revealed. The information and data collected will be kept in a safe place and will only be used for the purpose of this research project.

If you are willing to participate in this research, you are kindly requested to sign the attached form below.

For more information, please feel free to contact me or my supervisors on the contact details below.

Thanking you in anticipation for your positive response.
Yours sincerely

_____

Mr. Z. Petersen
alazharct@gmail.com
0745408487 / 0843215100

Prof Yusuf Sayed at SayedY@cput.ac.za / sayed.cite@gmail.com

Response

Letter of consent

I, _____an educator at _____
(details of participant) (name of institution)

have been fully informed about the purpose of the research and grants permission for the study to be conducted. I reserve the right to withdraw this permission, thus withdrawing from this study at any time.

Signature: _____ Date: _____

For further information or clarification, please feel free to contact me or my supervisors on the contact details below.

Kindly complete the table below before participating in the research.

Tick the appropriate column

		YES	NO
1	I understand the purpose of the research		
2	I understand what the research requires from me		
3	I volunteer to take part in the research		
4	I know that I can withdraw at any time		
5	I understand that there will not be any form of discrimination against me as a result of my participation or non-participation		

Thanking you in anticipation of your positive response.

Yours sincerely

_____

Mr. Z Petersen
alazharct@gmail.com

074 540 8487 / 074 762 5996

Professor Yusuf Sayed at SayedY@cput.ac.za

Appendix C: FIRST SESSION OF INTERVIEW QUESTIONS

SECTION B: Personal background and interest in teaching.

1. Good afternoon Mr/s… I hope you're doing well

2. With your permission and after confirming that I've explained the interview protocol to you earlier, would you mind to get started with our first session of interviews?

3. Would you mind telling me a bit about yourself and your career choice?

4. Would you mind informing of the school, the school background and demographics?

5. When did you start to teach at this school and why did you choose this school?

6. Tell me about your interest in Coding and where did this interest in the subject stem from?

SECTION C: Questions relating to TPD.

1. Would you care to explain your understanding of TPD?

2. How important is TPD for teaching, and explain why you think so.

3. Are there any other reasons why you would undertake professional development? Can you elaborate on a few reasons?

4. Do you think that development is a once off process and is there any benefit in continuous development? Can you elaborate?

5. What role does the trainer play in a development program, and why is his role important?

6. Please explain how you were initially trained to become a teacher, and indicate how long did your training program last.

7. Please describe the training that you received to teach coding and did it prepare you adequately for teaching the subject in class?

8. Were there any areas of coding that you found challenging during your training and how did you overcome these challenges?

9. Did you ever feel inspired or anxious during your training, and if so, why do you think you or teachers have these feelings?

Appendix D: Sample of transcribed Interview

SECTION B: Personal background and interest in teaching.

Started interview at: ***14. 36***

Interviewer:

Good afternoon Mr. Newman.

Interviewee:

Good afternoon Zain….. please call me Ashley.

Interviewer:

Thank you Ashley……..I hope you're doing well?

Interviewee:

I'm great.....thank you.

Interviewer:

Great! ….. With your permission and after confirming that I've explained the interview protocol to you earlier this week, would you mind getting started with our first full session of interviews?

Interviewee:

No problem, Zain.

Interviewer:

Would you mind informing of the school, the school background and demographics?

Interviewee:

Sure. I teach at Pinelands North Primary. Pinelands North Primary is ……..obviously in Pinelands…… Pinelands North Primary serves a multicultural community and caters mostly for the middle-income sector of the community. ……..pause….. The school was founded in the 1940's with less than 100 learners and currently has a learner total of over 500 learners……

We fall within Metro-Central and has been categorised as fee-paying school in quintile 5. Our curriculum includes a number of extra subject of which Coding is one…… Parents expect extra at this school, because they are willing to pay the additional costs.

Interviewer:

When did you start your tenure at this school and why this particular school?

Interviewee:

Well…. I started teaching here about six years ago….. After my return from the UK, where I taught at a primary school, I was unemployed, and saw the position advertised in the bulletin. ……. I was lucky to secure my position as an NS teacher almost immediately ……

I think it was one of the best moves I ever made as the school has a great culture and history. …. Also….. the staff and school Manager are pro-active and always strive to do things creatively.

Interviewer:

Tell me about your interest in Coding and where did this interest in the subject stem from?

Interviewee:

My interest in Coding started in the UK where it was part of the curriculum, though I never taught it. I did, however, recognise the many advantages that the subject offered the school and the learners. …. Here in South Africa… my school Manager introduced the subject as an additional subject in the Technology area two years ago through a private company and I volunteered to be trained. …… We only heard recently that Coding was to be formally introduced as a curriculum subject by the department of Education.

Interviewer:

Great Ashley! ….. Would you care to inform me on how many learners you are currently teaching in a coding class?

Interviewee:

OK, ...before COVID we had approximately 28 learners per class, but that has now changed..... we have 18 per class....to accommodate social distancing. Then.... the initial aim was to start with the Grade 3 learners, but we can currently accommodate learners starting from Grade 1 to Grade 7.

SECTION C: Teacher Professional Development

Interviewer:

Would you care to explain your understanding of TPD?

Interviewee

Sure Zain. ……. Development in any field is a good thing……pause……. : It is a fact that good preparation leads to great results. ……. It is thus important for people to be open to development. I also think that the more you are developed, the better you become.

Interviewer:

Thank you

Interviewer:

How important do you think TPD is for teaching, and explain why you think so.

Interviewee:

Very important…… I think…. No…. I know that develop helps a teacher to become an even better teacher. …. It expands his knowledge. …… *The benefits of my development became tangible as I experienced how it affected my teaching and the learners understanding of the work.*

Interviewer:

Are there any other reasons why you would undertake professional development? Can you elaborate on a few reasons?

Interviewee:

There are many reasons. Apart from becoming a better teacher, you become more knowledgeable in your subject. …….. It exposes you to new ideas and methods. …… long pause ……. *Our children are experiencing a world totally different from what their parents experienced a few years ago. New information obliges us to reconsider existing methods. Being in the teaching profession, we need to be knowledgeable and set the standard through constant development. ……..*

I think it makes you more versatile as a teacher. …… Primary school teachers are expected to teach all or any subjects when requested to do so, and I suppose that the Education Department will expect existing staff members to teach any new curriculum subject instead of employing additional teachers. ……

I also think it makes you more confident in class, for example…… pause…….. The development had positive spinoffs that applied to my subject of NS as well, as it taught them…. The kids and myself…. to be more critical in our thinking …… as well as motivated them and me to become better problem-solvers.

Interviewer:

Do you think that development is a once off process and is there any benefit in continuous development? Can you elaborate?

Interviewee:

Uhm..... Definitely not. ……. There are so many benefits to development as I just described. Any action that makes you a better person is good. If I look at my favourite sport….table tennis…. If I don't practice…..I lose my touch.

Interviewer:

What role does the trainer play in a development program, and why is his role important?

Interviewee:

I can say with conviction…. That a facilitator should be like a teacher….. He or she should be knowledgeable in their subject, ……pause……. Be sympathetic to the students' needs….. long pause …….. and be able to put over the knowledge in a manner that the student will be comfortable. Also, I think that the trainer should allow for interaction with other students or teachers to allow discussion between peers.

Interviewer:

Please explain how you were initially trained to become a teacher, and indicate how long did your training program last.

Interviewee:

As an initial student, I was subjected to 4 years of development. ….pause…. This was substituted with teacher practice sessions at various schools. I think that this length of training prepared me very well to become a teacher, which was totally the opposite of the very short training I got in Coding.

Interviewer:

Please describe the training that you received to teach Coding and did it prepare you adequately for teaching the subject in class?

Interviewee:

Well. …… Totally different. …….. The training period was only one day of face-to face training. ….pause ……. This was followed by links from the facilitator to check out the content and skills on my own. I also found the facilitator to be more teacher… sorry… should I rather say ….trainer centered.

Interviewer:

Were there any areas of coding that you found challenging during your training and how did you overcome these challenges?

Interviewee:

Uhm ....(long pause)..... Yes there were actually. …… The theory section was very difficult to understand…….. I really struggled with that section.

I had to overcome this problem by doing and practicing on my own…… pause …… I used the internet mostly.

Interviewer:

The final question for this session is: Did you ever feel inspired or anxious during your training, and if so, why do you think you or teachers have these feelings?

Interviewee:

Gosh! ……pause ……. Many times …….. Conflicting emotions.

I think people feel inspired if they have s sense of understand…pause or achievement…. Anxiety is caused by uncertainty….. pause ….. not understanding……pause …….perhaps not having support …..

Interviewer:

Thank you Ashley. That concludes our first session. I must say, that it went rather well. ……..

Our follow-up session will most probably be next week., Friday

Interviewee:

No problem, Zain. The session did go well, I must admit. …….. I will be available next week at the same time.

Ended interview at: ***15. 34***

Time of the interview session: 58 minutes.

End of first session

Appendix E: SECOND SESSION OF INTERVIEW QUESTIONS

Teachers experiences of the training.

1. Good afternoon Mr/s… Welcome to the second interview session.

2. Would you mind to inform me of some of your experiences during your training in Coding?
   Why do these experiences stand out?

3. What is your opinion of the facilitator e.g., his personal knowledge of the subject, his methodological approach, etc, Was the trainer able to meet the expectations that you had of the training program?
   Please elaborate.

4. What areas of the training would you change? Would you mind explaining why you would change these areas of the training?

5. What about the training program did you find most valuable for teaching the subject? Why you think it was?

6. What type of support did you receive during and after your training? Would you care to give examples?

7. What recommendations, if any, would you suggest for future development programs in teaching Coding?

END OF SECOND SESSION