Cape Peninsula University of Technology

Mathematics teachers' experiences of the influence of the changing curriculum on their professional practice in grades 10- 12 in the Cape Winelands district.

by

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DECLARATION

I, Jenéad Diana Nicole Joseph, 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.

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Signature   **Date**

DEDICATION

I dedicate this thesis to my family (dad, mom, two brothers, sister, and little niece) who always believed in me, and provided me with the love and constant support that was needed to complete my work, in which I have gained even more interest.

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ABSTRACT

Education in South Africa is a concern to many stakeholders, including government, teachers, teacher unions and non-governmental organisations, owing to the poor academic performances of learners. Mathematics teachers, the focus of this study, are confronted with a constantly changing curriculum. Teachers are often targeted by the education authorities and general public as the primary cause of the poor outcomes of education in South Africa. This study considers the experiences of Grades 10–12 mathematics teachers in the Cape Winelands regarding curriculum change and its influence on their professional practice. The basic assumptions of social constructivism served as overarching theory. The researcher judged that a conceptual framework would make for a clearer and more systematic way of dealing with the constructs that underpin this study. The conceptual analysis framework, which was developed by combining the work of Rogan and Grayson, as well as that of Remillard, which is a perfect fit to this study, guided the interpretation and analysis of the data. A deductive approach in data analysis was applied in accordance with the conceptual framework used in this study. Being explorative in nature, this study is a qualitative design and therefore an interpretive methodological approach was followed. A purposive and convenience sampling method was used whereby teachers from six schools were pre-selected: two from ex-Model C schools, two from previously disadvantaged black schools and two from previously disadvantaged coloured schools. Semi-structured interviews were conducted. The findings of this study pointed to teachers' acceptance of education reform and changes in the curriculum, provided they were not too radical. Teachers requested involvement on a broad spectrum throughout the planning and implementation process, and proper training and support prior to implementation. Factors that militated against implementation were, among others, poor facilities, resources and instructional aides; poorly trained change facilitators; poor leadership and management at schools; and the many constraints that the learners brought to the school and the classroom.

OPSOMMING

Verskeie rolspelers in onderwys in Suid- Afrika, onder andere die regering, onderwysers, onderwysunies en nie- regeringsorganisasies is bekommerd oor die swak akademiese prestasies van leerders in nasionale- en internasionale assesserings. Wiskunde onderwysers, wie die fokus van hierdie studie is, moet tred hou met 'n gedurig veranderende kurrikulum. Onderwysers word dikwels voorgehou deur die onderwysdepartement en die algemene publiek as die primêre oorsaak vir die swak uitkomstes wat in die onderwys bereik word. Hierdie studie het die ondervindinge en persepsies van Graad 10 tot Graad 12- Wiskunde onderwysers in die Kaapse Wynlandstreek betreffende kurrikulumverandering en die invloed daarvan op hul onderwyspraktyk geëksploreer. Die belangrikste aannames van Sosiale Konstruktivisme het as oorkoepelende teorie in die studie gedien. Die navorser het besluit op 'n konseptuele raamwerk, wat die hantering van die konstrukte wat hierdie studie onderlê, duideliker en meer sistematies moontlik sou maak. Die konseptuele analitiese raamwerk wat ontwikkel was, het die werk van Rogan en Grayson en dié van Remilliard gekombineer, - 'n pasmaat vir hierdie studie – en het die interpretasie en analise van die data gelei. 'n Deduktiewe benadering in data analise was in ooreenstemming met die konseptuele raamwerk wat, in hierdie studie gebruik word, gevolg. Hierdie studie is ondersoekend van aard met 'n kwalitatiewe ontwerp, daarom is 'n Interpretatiewe metodologiese benadering gevolg. 'n Doelbewuste- en gerieflikheidsmonsternemingsmetode was gebruik, waardeur ses onderwysers by die ses skole gekies is: 2 van voormalige Model C- skole, 2 van voorheen banadeelde bruin skole en 2 van voorheen benadeelde swart skole. Semi-gestruktureerde onderhoude was uitgevoer. Die bevindinge van hierdie navorsingsstudie het sonder voorbehoud aangedui dat onderwysers kurrikulumverandering as deel van onderwys aanvaar, tensy dit nie te radikaal is nie. Onderwysers het vir groter betrokkenheid op 'n wye spektrum regdeur die beplannings- en implementeringsfases gevra en het voorgestel dat voldoende opleiding en hulp voor implementasie beskibaar moes wees. Faktore wat implementering belemmer het, was onder andere gebrekkige fasiliteite en hulpmiddels (waaronder onderrigsmiddele), swak opgeleide fasilitators, swak leierskap en bestuur by skole en die inperkinge wat leerders na die skool en die klaskamer bring.

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LIST OF ABBREVIATIONS

CAPS   Curriculum Assessment Policy Statements

CNE   Christian National Education

COSATU   Congress of South African Trade Unions

DBE   Department of Basic Education

DoE   Department of Education

FET   Further Education and Training

GET   General Education and Training

MLMMS   Mathematical Literacy, Mathematics and Mathematical Sciences

NCS   National Curriculum Statement

OBE   Outcomes-Based Education

RNCS   Revised National Curriculum Statement

WCED   Western Cape Education Department

ZPD   Zone of Proximal Development

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

Education in South Africa has always been challenged because of its political heritage, which caused extreme discrepancies in resource allocation and quality of education. Examples are the quality and level of teacher training, per capita expenditure per learner, quality of school buildings (with their amenities and facilities), and, in fact, every aspect of service delivery.

Curricula predominantly have a political agenda. Christian National Education (CNE) was used as a powerful ideological state apparatus driving the philosophy of the ruling National Party, which was "divide and rule". In line with their policy of racial segregation, "white" South Africans benefited tremendously, enjoying many advantages, including education privileges. The rest of the population had to be content with what was called "gutter education", separated from mainstream education and all the institutions that the privileged had access to. In order to uphold white supremacy, the higher careers were exclusively allocated to "whites" and subjects like mathematics and physical science were completely diluted for the underprivileged (Msila, 2007). The philosophical approach of the curriculum was fundamental pedagogics, which was congruent with the ruling party's autocratic and coercive system (Naicker, 2000).

This study is framed by a conceptual model, which is a combination of the work of Rogan and Grayson (2003) and the work of Remillard (2005). Elements from the framework depicting the components of the teacher–curriculum relationship were abstracted from Remillard (2005) and developed into a conceptual framework for the distinct purposes of this study. These elements were further combined with the analytic framework of Rogan and Grayson (2003). The researcher argues that a conceptual framework will make for a clearer and more systematic way of dealing with the constructs that underpin this study. Furthermore, the literature exploration and the questions compiled for the in-depth interviews could then be negotiated in a more systematic way. The constructs in the work of Rogan and Grayson had been quantitatively determined; but in this study the researcher used the same constructs to be qualitatively explored to gain a deeper insight into the operating processes. Social Constructivism will serve as overarching theoretical framework.

The basic assumptions of Social Constructivism guided this study, particularly the work of Vygotsky. Mathematics is a social product, and is therefore socially determined. It is through social interaction that learning takes place. All cognitive functions could accordingly be explained as products of social interaction and the conception and experience of the social context. Social Constructivism could guide teachers in understanding the underlying processes in learners' reasoning, whereby learners are drawn into a knowledge community (Vygotsky, 1978). The way teachers' knowledge is constructed will influence the way knowledge is co-created with the learners. It is important to ascertain how teachers differentiate between learners, since all learners do not optimally acquire knowledge in the same way. Furthermore, the context within which learning takes place, and the social environments, advantageous or disadvantageous, that are brought by learners to the learning environment, are crucial to learning (Kalpana, 2014).

Social Constructivism posits that although one has no access to the learning of another, some learning is considered as shared. Learning is also culturally determined. It is therefore the role of the teacher to mediate between learners' personal meanings and the culturally determined meanings of wider society (Cobb, 1994).

A concept that has strong implications for the learning process is what Vygotsky calls the zone of proximal development, which distinguishes between two levels of learning. The first level has already been attained by the learner. At this level (level of actual development), the learner can function without assistance from teachers and peers. The second level (level of potential development) is the level that learners could reach with assistance from teachers and peers (Vygotsky, 1978). It is important to determine how teachers' interventions and classroom interactions influence the learning that takes place.

Interpretivism, because of its properties to deal with qualitative data, was the approach of choice to guide this study. The data extracted was expected to be rich, detailed and subjective in nature. Interpretivism lends itself to data that can be organised in themes and categories, thus providing meaning to the experiences and perceptions of the respondents. This approach consistently deals with the interpretation and understanding of human action. A purposive, convenience-sampling method was chosen for this study. All data-collection instruments were presented in terms of the study objectives. Semi-structured interviews were chosen as the data-collection instrument. The questions compiled for the interview schedule were guided by the literature review, the constructs on which the conceptual framework was based, and the basic assumptions of Social Constructivism. The data collection instrument was developed in collaboration with an expert in the field. A pre-run (pilot) interview was conducted with two mathematics teachers from the same school in the

form of a panel to determine possible loopholes in the process and to determine whether the required responses were gained.

A thematic analysis was used, guided by the constructs derived from the literature review, as well as the conceptual framework developed by the combined work of Rogan and Grayson, and Remillard. A deductive approach in data analysis was applied in accordance with the conceptual framework used in this study. Furthermore, attention was paid to the importance of reliability and validity of the instruments

The discipline of curriculum studies has emerged as an autonomous one, whereby education and educational problems may be studied independently, and not as a sub-branch of other subjects or disciplines like psychology or philosophy (Kelly, 2003).

Curriculum is a complex and multi-dimensional concept, which could mean different things to different individuals. Consider how curriculum could have different meanings and implications, for example, for the epistemologist and the methodologist. Furthermore, curriculum presents different dimensions, which have implications for its study and the users thereof. Therefore, the planned/intended curriculum could not be the same as the acquired/ enacted curriculum. The role of curriculum development could not be ignored. The teacher plays a major role in executing the curriculum; therefore curriculum development is presented as an important construct in this study. It is wrongfully assumed that teachers will automatically fully comply with a prepared product if they are told that the innovations are good for them and their learners. It must be strongly considered that change could be unsettling, intimidating and unpleasant. It may even happen that teachers form groups that reject the innovations. The teacher is not a static downpipe through which knowledge is transmitted; teaching is an active process and the classroom a dynamic setting where interaction takes place and where knowledge is co-constructed. Even in the most authoritarian settings, teachers have to make spontaneous decisions on how to proceed with instruction and teaching.

Since the democratic election of 1994, major changes have been made in education. Curriculum reform in South Africa was a complex endeavour. Eighteen departments divided along racial lines had to be transformed into a single national ministry, thus effecting a unified, non-discriminatory, centrally controlled national education department. The education system has undergone three phases of development: Curriculum 2005 (C2005), an outcomes-based curriculum, the National Curriculum Statement (NCS) and the Curriculum Assessment Policy Statements (CAPS).

OBE has been a radical paradigm shift in methodology, a shift from a teacher-centred curriculum to a learner-centred curriculum. Whereas the first was a content-based curriculum, with the teacher the sole source of knowledge and thus in complete control of the classroom situation, the latter was based on how outcomes should be reached through learner collaboration. The methodology was specified, yet the content unspecified. The teacher had enormous freedom in using a variety of texts to reach the different outcomes. Learning occurred through discovery, which had profound consequences for certain subjects like mathematics, where the basic arithmetic skills were downplayed. Considering that developed countries like the USA and Australia had discontinued this experiment, it was always an endeavour that was too optimistic, considering the many challenges that the country and education were facing. On top of these challenges, most schools were former sites of struggle, which in its aftermath would be ill equipped to cope with vastly different curriculum innovations. In this study the researcher explored the factors that have influenced teachers' capacity and willingness to adopt or reject the reforms.

The RNCS for Grades R to 9 and the NCS for Grades 10 to 12 came into being as a review of C2005 because of the many challenges teachers experienced in the classroom. NCS affirms the commitment to OBE. According to the recommendations of the review team, the design features were streamlined and the language was simplified. The curriculum was aligned with assessment, teacher training and orientation were improved, and learner support materials and provincial support were granted. NCS was not proposed as a new curriculum as it maintains the thrust of C2005, which is achievement oriented, activity based and a learner-centred approach (DoE, 2000). The purpose of the revised curriculum was to promote human rights and inclusivity and to shift the curriculum agenda from a local, primary skills- based, implicit context-based body of knowledge to a more coherent, explicit and systematic body of knowledge. Furthermore, the revision introduced assessment standards and other content frameworks to provide teachers with content-specific guidelines. Specification across subjects, learning areas and grades was problematic, resulting in additional documentation that needed to be supplied to address the gaps.

The CAPS was introduced as an amendment to the NCS and not as a new curriculum, because it is claimed that it follows the same process and procedures as the NCS (Pinnock, 2011). The CAPS is, however, written in content form, rather than in outcomes and assessment standards, which implies the use of traditional teaching methods instead of OBE methods. The CAPS is furthermore very specific about the content and time frames within which content and specified assessment tasks should be completed.

This study explored teachers' and schools' capacity to implement the above-mentioned curricula and the teachers' willingness and preparedness to implement the proposed innovations. The factors that hindered the implementation process were also explored. A major concern was how schools in poorly resourced contexts would be able to adhere to the requirements for implementing the new curriculum, having to cope with the lack of resources (reference works and textbooks, stationery, photocopying facilities and other technologies of teaching) (Chisholm et al., 2000). Sharp et al. (2009) stress that the requirements for implementation could not be the same for historically disadvantaged schools and advantaged schools, because at present most schools in the system still suffer the inequalities and injustices of the past. Rogan and Grayson (2003) accentuate the huge gap in teacher knowledge and skills between the disadvantaged and advantaged, especially in mathematics and science.

The literature suggests that teachers' beliefs and attitudes are good predictors for teachers' willingness to implement curriculum innovations. If teachers' beliefs are congruent with the requirements of the proposed curriculum, high take-up of the reforms will be a possibility. This study explored teachers' levels of involvement in the planning and implementation process and the teacher development that preceded the implementation. The influence of these aspects on the implementation process was also considered.

This study offers recommendations relating to this specific context on the influence of the constantly changing curriculum on the professional practice of teachers and their willingness and capability to implement change initiatives.

1.2 PROBLEM STATEMENT

Education in South Africa has become a concern to stakeholders such as the government, teachers, teacher unions and non-governmental organisations, owing to the poor academic performance of learners in national and international assessments. Mathematics teachers, the focus of this study, are confronted by a constantly changing curriculum. The widespread negative criticism of education in South Africa by the media, the general public and teaching fraternity became the driving force behind this study, which explored the experiences and perceptions of teachers regarding the influence that curriculum change had on their professional practice. The research problem under investigation is, "How do Grades 10–12 mathematics teachers in the Cape Winelands district experience the constantly changing curriculum of school mathematics and how is their professional practice influenced by it?"

1.3 RESEARCH QUESTIONS AND SUBSIDIARY QUESTIONS

Research questions

How does the Grades 10–12 mathematics teachers' experience of the changing curriculum influence their professional practice?

Subsidiary questions

1. How did the school mathematics curriculum change with regard to content and methodology?

2. What are the experiences of school mathematics teachers with regard to the continuously changing school mathematics curriculum?

3. How did the changed curriculum influence teachers' professional practice?

1.4 STRUCTURE OF THE STUDY

CHAPTER 1: INTRODUCTION

CHAPTER 2: LITERATURE REVIEW (General)

CHAPTER 3: LITERATURE REVIEW (Mathematics)

CHAPTER 4: CONCEPTUAL FRAMEWORK

CHAPTER 5: METHODOLOGY

CHAPTER 6: PRESENTATION OF THE FINDINGS

CHAPTER 7: DISCUSSION OF THE RESULTS

CHAPTER 8: RECOMMENDATIONS AND CONCLUSIONS

CHAPTER 2

LITERATURE EXPLORATION (GENERAL)

2.1 INTRODUCTION

In order to systematically explore the existing literature on the research topic, the following was done: Attention was given to the understanding of the concept 'curriculum', through which the conceptions of curriculum were explored together with the manifestations thereof. An operational understanding of the concept 'curriculum' was developed for the context of this study. The focus was shifted to curriculum development, where attention was paid to the process of curriculum development, including the view that teachers serve as curriculum developers. This study explored curriculum reform in South Africa against the backdrop of the process of curriculum reform. Finally the different curriculum policies pre- and post-apartheid, namely CNE, C2005, RNCS, NCS and the CAPS were reviewed. The background to every policy and how it differed from the previous policy, as well as the implications for implementation, were explored.

2.2 EXPLORING CONCEPTIONS OF CURRICULUM

A concise description of the formal or official curriculum and the informal curriculum is given.

Formal or official curriculum: Kelly (2004) posits that the formal or official curriculum includes all activities during regular hours of school. The timetable makes provision for all the different areas (subjects) of the formal curriculum.

Informal curriculum: According to Isserles and Dalmage (2000), the informal curriculum refers to those activities that occur outside normal school hours that also contribute to learning. Activities during lunchtime and after school, and educational trips are examples of these activities, which are called extra-curriculum activities.

Abramovic and Brouwer (2003) postulate that the hidden curriculum results from the way the school programme is planned and organised. The actual and the received curriculum are often similarly termed and encompass all learning that takes place at schools. It is thus learning that is planned, as well as that acquired through the hidden curriculum. For the purpose of this study, the school mathematics curriculum was investigated; therefore curriculum will refer to the official or intended curriculum.

2.3 CURRICULUM DEVELOPMENT

There are many existing models whereby curriculum development could be studied. It is a process that reviews, plans, develops and introduces the curriculum and promotes true commitment and ownership thereof (Ornstein & Hunkins, 2009). There are different curriculum orientations that refer to policy formulation with regard to its form, content and goals (Joseph, 2011).

Levin (2007) notes that different social and cultural groupings are pressurising the government to include their interests and subject areas into the new curriculum. In South Africa, it is evident that the school curriculum is overladen with content. Curriculum development strives to improve the quality and practicability of education (Lunenburg, 2011).

According to Bantwini (2009), the availability of and access to teaching facilities and resources, science apparatus and teaching aids could strongly enhance or hinder the implementation process. The key to successful implementation could well be in the development of teachers' knowledge, skills, attitudes, and the alignment of teacher training methods. Witz and Lee (2009) note that more research on teachers' feelings and attitudes towards change is needed to provide a more extensive understanding of these issues. This study explored teachers' experiences of curriculum change, and how these experiences towards curriculum change influenced teachers' practice of mathematics teaching in schools.

The presence of several characteristics of the work of teachers will determine how teachers use curriculum. Prominent features are teachers as curriculum designers, the multiple facets of curriculum design, and how individual teachers' characteristics and resources impact on this process. The difference between the written and enacted curriculum strongly indicates that teachers do not merely pass on the written curriculum, but are active agents who construct the enacted curriculum through working with their students (Clandinin & Connelly, 1992).

Ben-Peretz (1990) proposes two phases of curriculum development. The first phase is concerned with the conceptualization of the curricular plans and is also responsible for the writing up of teacher resources. The second phase alters and adapts the textbook content to make them more user friendly for learners, especially for those learners who are challenged in one way or the other, or for specific classroom situations. Curriculum development subsequently involves the enforcement of curriculum plans as teachers interact with their learners in the classroom situation. Stein et al. (1996) observed distinctions between the tasks presented to students and how these tasks were altered during the course of a lesson. When particular features of reform-oriented tasks were adjusted, teachers found ways of

simplifying these tasks. The enacted curriculum emerges as responsive and interactive. Curriculum-development decisions have to be made even by the least innovative teachers. The enactment of the curriculum involves the making of spontaneous decisions because teachers are dealing with a unique context and unpredictable learner actions. This refers to the improvisational work of teachers (Heaton, 2000).

Design is conceptualised as a succession of decisions made to meet goals and to discover possible barriers (Edelson, 2002) and design research as a repeated process in which every cycle in the implementation process creates an opportunity to study the artefact and the implementation process. The creativeness and inherent characteristics of teaching as design is illuminated. Teachers strive to constantly redesign their activities, whenever the need arises (New London Group, 1996).Curriculum materials are classified as material artefacts, and teaching as a design process in accordance with available resources in order to meet teachers' goals in the best possible way (Brown & Edelson, 2001).

2.4 CURRICULUM REFORM IN SOUTH-AFRICA

Under apartheid education, CNE schools were predominantly divided along racial lines, thus enhancing divisions and segregation of society. These divisions reinforced prejudice and repression and the dominance of one race over others (Msila, 2007). Fiscal allocation was done in terms of race, where "white" education enjoyed more funding than all the other racial groups, leading to the huge disparities amongst racial groups concerning all aspects of education. These discrepancies were evident in the quality- and level of teacher training, facilities, resources and support materials at schools and the location of schools. Education policy and curriculum development in apartheid South Africa was politically driven and used to repress and marginalise the non-white majority in a concerted effort to uphold white superiority. Fundamental pedagogics as philosophical approach was well aligned to government's autocratic and coercive rule (Naicker, 2000). Education in South Africa was structured in such a way that non-whites should assume a position of subordination.

CNE roots can be traced back to fifteenth-century Europe (especially the Netherlands, Germany Scotland and France), where the first schools were established according to religious (Christian) principals. The ideas of the renowned reformist Martin Luther drove the educational philosophy of the Afrikaners. Luther proposed two reasons for children to attend school: for the spiritual benefits that served as preparation for the Christian ministry and for the advantage of having well-educated boys and young men (Powers, 1970). Some intellectuals abroad and also in South Africa respected another reformist, John Calvin, for his thinking on the restoration of society that should take place on the firm foundations of the Christian faith (Schoeman & Manyane, 2002).

The South African political situation had profound consequences on curriculum change during the 1950s. The *Bantu Education Act No. 47 of 1953* greatly influenced education in South Africa. The harshest implication of this act was that black learners were forced to be instructed in Afrikaans, which in effect meant that half of the subjects in Grades 7 and 8 were to be taught through the medium of Afrikaans (Christie, 1991)

The *Bantu Education Act* led to poor salaries for black teachers, who were forced to handle large classes. It led to teachers resisting Bantu Education, which gave rise to an earnest call for People's Education, which would see the translation of the Freedom Charter into practice (Christie, 1991).

In South Africa, the education system has undergone three major phases of development since the inception of democracy in 1994. C2005, an outcomes-based curriculum, led a succession of curriculum initiatives; second the RNCS for Grades R to 9 were introduced, followed by the NCS for Grades 10 to 12 in the same phase; and finally followed by the CAPS for Grades R to 12. Such changes required constant professional development, because former teacher training and education differed from the training that is required today (DoE, 2010).

In the democratic dispensation education and training in South Africa has undergone fundamental transformation. Eighteen racially divided departments had to be restructured into one education ministry to bring about a unified and non-discriminatory, overarching national Department of Education (Chisholm, 2004). Harley and Wedekind (2004) acknowledge that the national curricula had a strong political agenda, which is clearly evident. The new curriculum was inevitable in celebrating the new democracy and was therefore welcomed by the majority of South Africans, whose cultures, backgrounds and values differed significantly. The result, however, was widespread confusion as the shift from a teacher-centred to a learner- centred approach posed considerable challenges to most teachers, as they tried to make sense of a completely new methodology, for which they were ill prepared. Learners did not use textbooks, as they were substituted by portfolios and workbooks (Malada, 2010). Crucial basics like reading, writing and arithmetic shifted in favour of a process of discovery, which was time consuming and yielded even weaker outcomes. University students were also found to struggle with reading and the comprehension of content, which would generally be expected of a university student at that level (Blaine, 2010; Malada, 2010).

Jansen and Christie (1999) stated that the curriculum revision process in South Africa followed through three main waves. The first wave determined which racist language and controversial content had to be scrapped from the official curriculum. The purpose of this

process was also aimed at creating a single national core syllabus brought about through participation by all stakeholders. The second wave celebrated, amongst others, the launch of C2005 in March 1997, which strongly accentuated social values such as prosperity, non-sexism, peace, non-racism and democracy, on which the constitution of South Africa is built. The curriculum had to be non-authoritarian (Fiske & Ladd, 2004). Fiske and Ladd (2004) describe OBE as an instructional method in which the general knowledge, skills, and values that learners should acquire, are defined, which differs from the traditional instruction methods, in which curriculum planners prescribe specific kinds of knowledge and skills that have to be acquired. Traditional instruction methods provide less freedom of operation. Because of the many challenges that teachers experienced with the implementation of C2005 in classrooms, Professor Kader Asmal, former minister of education, set up a task team, under the leadership of Professor Chisholm to review C2005 in 2000.

The main recommendations made by the Review Committee were the streamlining of the elements of the curriculum design, to make the language used in the document more comprehensible, providing clarity on assessment, and providing improved teacher orientation and training, and support from the WCED (DoE, 2000). These processes initiated the third wave of curriculum reform. C2005 was thus revised, which led to the launch of the RNCS in 2002. The RNCS builds on the vision and values of the South African Constitution and C2005. The thrust of C2005 is maintained and the commitment to OBE is reaffirmed (DoE, 2000).

Teachers mediate the external demands of the new curriculum to prioritise the desirable classroom practices, which often differ from the intended curriculum practices (Osborne, 2001). In order to retain their preconceived beliefs, and pre-existing teaching practices (Fullan, 2007), teachers react to the new policies by adopting, mediating, resisting, or rejecting the reforms. They actively influence the measure of penetration of the intended education reforms (Napier, 2003). The portrayal of the teacher as a neutral agent that simply passes knowledge to learners distorts reality and is short sighted. Mostly teachers are dynamic, active and creative beings living out their many roles (Schweisfurth, 2002).

Education level, knowledge, skills, identity and beliefs are some of the factors that influence teachers' abilities and motivation to adapt to curriculum changes and reforms (Van Veen et al., 2005). How teachers react to the proposed curriculum reforms, is influenced by the stage that they have reached in their personal lives and careers (Fullan, 2007). Teachers' classroom practices are strongly influenced by their beliefs about teaching and reform initiatives (Lumpe et al., 2000; Van Driel et al., 2001). Beliefs function as information filters and they influence the way knowledge is used, organised and retrieved. In addition, beliefs

are powerful predictors of behaviour as they can reinforce actions that are consistent with beliefs (Gess-Newsome, 1999).

2.4.1 Curriculum 2005 (C2005)

C2005 was launched in March 1997 by the National Education Ministry. This curriculum was to replace content-based education with OBE, a learner-centred pedagogy. Forty- two primary school subjects were replaced by eight learning areas. Several old subjects were combined in an attempt to bring about an integrated approach. Each learning area was matched with curriculum-linked outcomes Learners were required to engage with certain learning activities to attain these prescribed outcomes. The curriculum was gradually phased in, with accompanying reviews. The curriculum revision process was accompanied by heated debate as to the merits of OBE in the South African context (Jansen & Christie, 1999). A major concern was whether the new curriculum could be successfully implemented in poorly resourced contexts. It was observed that historically disadvantaged schools lacked the resources critical for successful implementation of the new curriculum: stationary, textbooks, photocopying facilities and other teaching technologies (Chisholm et al., 2000).

1994 marked the end of a political era that was highly oppressive and radical political- and educational transformation was experienced in South Africa. During the period (1994–1997), new policies and legislation were passed to inform the proposed educational changes. OBE was introduced in 1997 as the educational reform model to replace the apartheid curriculum. The introduction of OBE brought about many changes in the South African curriculum. Curriculum and assessment based on the constructivist approach was encouraged in favour of traditional educational approaches (Lekgoathi, 2010). The vision for education was to integrate education and training as far as possible. OBE was adopted as an approach to accomplish this vision.

C2005 centred on outcomes as goals of education, the learner as centre of education, and knowledge as an integrated approach (Chisholm et al., 2003). C2005 applied to all bands of education, namely General Education and Training (GET) Grades 1–9, and Further Education and Training (FET) Grades10–12.

Apartheid education had to be redressed to bring forth a curriculum that promotes a shared citizenship (DoE, 1997b; Jansen, 2001). The post-apartheid curriculum's main shift was from that of a content-based syllabus to an outcomes-based approach (DoE, 1997b). The then Learning Area of MLMMS for Grades 1 to 9 indicated specific outcomes relating to the general skills, values and abilities that learners was expected to attain at the end of the (GET) band (DoE, 1997c). Being learner centred in nature, C2005 expected learners to

accept co- responsibility for their learning by actively engaging in learner- activities (DoE, 1997a).

Teachers were no longer in complete control of what must be taught and how it must be taught but rather became facilitators of learning, who were required to develop their own learning programmes (DoE, 1997b). C2005 involved the most radical form of integration, across all learning areas, through the pursuit of cross-curricular themes (DoE, 1997a). Because C2005 tapped on learners' personal experiences and everyday knowledge, learners were mainly evaluated through continuous portfolio-based formative assessment. Teachers awarded learners marks not only for subject knowledge, but also for their creativity and critical thinking (DoE, 1997b). Through C2005's emphasis on integrating mathematics with other learning areas and applying it to real-life situations, conceptual mathematical knowledge took a backseat (Chisholm, 2005). Graven (2002) points out that the MLMMSs' specific outcomes and its rationale had political reconstruction aims, and revealed a shift in mathematics and the development of mathematics teacher identities.

 It was intended for C2005 to be phased in progressively to cover all sectors of schooling by 2005 (Harley & Wedekind, 2004, Steyn et al., 2011). C2005 consists of two bands, namely GET (Grade 1–Grade 9) and FET (Grade 10–Grade 12). GET is compulsory for all learners. The new curriculum constituted of three design features, being outcomes-based, being located in the notion of an integrated knowledge system, and being learner-centred. It consisted of eight Learning Areas, replacing the traditional subjects in the GET phase. C2005 was also a complex system, which consisted of 66 Specific Outcomes, Range Statements, Assessment Criteria, Performance Indicators, Phase Organisers and expected Levels of Performance (Steyn et al., 2011). C2005 rejected each of the principles of the traditional curriculum. Outcomes were linked to course assignments and replaced syllabuses, and terminal examinations and criterion references replaced normative-based assessment. The curriculum had to be relevant to all children, integrating the curriculum to their experience. It also had to be made sure that learners gained access to the curriculum despite a complex system (Young & Kraak, 2001).Curriculum documents need to progressively and sequentially describe knowledge within a subject (Bertram, 2011).

What differed from the previous: C2005 contained radically new curriculum features and introduced a whole new curriculum discourse in education. It was strongly driven by labour and the insistence of the trade union federation, the Congress of South African Trade Unions (COSATU), on an outcomes-based approach. The broad acceptance of this new OBE discourse was helped by the fact that it adopted some terminology and principles of both People's Education and Progressive Education. For example, all the documents on OBE and

C2005 refer to learner-centred teaching, teacher as facilitator, critical thinking, articulation and mobility, and relevant education. The curriculum demanded that teachers be remodelled as professionals, who continually make decisions in developing the curriculum, selecting and sequencing content, and developing learning materials, which best suit their learners in their context (Hoadley, 2012).

The implications: Given the poor state of education in South Africa, the successful implementation of a proposed curriculum policy as revolutionary as C2005, which was outcomes based, learner centred and where learning was an integrated process of discovery, was the least to say, optimistic. Against the backdrop of the South African context, where most schools were historically extremely disadvantaged, lacking even the most basic resources like running water, textbooks, stationery and photocopying facilities, coupled with the urgency of government to have the new curriculum implemented, the practicability and workability of the curriculum were always questioned. Most schools simply did not have the capacity to support all these changes. Furthermore the quality of teacher training and development was always in question and further questions were asked regarding the capabilities of the drivers of the change initiatives, like the curriculum facilitators. Historically disadvantaged schools came from a background of resistance against apartheid education that resulted in serious disciplinary problems that would provide further obstacles to practising the new methodology. A further implication would be how previously advantaged teachers and schools would react to the changes, given their successes with the old curricula.

Another major hiccup would be the totally different assessment profile of the new curriculum, which would lead to a major administrative burden for educators.

2.4.2 RNCS (Grade R–9) and NCS (Grade 10–12)

The RNCS for GET was an attempt to simplify C2005, developing a more streamlined version of C2005 (Chisholm, 2005). The intension was to make OBE easier to implement. Also the RNCS wanted to promote human rights and inclusivity (DoE, 2002a). The curriculum had to be made more coherent, explicit and systematic. In addition assessment standards and other content framework provided teachers with content-specific guidelines. The problem encountered with the uneven specification across learning areas, subjects and grades, required additional documentation to address these gaps.

The NCS for the FET Phase was developed in 2002. The development proceeded through a separate and different process of the GET, but with the same design. Subject frameworks and assessment guidelines were developed by some of the same people who previously

developed the NCS subject statements. These documents were tested for rigour. The goal of the FET- curriculum was clearly aligned to the national Grade 12 examination, which left limited room for provincial reinterpretation of national documents, particularly pertaining to assessment. The result was less inconsistency and confusion about what was required at the FET level. The greater clarity concerning content and assessment was advantageous to teachers.

 The NCS had to redress the jargon used in the documents, reduce the excessive workload and to reinstate the development of proper reading skills and basic mathematics and science skills, which were apparently neglected in C2005 (Geyser, 2000). In addition the design features were reduced from eight to three (Vandeyar & Killen, 2003). Marsh and Willis (1995) note that curriculum development calls for a new form of grouping structures, new curriculum materials, a change in the professional practice of teachers, as well as changes in teacher beliefs and attitudes.

The two most significant differences between C2005 and the NCS are the following:

Firstly, there are differences in the specification of content. The assessment standards in the NCS give a clearer indication of what is to be achieved than the Range Statements or Performance Indicators in C2005. Secondly, the assessment standards also show progression across grades, something that was completely absent from C2005 (Hoadley, 2012).

A very prominent implication for implementation was the on-going commitment to C2005 amidst the call for the abandonment of the curriculum policy. Even though the initial reaction by a great proportion of the population was to welcome a policy that fundamentally differed from apartheid education, the reality showed that C2005, which was outcomes based and explorative in nature, could not produce the goods in the South African education context. The attempts to streamline the curriculum features did not appear to be convincing.

2.4.3 CAPS

The CAPS is not advanced as a new curriculum, but an amendment to the NCS. It therefore still follows the same process and procedure as the NCS Grades R–12 (Pinnock, 2011). The CAPS unpacks the content and not teaching methods. There is much debate about the possible implications for future reforms regarding the eradication of OBE, but OBE is advanced as a methodology, and not a curriculum. The CAPS curriculum is written in content format and not in the form of outcomes, which implies the use of traditional teacher methods and not OBE methods.

The main criticism against the RNCS was that it did not select socially valued knowledge, but instead concentrated on nation building. Schools and teachers had to apply this curriculum according to their own interpretations and to satisfy their own educational needs. Another concern was the assessment profile with no clear policy guidelines that was used. The use of various forms of assessment resulted in an administrative burden to teachers (Chisholm, 2005).

The CAPS seeks to provide teachers with enough room for interpretation of the curriculum. In order to bring about coordination, centralisation of the curriculum could undermine the leverage of diversity (DoE, 2010). Provincial curriculum development should not have been discouraged.

The CAPS was implemented at the primary level across grades in 2012. This new curriculum took into account the many criticisms at all levels against the NCS (Schollar, 2008) and repackaged the NCS into a content-based curriculum organised around knowledge. The restructured CAPS curriculum hopes to result in standardisation of the curriculum requirements across the country (DBE, 2011d) and aims to improve the knowledge and learner performance levels in numeracy and literacy (DBE, 2012). It specifies content knowledge and skills to be taught, with explicit sequencing and pacing (DBE, 2011c).

The CAPS document encourages an active and critical approach to learning, in which learners actively participate by demonstrating and recording their mathematical thinking skills (DBE, 2011c). The new policy also recommends that evaluation of learners' work include both informal and formal assessments, which must be recorded, rated and reported to all stakeholders (Van der Berg & Louw, 2007).

The CAPS attempts to strengthen the NCS to improve the quality of teaching and learning in schools. The CAPS stipulates the content to be taught every term and specifies the required number and type of assessment tasks to be completed every term in each subject. A clear portrayal of all the topics and assessments to be covered in each subject, is provided (Moodley, 2013).

All the outcomes and assessment standards were illuminated. The CAPS uses only one document and not the many documents that were needed by the NCS. The CAPS document leaves no freedom to decide what to teach; teachers only have to follow exactly what is in the document. The CAPS is not prescriptive about *how* teachers must teach, it only tells teachers *what* they must teach. Teachers have some sort of freedom to decide whether they

will make use of group work, worksheets, activities, tests, assignments, projects, etc. (Haodley, 2012).

Implications for implementation: The CAPS prescribes clearly what should be taught (content) and when. Many teachers perceive the CAPS curriculum to be too swamped with content. Teachers at historically disadvantaged schools will always struggle to keep up with the pace, given that no provision is made for different levels of education.

The return to the use of standard methods to improve literacy and numeracy could lead to a distrust of curriculum reforms by South African teachers.

2.5 FACTORS THAT HINDER THE SUCCESSFUL IMPLEMENTATION OF THE MATHEMATICS CURRICULUM IN SCHOOLS

Bantwini (2009) and Rogan and Grayson (2003) argue that well-designed curriculum initiatives could fail because of weaknesses in the implementation processes. Sayed and Jansen (2001) contend that although some head teachers bought into the changes, they lacked the capacity to lead the transformation.

Rogan and Grayson (2003) acknowledge great disparities between schools in South Africa regarding facilities and resources, and also in the skills and knowledge of teachers. This is particularly true concerning mathematics teachers, as a large number of mathematics teachers have no formal training in mathematics (Chisholm, 2005).

Bantwini (2009) reports that many teachers lack adequate pedagogical content knowledge and lesson-planning skills, and also lack instructional and assessment approaches. These shortcomings in teachers' repertoires need to be addressed effectively because of their influence on teacher quality and performance and eventually on learners' learning.

Rogan and Grayson (2003) call for greater emphasize to be placed on implementation issues in South Africa to ease the implementation process.

2.6 DISPARITIES BETWEEN PREVIOUSLY DISADVANTAGED AND ADVANTAGED SCHOOLS

It is of utmost importance to portray a clear perspective of the different schools in the South African schooling system.

The new government of South Africa introduced C2005 as a means of overcoming the wrongs and inequalities of the past in helping its citizens to participation in a free and democratic society (Rogan & Grayson, 2003). Most schools in South Africa still suffer the

inequalities and injustices of the past, especially with regard to the availability of facilities and resources. Therefore, Rogan and Grayson (2003) call for greater cognisance of the diversity of schools on the part of the education authorities in developing their plans for implementation. Sharp et al. (2009) agree that the capacity to implement change initiatives varies greatly from school to school and class to class, meaning that the needs of previously disadvantaged schools cannot be the same as previously advantaged schools. Dean (1998) notes that schools in previously disadvantaged areas still face a dearth of resources, overcrowded classrooms and demoralised and undertrained teachers. Rogan and Grayson (2003) also note significant differences in terms of quality, knowledge, and skills of teachers, especially in mathematics and science.

Rogan and Grayson (2003) also argue that schools, which are better equipped with resources, both physical and human, are better placed to take advantage of the benefit of the new curriculum in South Africa. They further observe a tendency in South Africa to underestimate poorly resourced schools' capacity to support all the changes necessary for implementation of reform initiatives.

It was wrongly assumed that all schools were the same and would therefore benefit from the same kind of in-service training and - strategies. It is imperative that change facilitators understand and elaborate on the factors that support or hinder the change initiatives and acknowledge that not all schools have the capacity to implement changes to the same extent.

2.7 CONCLUSION

In this chapter the main constructs from the theoretical framework, constructed for this study were systematically explored by making use of the available literature. Major challenges in curriculum development and reform are the great inequalities and disparities between advantaged and disadvantaged institutions, mainly in the distribution of resources. The next chapter will explore the existing literature on the constructs for mathematics.

CHAPTER 3

LITERATURE EXPLORATION (MATHEMATICS)

3.1 INTRODUCTION

This chapter explores the literature regarding the curriculum development and reform of mathematics in the classroom. It interrogates the major curriculum reforms, especially post-apartheid, during which time the most dramatic curriculum innovations were developed. Attention is paid to CNE, the education policy of the apartheid regime, which will be followed by C2005, NCS and the CAPS. A short background sketch and how each mathematics curriculum differs from the previous policy, including its assessment profiles, are provided. Consequently the process of curriculum reform is explored, in which attention is paid to the role of teacher beliefs and attitudes in the implementation process. Mathematics teachers' experiences of curriculum change and their professional practice, in particular their changing roles and the importance of professional development programmes, are illuminated.

3.2 CURRICULUM REFORM IN MATHEMATICS

There exists a complex relationship between mathematics teachers' beliefs and their classroom practices (Pajares, 1992). Although many studies on teachers' beliefs confirm a relationship, causality is difficult to explain. In some studies it was found that teachers' beliefs influence their instructional behaviour, while in other studies it was found that instructional behaviour influences teachers' beliefs (Buzeika, 1996). It is also suggested that other factors, such as teachers' own school experiences, influence the nature of this relationship (Brown & Rose, 1995; Foss & Kleinsasser, 1996).

The degree of success of an innovation is strongly dependent on the level of agreement between teachers' beliefs and the beliefs that underpin the educational reform. If these two are not compatible, it may lead to low teacher morale and even resistance to the innovation. Conversely, if they are compatible, the opposite may hold true. Therefore, mathematics teachers will also determine whether they will make the effort to translate curriculum guidelines into their teaching practices (Haynes, 1996). If teachers hold beliefs contrary to what are expected of the new curriculum, many challenges will be experienced by teachers in taking up the innovations (Burkhardt et al., 1992). Hart (1992) notes that teachers will mistrust the innovations if they consider the new tasks to be trivial or redundant. Innovations can therefore have the adverse consequence of disunity among teachers when they form groups that are resistant to the reforms (Fullan, 1993).

According to Martin (1993a, 1993b), curriculum implementation approaches have to consider teacher beliefs, or the innovation will have a short existence. Many educational reforms in mathematics had a top-down approach, which is an indication that mathematics teachers' beliefs were overlooked (Doyle & Ponder, 1977).

A prepared product is often presented to teachers, who are required to follow a set of procedures. These programmes are apt to fail because they neglect to incorporate teachers' pedagogical knowledge and beliefs into these innovations (Knapp & Peterson, 1995). Curriculum innovations fail because it is wrongfully assumed that teachers will automatically do according to expectation if told that the innovation was beneficial to them and their learners (Grant, Hiebert & Wearne, 1994). The complex nature of changing teaching approaches, styles and practices have to be taken into account to ease the implementation process (Mousley, 1990). It also has to be taken into account that change will cause feelings of discomfort that could be unpleasant and intimidating (Martin, 1993b).

Since the 1980s, mathematics has had the highest number of transient innovation attempts, which further led to the distrust of mathematical innovation and reforms (Blane, 1990). Clements (1995) and Clements and Ellerton (1996) complain that the last three decades relied on quick fix instructional recipes such as Cuisenaire rods, mastery learning, problem solving, applicable mathematics, meta-cognition, and more recently, outcomes-based education. Many of these innovations expected major operational changes, which were poorly defined in operational terms (Hall & Loucks, 1978). Therefore, it is important that teachers are convinced of the value that could be added to their learners learning and performance (Martin, 1993b).

Several influences are discernible in South African mathematics curricula, textbooks and teacher education programmes. The New-Math movement, Behaviourism, Structuralism, Formalism, Back- to- Basics, problem-solving and integrated curriculum approaches, which have shaped curriculum development in Western countries, have also left their mark on mathematics curricula in South Africa, resulting in the implementation of an eclectic mixture of all or some of the above approaches (Carrim, 2003).

A short description of each of these influences is deemed necessary: Back-to-Basics is known as a skills-oriented mathematics instruction approach, which decontextualises and compartmentalises the proposed skills. This basic skills approach was most prominent throughout the early 1980s (English & Halford, 1995), but was criticised for failing to adequately prepare students for mathematics coursework, which require higher levels of reasoning and understanding (United States Congress Office of Technology Assessment, 1992; Tate, 2000)

Behaviourism in mathematics education was characterised by skill and drill teaching, where procedures and outcomes should follow hierarchically. Attained knowledge and skills served as a platform to acquire more advanced mathematical skills. In this paradigm mathematical knowledge is external and absolute. Teaching is didactic, and learning is acquired by applying the appropriate algorithms to obtain correct answers. Learner behaviour is conditioned and reinforced either positively by rewards or negatively by disapproval and punishment (Klinger, 2009).

Cognitivism arose largely in response to Behaviourism, recognised as an adaptive process where knowledge is shared and passed on between individuals and stored as internal mental constructs or representations. Social Cognitivism recognises learning as a social, behavioural and a cognitive activity. Elements of Behaviourism and Cognitivism are combined with social aspects of learning (Bandura, 1986). By observing others and making comparisons to one's own behaviour, behavioural and/or cognitive changes are made (Bandura, 1997).

In Formalism, strong emphasis is given to content and intuitive, inductive processes, whereby attention is turned to problem-solving processes. The axiomatic foundation of Euclidian geometry is a representative example of the Formalistic philosophy (Voskoglou, 2007).

The late apartheid years saw Constructivism replace Fundamental pedagogy and Behaviourism in mathematics education (Jaworski, 2005). Both of these developments had parallel roots in mathematics education curricula in different parts of South Africa, which impacted on their development (Reddy, 2006). For example, in the Western Cape the development of People's Mathematics faced particular difficulties when it came into conflict with those promoting Constructivism, in contrast to the different challenges faced in the then Southern Transvaal, another part of the country, where People's Mathematics was promoted (Vithal, 2003).

People's Mathematics was less of a mathematics educational theory or philosophy and more of a political programme intended to bring awareness of and a tool against the injustices of apartheid. It was an explicit attempt to develop a curriculum framework outside the control of the apartheid state, Even though it was used to meet political objectives within the mathematics classrooms, it never progressed in the education system, either during the apartheid era or in the post-apartheid education system. Constructivism, however, was embraced by the Western Cape Department of Education and survived successive mathematics curriculum reforms of post-apartheid education (Vithal et al., 2005).

A feature of the late 1980s and early 1990s was an orchestrated effort on the part of all mathematics educators to have teaching and learning of mathematics transformed. The result was that different approaches were advocated and researched. There had been a worldwide swing towards a Constructivist perspective, which was implemented mainly in white primary schools in South Africa and known as the problem-centred approach. This perspective presented as a prescriptive methodology, which replaced all known ideas that South African mathematics teachers might have had about the teaching of the subject.

After 1994, OBE was introduced, which was strongly driven by its methodology but did not specify its content too clearly. This approach endeavoured to meet labour market needs by matching theory and practice in the South African context (Jansen, 1999).

The mid-twentieth century moved to the New Math Movement, which originated in the United States of America, and known as an expert-driven curriculum that brought a dramatic change in the way mathematics was taught. This curriculum concentrated on the basics, unifying common ideas into mathematical logic. Surprisingly, it is difficult to describe the New Math Movement, but any attempt during the late 1950s and the 1960s to reform, repair and improve mathematics education at school level, could be considered part of the New Math Movement (Bossé, 1995). The twenty-first century moved to curricula that considered all stakeholders, consumers and producers of mathematics (Kraak, 1999).

Certain amendments were made to the NCS mathematics curriculum: Euclidean geometry and probability were covered in the mathematics Grades 10–12, Paper 3, which was optional for mathematics learners. These sections are now included in the core mathematics curriculum. To accommodate the above-mentioned sections, the following themes were omitted: linear programming, transformational geometry and recursive sequences. Small adjustments were made to the NCS mathematics curriculum also (Olivier, 2013).

 In Grade 10, reciprocal trigonometric functions for special angles and their derivations are introduced. Comparison of theoretical probability and relative frequency is made in the use of Venn diagrams in solving problems. In Grade 11, geometry of circles is covered, which includes tangent theorems. Furthermore in probability, dependent and independent events have to be identified, using Venn diagrams, contingency tables and tree diagrams to solve these problems. In Grade 12 similar triangles are covered, including the Pythagorean Theorem. Fundamental counting principles are used to solve probability problems. In algebra, remainder and factor theorems are covered. In statistics, bivariate data are studied, which include scatter plots, regression lines, and correlation coefficients (Survival Guide to FET Curriculum and Assessment Policy Statements (CAPS), 2012).

3.3 THE PROFESSIONAL PRACTICE OF TEACHERS

According to Cochran-Smith and Lytle (2009), engaging learners in classroom activities is an important aspect of teachers' practice. The environment should be challenging and learners should raise their opinions without fear of any harmful consequences. It is also about creating a warm, trusting and invitational environment, conducive to learning and exploration. It is of utmost importance that the teacher should create good interaction between the parties in the classroom situation. Teachers must be equipped with good communicative skills to ensure quality teaching. Carr and Skinner (2009) note that teachers should possess effective teaching approaches, techniques and strategies to inform their teaching programmes and lessons. They evaluate their teaching practice to meet the educational needs of learners. Learner assessment information is used to evaluate learner performance and barriers to learning, using this information as a mechanism for motivation.

The whole cycle, from planning, to providing feedback to parents and carers, should be effectively undertaken (Supovitz & Turner, 2000). High on the priority list of teachers' responsibilities is to maintain and develop their professional profiles by being lifelong learners to keep up with advancements in their fields of study and develop their pedagogical skills, always reflecting on their teaching practice in conversation with colleagues, curriculum advisors and other superiors (Danielson, 2007).

Mathematics teachers' roles changed in the following ways in the democratic era in the education system of South Africa. According to Vithal (2003), the teacher's role in the democratic era is to prepare learners for critical democratic citizenship in the way mathematics is analysed politically, socially and economically. Mathematics is applied to everyday life situations, bringing mathematics from outside the classroom into it. The teacher serves as an example to everyone who has an interest in mathematics. The teacher is also a custodian of mathematical knowledge and a conveyor of the practices of mathematics teachers.

For the purpose of this study, professional practice in essence refers to teachers' ability to effectively teach and adapt to change according to the requirements of the new policy and to realign teaching methods and pedagogy accordingly. It will also enquire how teachers effectively cope with administrative responsibilities, which include planning, assessment, and programme development, and how they interpret official documents and contextualise these within their environments.

Dealing effectively with educational reforms in the world requires a study of the role of professional teacher development (Villegas-Reimers, 2003). There exist a strong relationship between educational reform and teachers' professional development.

'Educational reforms have to consider the efficacy of teachers' professional development in order to be successful. Professional development initiatives should be prevalent in the structures and policies of curriculum reforms to have any chance of success (Villegas-Reimers, 2003).

Professional development is also called in-service education or staff development. Villegas-Reimers (2003) identifies four categories of in-service education by purpose: for certification of unqualified teachers, to upgrade teachers, to prepare teachers for new roles, and curriculum-related dissemination or refresher courses. Traditional teacher professional development programmes take the form of workshops, seminars, conferences or courses (Schwille et al., 2007). Even though these efforts may have some merit, they are often criticised for their brevity, fragmentation and not meeting the needs of teachers (Collinson & Ono, 2001). Kelleher (2003) calls the traditional approaches to professional development of teachers, adult pull programmes. These programmes seldom result in any improvement once teachers return to their classrooms.

Fullan (1991) voices his dissatisfaction with the workshops and conferences that lead to few significant changes in effective teaching. This tendency appears to apply also in developing countries (MacNeil, 2004). In many developing countries, professional development of teachers has been neglected even more because of economic constraints and a strong emphasis on pre-service education. The cascade approach is employed the most in professional teacher development because big numbers can be reached in a short period of time (Leu, 2004). The cascade approach, also aptly called the multiplier approach, passes the knowledge or information from the top to bottom groups of teachers. This consequently involves the training of the trainers, who will on their part train other groups of teachers. This approach makes sure that the message transmits from the experts and specialists to the teachers. Selected teachers receive short training courses, after which they are required to to provide formal short courses to other teachers (Peacock, 1993). This training model could be advantageous in that training could take place in stages so that progress can be monitored. Information can also be distributed quickly to a large number of teachers, which is a cost- effective endeavour. This approach was employed by the South African Department of Education for introducing OBE and C2005. The cascade model could be effective if the appropriate mechanisms and support structures are in place (Leu, 2004). It

remains inevitable that some information may be diluted or lost in the training process (Fiske & Ladd, 2004).

Lessing and De Witt (2007) believe that teachers should receive on-going professional development to gain confidence, knowledge and skills to implement the new curriculum demands. Although teacher professional development is important for improving teachers' content knowledge and developing their teaching practices (Smith & Desimone, 2003), it did not meet the desired goals in education in South Africa because it fails to align classroom practice with the new curriculum reforms. It must, however, be acknowledged that various factors contribute to the ineffectiveness of these initiatives as professional development is a complex enterprise that creates, among others, ethical, structural and cultural dilemmas (Richardson, 2003).

Darling-Hammond and McLaughlin (1995) believe that the success of new policies depends on effective local responses to specific teacher and learner needs. These authors propose seven elements that should be included in teaching practice development: engagement of teachers in practical tasks, which provides opportunities to observe learners, assess and reflect on the new practices; participant-driven and grounded in enquiry, reflection and experimentation; collaborative, involving the sharing of knowledge; directly connected to the work of teachers and their students; sustained, ongoing and intensive; providing support through modelling, coaching and the collective solving of problems; and connected to other aspects of school change.

Griffiths (2014) proposes the coordination of at least four major roles which teachers have to live out inside the classroom. The first is the teacher role in a dyadic relationship, which is between the teacher and the individual learner. Learners sometimes have need of individual support in tasks and in discussion. The second role is the cognitive and physical organisation of the class in search of the establishing of a common goal. The teacher has to make instinctive decisions whether individual needs should take preference over the responsibility to take the group forward. The third is an instrumental role in ensuring that goals are met. Here we note the practical day- to-day requirements of doing homework and submitting assignments on time, and keeping to timelines of tests and examinations, which are all part of what it means to be a teacher. The fourth role is coordinating the triadic relationship between subject matter, teacher and learner.

3.4 EXPERIENCES OF TEACHERS OF A CHANGING CURRICULUM: AN OVERVIEW

The process of change is complicated by the contrasting interests of the various role players and interested parties in the education process. Radical curriculum reforms, which aim to

change amongst others, teachers' pedagogical assumptions, classroom organisation, teaching methods and assessment strategies, are extremely difficult to achieve. Stoffels (2004) notes that teachers in all contexts (developing and developed countries) struggle to successfully implement curricula that were radically changed

The majority of South African teachers are troubled by the constant revising and changing of the curriculum, which make them feel incompetent (Remillard, 2005). Curriculum change is a worldwide phenomenon and a natural consequence to the changing social, political economic and cultural nature of society. Goal-centred, dynamic and adaptable teachers who diligently apply themselves for the common good of the nation, are needed. A curriculum plan should be developed to suit the special character of the school (Lumadi, 2014).

Teachers experience different feelings towards curriculum change for different reasons. Flett and Wallace (2005) reason that teachers' willingness to adapt to change is largely determined by their acceptance or rejection of the curriculum change. Teachers, who lack innovative skills and have a paucity of instructional and material resources, could experience a lack of motivation.

Teachers call for sufficient training and development prior to curriculum implementation. Rural teachers generally receive brief in-service training before implementation of the new curriculum (Marsh & Willis, 2007). Lumadi (2014) calls for training sessions to continue for longer periods of time. Tshiredo et al. (2013) found in their study that 60% of teachers in their cohort confirmed that they were inadequately prepared to face the demands of the new curriculum.

Centrally managed reforms stifle the implementation of change initiatives and the development and creativity of teachers (Kennedy, 1996). According to Pinto (2005), the imposed innovations are often ineffective, and may lead to failure if teachers do not understand the innovations or do not accept the innovations. Conversely the innovation is more successful when teachers experience some sense of ownership of the innovation. Ware (1999) believes that as long as teachers do not buy into the innovations and see themselves as executors of someone else's plans, they will not easily to commit themselves to those reforms. The implication is that every effort should be made to make teachers an active part of the development of the innovation. Fullan (2001) suggests that the extent to which teachers will commit themselves to the change depends upon the extent to which users are clear about the change Ogborn (2002) warns against communication which is not clear, for teachers will interpret the communications in their own way.

Fullan (2001) proposes a model that could explain teachers' responses when they first encounter innovations. This model advances that when teachers are first confronted with change, they approach it with mixed feelings, irrespective of how good and valuable the change may be. Hall and Hord (2006) suggest the following reasons for this reaction: They are at first uncertain about the demands of the change. Secondly, they may doubt their own ability to successfully implement the new demands. Thirdly, they may be sorrowful for the loss of the old ways of doing things. Because of the above-mentioned feelings, when teachers interact with the innovation, they may accept, reject or modify some parts of the innovation to make it suit their particular contexts. The old curriculum and proposed innovations merge and are transformed into a unique blend of the two (Pinto, 2005).

Inadequately trained change facilitators can seriously hinder the successful implementation of change initiatives. Changes have to be introduced to the users effectively (Fullan, 2001) by knowledgeable and experienced change facilitators and policymakers, who fully understand the change and who can clearly envisage how the changed product will look like when it is implemented in the envisioned way (Hall & Hord, 2006).

Fullan (1991) notes that people in authority may be granted the responsibility to lead innovations, which they may not completely understand themselves. Their lack of understanding may have been because the innovation itself was not well developed. They could also have been excluded from the change process and could have received inadequate orientation and training themselves.

Teachers are central to the successful implementation of new curricula, for they are the means used to successfully adopt innovations into classroom realities (Pinto, 2005). Teachers are expected to implement them in their teaching, thus bringing about a change in their practices (Fullan, 1991), which may cause stress as they have to revert to a position of newcomer (Fogleman & McNeil, 2005).

3.5 CONCLUSION

Given this contextual reality and challenges as expressed in this chapter, Chapter 4 will explore and develop a conceptual framework to drive the study, engage with teachers and make sense of the data collected.

CHAPTER 4

CONCEPTUAL FRAMEWORK

4.1 INTRODUCTION

This study employed a conceptual model. This model is a combination of the work of Rogan and Grayson and that of Remillard. Elements from the framework depicting the components of the teacher–curriculum relationship were abstracted from Remillard (2005) and developed into a conceptual framework for the purposes of this study. These elements were further combined with the analytic framework of Rogan and Grayson (2003). The researcher argues that a conceptual framework is best suited to guide the exploration of teachers' experiences of the influence of curriculum change on their professional practice. In order to guide this study and strengthen its theoretical or philosophical conception, Social Constructivism served as overarching theoretical approach.

4.2 SOCIAL CONSTRUCTIVISM

The basic assumptions of Social Constructivism guided this study, particularly the work of Vygotsky, who argues that learning cannot be separated from its social context. This understanding served as premise in understanding how learning takes place. He further argues that all cognitive functions can only be explained as products of social interaction and one's conception and experience of one's social reality. As a perspective, Social Constructivism can assist teachers in understanding the underlying processes in the reasoning of learners and guiding teachers' approach in their teaching processes. Learning thus becomes a process through which learners are incorporated into a knowledge community (Vygotsky, 1978). For Constructivists, the context within which learning takes place, as well as the social contexts that individuals bring to their learning environment, is crucial for learning (Kalpana, 2014).

The following constructs guided the framework:

Social and cultural: The teacher has to mediate between students' personal meanings and culturally established mathematical meanings of wider society. Individuals draw from their social and cultural environments as they construct meaning, which is strongly influenced by their cultural heritage (Cobb, 1994). The researcher paid careful attention to the social and cultural backgrounds of the schools where the teachers are positioned during the analysis of the data. Even though it was not the main objective of the study to distinguish between social and cultural backgrounds, it was important to verify what social interaction and culture guided the teachers' experiences and perceptions.

Constructivism is a process of active construction of knowledge in trying to make sense of the world (Mascolo & Fischer, 2005). Teachers' ability to adapt to the new curricula and their efforts to change their pedagogical techniques and methods were considered.

ZPD: Learners can master concepts and ideas too difficult to solve on their own with help from adults and other learners who are more advanced than they. Two developmental levels are distinguished: the level of actual development, which is the point that learners already have already comprehended, being able to solve problems independently; and the level of potential development, which is the point of capability learners can reach with assistance from teachers or peers (Vygotsky, 1978). It is important to determine whether teacher assistance at the above-mentioned levels improves learners' performance, as this is of vital importance for good teachers' professional practice.

Reality: Reality is a construct of human activity. For the Social Constructivist, reality is only drawn into existence through social intervention (Kukla, 2000). It has to be ascertained which interventions (workshops, courses, conferences, teacher training and development sessions, etc.) are in place or should be put into place to inform the social realities of the different schools under study.

Knowledge: Knowledge is a human product, constructed in social and cultural terms. Meaning is created through personal interactions and interaction with the environment that they live in (Ernest, 2003). The researcher explored how teachers construct their knowledge, which in turn will influence how knowledge is co-created in their classroom interaction with their learners. It is required that teachers should diversify, since learners do not acquire knowledge in the same way. Teachers must engage with other peers and superiors (their seniors, curriculum advisors and inspectors) to gain greater insight into the content, methodology and pedagogical practice that could benefit their learners.

Learning: Learning is viewed as an active social process shaped by external forces. Constructive learning occurs when individuals engage in mathematics, which is a social activity (McMahon, 1997). Teachers should understand the underlying processes in learners' reasoning and learning to be able to meet their individual needs and to implement a learning programme. It should also be established in which ways teachers remain active lifelong learners.

4.3 CONCEPTUAL FRAMEWORK

This study explored teachers' experiences of the implementation of the different curricula post 1994 for mathematics in Grades 10–12 in the Cape Winelands district of the Western

Cape. The sense making and interpretation of the new mathematics curricula by teachers and their attempts to change their pedagogical techniques were considered. Mascolo and Fischer (2005) argue that it is this active construction of our understanding of the world that drives this sense-making process. It is the impact of this process on the teachers in their context that guided the focus of this study. Kukla (2000) points out that it is through social interaction that people create their reality. That is why the social interaction of the teachers was critical to this study.

It is crucial to note that teachers' experiences take place in their personal contexts and makeup as well as in the curriculum implementation process. The teacher is engaged in a relationship with the new curricula framed by the dynamic implementation process as well as all the challenges that go with it. Altinyelken (2010) argues that teacher experiences of curriculum change can only be successfully explored against the backdrop of the curriculum implementation process. The current study espoused this view and adapted the analytical framework of Rogan and Grayson (2003) as presented by Altinyelken (2010).

The second important understanding was the particular relationship between the teacher and the curriculum (Remillard, 2005). The elements depicting the components of the teacher–curriculum relationship was abstracted from Remillard (2005) and developed into a conceptual framework for the purposes of this study. These elements were then combined with the analytic framework of Rogan and Grayson (2003) to construct the following framework for the purpose of this study.
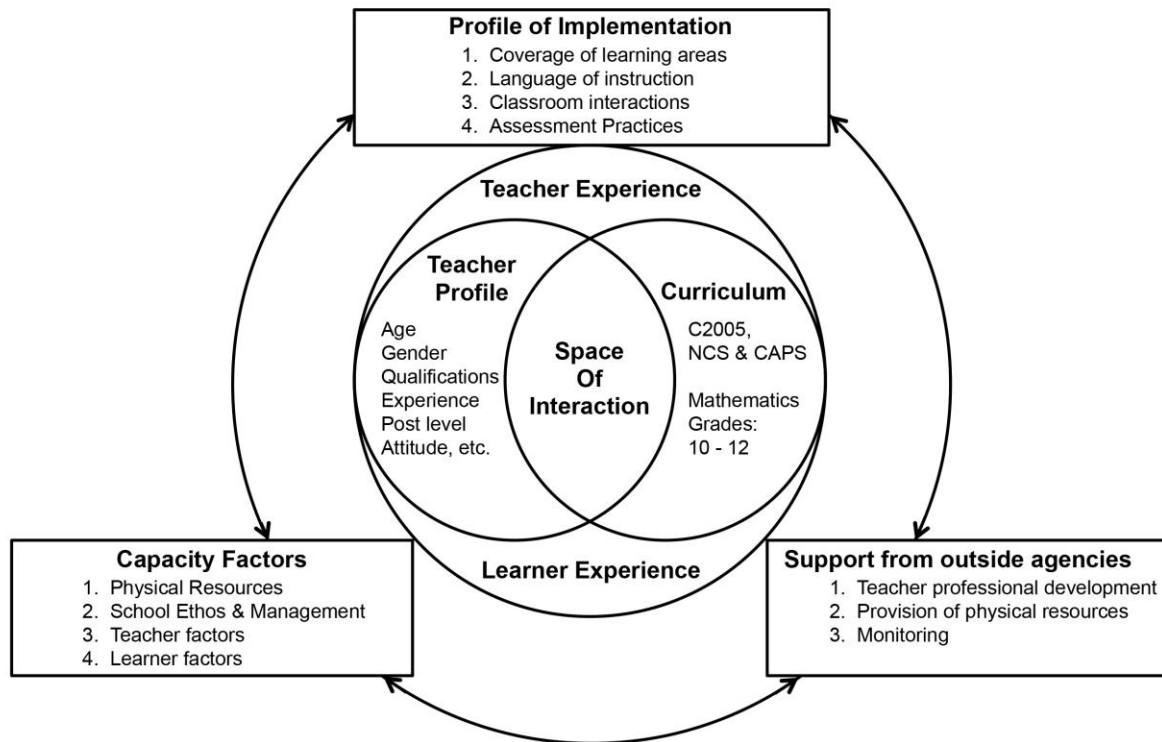
Teacher Curriculum implementation experiences: Conceptual analysis framework

Adapted from: Altinyelkan (2010) and Remillard (2005)

Figure 4.1: Conceptual framework

4.4 CONCEPTUAL FRAMEWORK

This conceptual framework comprises the curriculum change framework that consists of three main constructs unpacked under the construct macro context. In addition, the micro context describes the relationship between the teacher and the new curriculum and the interaction that takes place between them. The teacher and learner experiences were therefore extracted from this relationship.

4.4.1 Macro context

The three blocks in the outer circle represent the curriculum change framework. The three main constructs, according to Rogan and Grayson (2003), on which curriculum change is based (as represented here) are supported from outside agencies, capacity to support innovation, and the profile of the implementation. These constructs are explored in the data analysis process as part of the context of sense making of the findings.

4.4.1.1 Profile of implementation

This profile encompasses the factors that will have an effect on how the process of implementation is enhanced or hindered. The first factor impacts on all the learning areas in mathematics that are affected, whether teachers are well equipped with knowledge and methods to deal with the areas effectively and whether learners are sufficiently equipped with pre-knowledge to cope with the new learning areas. The language of instruction of the school should be aligned to the needs of its learners and schools should make every effort to provide instruction in the language of preference of their learners, because it leads to better academic performance. It is thus important that structures are put in place to deal with the challenges associated with the language of instruction. Classroom interaction is determined by the type of methodology that the new curriculum requires. Classroom activities and practices should be aligned with the curriculum demands.

4.4.1.2 Capacity factors

The construct capacity factors focus on issues likely to support or hinder the implementation of new ideas and practices in the new curriculum. This construct recognises that schools differ in terms of their capacity to implement innovations. Possible factors fall into four categories: physical resources, school ethos and management, teacher factors, and student factors. Access to physical resources is crucial because poor conditions and limited resources can limit the performance of the most promising teachers and students (Fullan, 2007). Moreover, teachers, as the primary executors of reform initiatives and processes, do not merely assimilate the institutionalised curriculum texts, but incorporate them into their knowledge, beliefs and pre-existing teaching practices (Fullan, 2008; Lopes & De Macedo, 2009). Many different factors, amongst others, inadequate teacher training and subject knowledge, low motivation, negative beliefs and expectations, influence teachers' capacity and willingness to implement change (Levin & Nevo, 2009). The backgrounds of learners and the kind of strengths and constraints they might bring to the school and the classrooms are crucial factors. Student attitudes to learning and responses to change are influenced by different factors, which include their home environments, parental commitment to education, health, and nutrition.

The capacity factors are represented by key constructs of which physical resources are vital for successful implementation. A dearth of appropriate support material for teachers could challenge teachers, depriving teachers of direction on how to enact the curriculum (Schneider & Krajcik, 2002). Stronkhorst and Van den Akker (2006) accentuate the role of curriculum materials to clarify early uncertainties regarding implementation issues. Also these curriculum materials help to reduce early implementation fears and concerns of

teachers (Stonkhorst & Van den Akker, 2006). Ball and Cohen (1999) indicate that support materials could be helpful in mediating the context of the classroom, planning and structuring learner activities accordingly.

Rogan and Grayson (2003) draw the attention to changes and innovations that should be implemented by top-down structured education systems. Innovations mostly require skilled, well-qualified teachers who can understand and internalise the new approaches and reforms, which in our education context, is often not the case. As a result gaps arise between the intended curriculum (expressed in policy documents), the implemented curriculum (expressed by real life in schools and classroom practices), and the attained curriculum (expressed by learners' experiences) (Fogleman & McNeil, 2005). Hall and Hord (2006), however, have a different opinion in that top-down management can work provided it is accompanied by continuous communication, ongoing teacher development and training, continuous monitoring and feedback, and realistic timelines for implementation.

Learner support materials in the form of textbooks is of great importance to learners as their most accessible and primary source of information (Lewin & Stuart, 2003). Research has shown that good quality textbooks, appropriate to the innovation, could contribute significantly to students' learning and performance (Montero-Sieburth, 1992). A paucity of appropriate resources, mainly textbooks, had been identified as a great hinderance in the implementation process in many developing countries (Tabulawa, 1997). A review of the new curriculum in 1998 in South Africa revealed that in many schools and provinces old books, which were not designed for the new curriculum, were still in use (Chisholm et al., 2000). Rogan and Grayson (2003) concluded that the lack of resources or the poor quality of resources could greatly hinder the implementation of new ideas and also the efforts of even good teachers, with which the researcher concurs.

4.4.1.3 Support from outside agencies

Outside organisations, such as departments of education, aid agencies or teacher unions, can influence (either by support or sanction) implementation practices (Rogan & Aldous, 2005). In many developing countries, outside agencies may also involve international development agencies and local or international NGOs. The sub-constructs are divided into two categories: material support and non-material support. Material support may include the provision of physical resources such as school buildings, books, or apparatus, and direct support to students (such as a school feeding scheme). Non-material support is mostly provided in the form of professional development. It is probably one of the most visible and obvious ways in which outside agencies attempt to bring about change in schools. Teacher professional development can also be promoted through cooperation and support among teachers (Karsten et al., 2000). Therefore, it can also be regarded as a sub-construct of school capacity. To bring about change, outside organisations can exert pressure for example by monitoring.

4.4.2 Micro context

The two inner intersecting circles to the left and to the right of Figure 4.1 capture the relationship between the teacher and the curriculum. The circle in the centre that circumscribes the intersecting circles introduces teacher experiences at the top and learner experiences at the bottom. This section was adopted from Remillard (2005). The teacher is central not only to the curriculum implementation process, but also to this study.

Constructs pertaining to the teacher are set out in the first circle (to the left) and those describing the curriculum are set out in the second circle (to the right). The intersection represents the interaction space where the teacher and the new curriculum interact in the implementation process, depicted by the three blocks linked by the outer circle framing the implementation process. This interaction space is also the key focus of the study, which explored the experiences and perceptions created here. This is the unit of analysis of this study. Finally, the opposite sides of the centre circle circumscribing the interaction space incorporate the experiences of the teacher at the top and those of the learner at the bottom. It is the interaction space where the teacher–learner relationship is impacted on in the curriculum implementation process.

The key constructs of the framework include a) the teacher, b) the curriculum, and c) the relationship between them.

4.4.2.1 Teacher profile

The circle on the left of the framework represents the resources, stances, and perspectives that the teacher brings to the participatory relationship with curriculum resources. These include age, gender, qualifications, teacher experience, post level, attitude, etc. Other characteristics may still be identified. Of particular relevance to this study are those characteristics that relate specifically to teachers' interactions with curriculum, such as the teacher's perceptions of and attitudes towards curriculum materials or the teacher's professional identity as it relates to the utilisation of curriculum resources.

4.4.2.2 Curriculum

The circle on the right represents the particular curriculum resource or text being used. Here follows a concise description of the different curricula pertinent to this study.

- C2005

C2005 is centred on outcomes as goals of education, the learner as centre of education, and knowledge as an integrated approach (Chisholm et al., 2003). C2005 applies to all bands of education, namely GET (Grades 1–9) and FET (Grades 10–12). The main shift in the post-apartheid curriculum was from a content-based syllabus to an outcomes-based approach (DoE, 1997b). The then Learning Area of MLMMS for Grades 1 to 9 had specific outcomes which outlined the general skills, abilities and values that a learner was expected to demonstrate at the end of the General Education and Training (GET) band (DoE, 1997c). Because C2005 was learner centred, it emphasised that learners should take responsibility for their own learning through cooperative and learner-engaging activities (DoE, 1997a).

Teachers were no longer the sole sources and conveyers of knowledge, but rather facilitators of learning, who were required to develop their own learning programmes (DoE, 1997b). C2005 involved the most radical form of integration, across all learning areas, through the pursuit of cross-curricular themes (DoE, 1997a). Because C2005 tapped into learners' personal experiences and everyday knowledge, learners were mainly evaluated through continuous portfolio-based formative assessment.

- NCS

RNCS and NCS was the response to the criticism of C2005. It is described as the streamlined version of C2005. This curriculum was intended to strengthen the implementation of OBE, human rights and inclusivity (DoE, 2002a). The NCS is a

continuation of the RNCS. It now includes the FET band, which commenced in 2006 for Grade10, in 2007 for Grade 9 and in 2008 for Grade 12.

The Review Committee on C2005 did not reject the curriculum outright, but redressed the structural design flaws to bring forth an implementable, streamlined curriculum for the 21st century, which was named Curriculum 21 (DoE, 1997a).

Three main areas that needed to be redressed was the unfamiliar jargon used in the documents; the overloading of the curriculum that led to the inadequate development of effective reading skills and basic mathematics and science concepts and also weaknesses in the design features as well as inadequate training of teachers (Geyser, 2000).

The assessment profile had no clear policy guidelines. Teachers were confused about how assessment should take place and which criteria should be used. The use of various forms of assessment resulted in an administrative burden to teachers (Chisholm, 2005).

- CAPS

The CAPS seeks to bring about coordination and centralisation of the curriculum. Provincial curriculum development had been discouraged.

The CAPS was implemented at the primary level across grades in 2012. This new curriculum took into account the many criticisms at all levels against the NCS (Schollar, 2008) and repackaged the NCS into a content-based curriculum organised around knowledge. The restructured CAPS curriculum endeavours to standardise the curriculum requirements across the country (DBE, 2011d) and aims to improve the knowledge and learner performance levels in numeracy and literacy (DBE, 2012). It explicitly specifies sequencing and pacing of content and skills to be taught (DBE, 2011c).

4.4.2.3 Interaction space (intersection)

The most important construct of the framework for this study is the intersection between the teacher and the curriculum. This interaction space resulted in insider perspectives on the influence of curriculum change on teachers' professional practice. Change initiatives do not occur in a vacuum and the teacher is not a down pipe through which knowledge and skills are transmitted. The classroom is a dynamic environment that requires skilled and innovative teachers that have to think on their feet. Teachers more than often have to improvise, especially in the absence of adequate resources. The relationship between teacher and the curriculum is highly complex and multi-faceted, and refers to interactions in which both the teacher and the curriculum are significant and active participants. The profiles of teachers

are supposedly of great significance and refer to characteristics like age and gender, post level, experience, and attitude. The expectation is that older and more experienced teachers will cope better with curriculum use and be better equipped to deal with curriculum reforms. Likewise teachers with a positive outlook on the teaching profession and curriculum reform will better deal with the proposed changes and reforms. The researcher eagerly explored the experiences of the cohort in respect of these factors. According to the socio-cultural perspective on cultural artefacts and tools, curriculum can be an active participant in these interactions. This interaction encompasses how teachers read, evaluate and interpret the curriculum texts (Remillard, 1999). Also included in this interaction are offloading, adapting, improvising, omitting, creating, and replacing of curriculum content.

The teacher–curriculum relationship explored how teachers use the curriculum as a process of active engagement and collaboration with curricular resources. Because curriculum use is such a multifaceted activity, it is not easily described, as teachers draw on their individual resources and capacities to make sense of the available curricular resources. Teachers make explicit or implied decisions about what to read, and they read for different kinds of information, which is indicative of the complexity of understanding curriculum use. Previous studies of teachers' curriculum use have explored individual teachers' resources and characteristics, but have not analysed the structures and features of the curriculum.

Curriculum use is an active process of engagement and collaboration among many stakeholders and the curriculum itself. A plethora of factors and teacher characteristics impacts on teachers' willingness and ability to accept curriculum change. Furthermore, teachers have an individual agenda and draw on their own resources and capacities to make sense of curriculum changes. They make conscious and instinctive decisions daily in the classroom as they engage with the curriculum and interact with their learners. It is known that learner profiles also play an important part in teachers' curriculum use and professional practice. Learners' support systems at home and in the community, their attitudes towards school and schoolwork, their socioeconomic profiles and other factors constitute the strengths and constraints that they bring to the classroom.

As is indicated in the framework and as has been suggested in a number of studies of curriculum use, the teaching and school contexts influence the participatory relationship (Manouchehri & Goodman, 1998).

The key constructs as represented in this conceptual model are applied in the interview schedule and form part of the themes explored in the study. The framework was utilised in the data-analysis process in this exploration of the teachers' experiences and perceptions of the curriculum implementation process.

4.5 CONCLUSION

The conceptual framework was constructed as a perfect fit for leading the methodology and the interpretation of the data collected for this study. In the next chapter the methodology is systematically explored and described.

CHAPTER 5

METHODOLOGY

5.1 INTRODUCTION

This chapter contextualises the study and the research design adopted for data collection. A qualitative design was deemed the best choice to suit the research questions to be answered. This design lent itself to explore people's experiences and perceptions of a phenomenon in a social context, which is a great determinant of how they experience things in the real world. In this study the experiences of FET mathematics teachers were explored to determine how the constantly changing curriculum influenced their professional practice, which was radical in the case of C2005 and moderate in the case of RNCS and CAPS. The researcher expected that schools would be more challenged in implementing the vastly different curriculum, C2005, which was based on a totally new methodology, than NCS and the CAPS.

Interpretivism was a logical choice to guide the methodology in its analysis of data, which was expected to be rich, in great detail and subjective. Interpretivism allows for the data to be categorised in themes and categories, providing meaning and purpose to the respondents' experiences and perceptions. Furthermore, this paradigm allowed for the consistent interpretation and understanding of human action. This paradigm is helpful in imputing meaning to data (Bassey, 1999) that could be specific, atypical and mostly strongly linked to a cultural identity (Merriam, 2002). A purposive, convenience selection method was chosen for this study. Semi-structured interviews were chosen as data-collection instrument. The questions compiled for the interview schedule were guided by the literature exploration and the constructs on which the conceptual framework was based. A thematic analysis was used, which was guided by the constructs derived from the literature exploration, as well as the conceptual framework developed by the combined work of Rogan and Grayson, and Remillard. A deductive approach in data analysis was applied in accordance with the conceptual framework used in this study. A step-by-step description of the data-collection procedure is given. Lastly, the methods for data analysis and the ethical statements are presented. Attention was also paid to the importance of reliability and validity of the instruments.

The purpose of the diagram presented below is to streamline the presentation of the methodology used for this study. The researcher also endeavoured to enhance continuity and readability.

OBJECTIVES

To determine how the school mathematics curriculum has changed since 1994.

To explore the experiences of Grades 10–12 mathematics teachers regarding curriculum change.

To determine how curriculum change influenced teachers' professional practice.

CONCEPTUAL FRAMEWORK

*Social constructivism theories

*Rogan and Grayson's & Remillard's theories:

*Profile of implementation

*support from outside agencies

*Capacity factors

*Teacher-& learner experiences

*Teacher profile & curriculum change

RESEARCH QUESTION

How does the Grades 10–12 mathematics teachers' experience of the changing curriculum influence their professional practices?

METHODS

*Qualitative research

*Interpretivism as a philosophical worldview

*Purposive selection

*FET mathematics teachers

* Data-collection instrument

*Semi structured interviews

VALIDITY

*Triangulation of the data-collection tool, sources, and theories

*Search for discrepant evidence

*Compare with relevant literature

Figure 5.1: Diagram of research methodology

5.2 QUALITATIVE RESEARCH

Qualitative description was used as the methodology of choice as this study is explorative in nature. The researcher investigated the experiences and perceptions of mathematics teachers as these related to curriculum changes and how they influenced their professional practices. The researcher endeavoured to acquire a deep and rich array of data. Atieno (2009) suggests that when the purpose of a study is to understand phenomena deeply and in detail, the researcher should use methods that reveal themes and fundamental issues, which are, in this case, linked to curriculum change and the professional practice of teachers.

The qualitative method is a systematic and empirical strategy for exploring human phenomena in a social context (Locke et al., 1993). This can be associated with respondents' descriptions and understandings of their experiences. Respondents indicate their perceptions in a qualitative manner.

Creswell (2008) describes qualitative research enquiry as a process of understanding a social or human problem in a natural setting, by gaining a holistic picture from the detailed views of the informants. One of the prominent features of qualitative enquiry is that it is naturalistic. Participants are seen in their natural setting with all its complexities and ambiguities. In this study teachers' experiences and perceptions of the influence of curriculum change on their professional practice were explored in their individual contexts and environments. Data collection took place in their natural setting, either in the participant's office or in the classroom, which the researcher believes helped them to relate better to events and feelings that had to be recalled.

5.3 INTERPRETIVISM AS A PHILOSOPHICAL WORLDVIEW

The preferred methodological approach for this study was Interpretivist, which allowed for the experiences of teachers to be organised in themes and categories that could be interpreted in terms of their social and natural contexts. The interpretivist studies behaviour or some aspect of a phenomenon in an in-depth, rich, and subjective manner. In this manner the meaning and purpose etched in an individual's personal experiences and actions can be arrived at (Du Plooy-Cilliers et al., 2014). Interpretivism assumes that reality can only be constructed through social constructs such as language, meaning, and consciousness (Myers, 2008). The Interpretivist constructs meaning from what is specific, unique and contrasting (Merriam, 2002). The relationship between participants and the researcher should be interactive, cooperative and participative.

This research was interpretive, descriptive and explanatory, which provided an opportunity to understand and give meaning to the study. Operating in this paradigm helped the researcher to understand and interpret teachers' experiences of the changing curriculum and how it influenced their professional practice. Bassey (1999) views interpretive research as a category of empirical research. He describes interpretive research as research that focuses on data collection. Human action must be interpreted to give it meaning.

5.4 RESEARCH PROBLEM

South African learners perform poorly in national and international assessments, despite the fact that a large percentage of the country's budget is allocated to education. This is of great concern to stakeholders such as the government, teachers, teacher unions and non-governmental organisations. Teachers are mainly blamed for poor performance, especially in mathematics and sciences. Mathematics teachers, the focus of this study, are confronted with a constantly changing curriculum, which could in part account for the poor performance of learners. The researcher therefore chose mathematics teachers as the objects of the study, because they are the primary agents in implementing the new curricula. The researcher wanted to obtain rich data to gain a deep insight into teachers' perceptions and experiences regarding curriculum change on their professional practice.

The research problem under investigation is how Grades 10–12 mathematics teachers in the Cape Winelands district have experienced the constantly changing curriculum of school mathematics and how their professional practice has been influenced.

5.4.1 Subsidiary questions

The following subsidiary questions guided my research:

- How has the school mathematics curriculum changed with regard to content and methodology?
- What are the experiences of school mathematics teachers with regard to the continuously changing school mathematics curriculum?
- How has the changed curriculum influenced teachers' professional practice?

5.5 UNIT OF ANALYSIS

The unit of analysis for this study was mathematics teachers' experience of the changing curriculum and how it influenced their professional practice. The unit of analysis was not representative of a large group of mathematics teachers and the findings were not used to make generalisations. The primary objective of this study was to add knowledge to the

themes of curriculum reform and the professional practice of teachers, and to make recommendations to the DoE on how to assist teachers to facilitate the process of curriculum implementation.

5.6 SELECTION

The target group for this study was mathematics teachers in the Cape Winelands district, who taught mathematics from Grades 10 to 12.
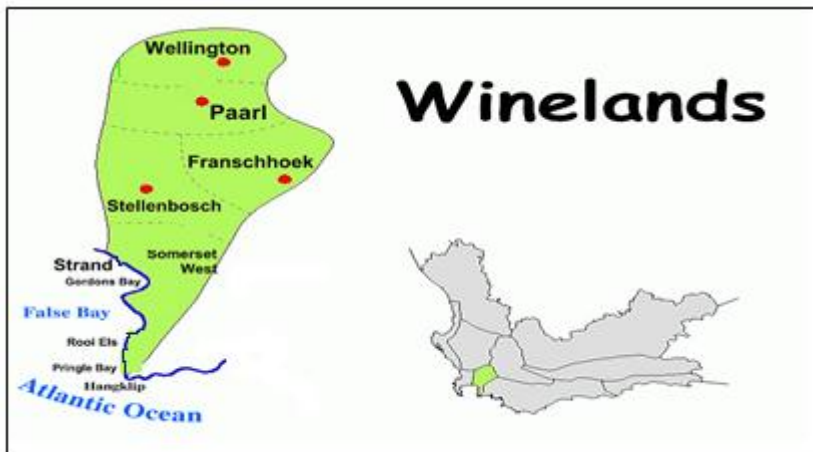
Figure 5.2: Catchment area

*The dots indicate the major towns in the catchment area and participants were recruited from all the red-dotted indicated areas.

A purposive selection method was employed for this study in order to gain rich data from a diverse group of participants, especially concerning their education backgrounds. In this study the population consisted of 58 public high schools, which yielded 107 FET mathematics teachers that qualified for the study. In addition, a convenience selection method was used in which the researcher accessed the schools that reacted to the electronic mail invitation extended to all the schools in the geographic area that met the inclusion criteria (Punch, 2009). Schools from diverse socioeconomic backgrounds, both previously advantaged (ex-Model C schools) and previously disadvantaged schools (ex-coloured and ex-black schools) were selected to obtain a more representative and realistic view of teachers' experiences. The researcher recruited six teachers at six different schools (two ex-Model C schools, two ex-coloured schools and two ex-black schools). Only teachers who had experienced curriculum change during their teaching tenure qualified for this study.

5.7 ACCESS NEGOTIATION

The schools of interest were searched on Google to gain access to their email addresses and telephone numbers. The principals at the target schools were contacted via email and the nature, scope and purpose of the study were explained. In the email, permission was asked for a meeting with the principal and mathematics teachers at the school that met the inclusion criteria, in which detailed information about the study would be discussed. The email was followed by a telephone call, after which the target schools were visited. All the school principals and teachers responded positively. The participants signed the permission forms and a set time was scheduled for the in-depth interviews to be conducted.

5.8 DATA-COLLECTION INSTRUMENT: SEMI-STRUCTURED INTERVIEWS

The purpose of this study was to collect rich and detailed descriptive data on a specific community, that is, mathematics teachers. Semi-structured interviews were used as an appropriate instrument to answer the research question. Semi-structured interviews consist mainly of open-ended questions that reveal themes that may be probed. The interview schedule included the following themes as explored in the conceptual framework: professional practice, teacher training and development, available resources and facilities at the school, teacher support (parental, governing body, senior personnel, the Education Department), curriculum change, content knowledge and viability of the curriculum. Interview transcripts, field notes and documents are primary forms of information in qualitative data, according to Locke et al. (1993). As the site visits continued, field notes were taken to maintain a fresh memory of observations made and to record the researcher's experiences during the study.

The interview as qualitative instrument is beneficial to this research paradigm because of its dynamics in dictating the direction that the interview should go and when the researcher wishes to gain more information on a given theme. It lends itself to move to another theme or area when a theme appears to be saturated. In an interview, which is one-on-one communication, the chances of ensuring accurate and honest answers are exceptionally good (Gay, 1992). Thomas (2011) indicates that the interview schedule reminds the researcher of potential questions, possible follow-up questions, and probes, and encourages the interviewee to say more on these follow-ups. Furthermore, Rule and John (2011) argue that semi-structured interviews allow for more flexibility during the data-collection process. According to Johnson and Christensen (2000), the interview allows questioning to be redirected, ensuring that all questions are answered in full. The interview as data-collection instrument may be time consuming and costly (Bailey, 1994). This instrument was chosen

because of its overall good qualities, which are very beneficial in qualitative research. Therefore it was utilised in this study.

Interviews took place from February 2016 to April 2016 in the teachers' natural setting. The interviews took place either in the teachers' offices or their classrooms. The interview commenced with the nature and purpose of the study. The environment was informal and relaxed for the interview. The next step was to enquire whether there was any uncertainty about the interview or study. Participants were assured that they were not obliged to participate if they did not wish to. Respondents were asked whether their responses could be audio-recorded. After these explanations, respondents were asked to sign the consent form. The interview was then concluded for transcription

5.8.1 Validity of my instrument

The researcher designed the interview schedule taking into account the various constructs on which the theoretical framework was based. Questions were formulated for each of these constructs and sub-constructs to obtain the desired responses from the participants. An expert in the field of mathematics (with a PhD in mathematics) reviewed the process and the questions to validate the tool.

5.8.2 Development of the Interview schedule

The first part of the interview schedule required personal questions such as why participants had decided to become teachers, specifically mathematics teachers, and how they experienced the teaching of mathematics as a subject.

The second part of the interview schedule asked questions relating to their perceptions of curriculum reform. Teachers needed to distinguish between the different curricula and the amendments that had taken place in the content, pedagogical methods, and techniques.

Part three focused on issues pertaining to school-based factors that could influence the implementation process. Questions were asked about the availability of resources and facilities at the particular school, the management structures and management style, and initiatives such as support programmes developed for teachers.

Part four asked questions related to possible factors beyond the school context that might influence the implementation process, for example NGOs' assistance with professional development and training, resources, equipment, and buildings.

Part five interrogated the curriculum implementation process and how the level of interaction and engagement among learners in the classroom was influenced by the constantly

changing mathematics curricula. Questions were also asked regarding the fluctuating assessment criteria of the different curriculum statements.

Lastly, important questions that could provide greater insight into teachers' experiences were added to ensure that all possibilities were covered.

5.9 DATA ANALYSIS

A thematic analysis was used in this study. Themes and categories were developed in accordance with the constructs deduced from the literature exploration and the conceptual framework. A deductive approach was followed as the researcher assigned the data to the various themes and categories (Zhang & Wildemuth, 2009). The conceptual analysis framework, which was developed by combining the work of Rogan and Grayson and that of Remillard, guided the interpretation and analysis of the data. The researcher ascertained the relations between the different categories. When the concepts were described similarly, it served as an indicator that the theme had been saturated (Smith & Osborn, 2007). The purpose of this study was to make recommendations derived from the data collected.

Open coding was applied for the data obtained from the interviews, which was a line-by-line coding. The researcher read through the entire text for an overall understanding of the text. Concepts related to the words of the participants were identified and documented. These concepts were placed into bigger categories (Du Plooy-Cilliers et al., 2014). Audio-recordings were transcribed verbatim. The interviewer asked herself frequently what the data meant (Smith & Osborn, 2007).

The stages in the analysis process:

The aim of the process of analysis was to produce a detailed and systematic record of the themes and issues addressed in the interviews and the linking of the themes and interviews under a reasonably exhaustive category system.

1. Notes were made during and after each interview to record perceptions and information that could be insightful for the discussion section. Notes were also made on a continuous basis throughout the study (Burnard, 1991) to reduce possible recall bias.

2. Transcripts were read attentively and notes were made throughout the reading of the transcribed text in an attempt to become immersed in the data. This process of immersion was used to be drawn into life-world of the respondents.

3. Transcripts were reread and as many headings that could be attached to the respondents' words were written down to describe all aspects of the content.

4. The new list of categories and sub-headings was worked through, omitting repetitions or very similar headings to produce a final list.

5. Transcripts were then reread alongside the final list of categories and sub-headings to ascertain to which extent all aspects of the interviews were covered.

6. Each transcript was worked through with the list of categories and sub-headings and coded according to this list. To distinguish between each piece of the transcript that was assigned to a category or a sub-heading, different colour highlighting pens were used.

7. Each coded section of the interviews was cut out from the transcript and all items of each code were placed together.

8. All the sections were filed for the writing up of the findings. Copies of the complete interviews were kept at hand during writing, and also the original tape recordings.

5.10 VALIDITY AND RELIABILITY

Even though validity varies in quantitative and qualitative research, it tests the quality of data and results in both (Creswell & Piano Clark, 2007). Mustafa (2011) considers validity to be a tool for determining whether the research indeed measures what it intended to measure, or how true the results are. Reliability determines whether the study can be reproduced when using a similar methodology (Lewis, 2009). In a qualitative study there is a distinction between internal and external validity, and internal and external reliability. Internal validity refers to the credibility, while internal reliability focuses on the dependability. External validity refers to confirmability, while external reliability pertains to the issue of transferability.

Credibility:

To ensure the credibility of the findings, the researcher developed a semi-structured interview guide that was used consistently during all participant interviews. This ensured that the phenomenon was clearly operationalised during all interviews. Further enhancing credibility, the researcher engaged with the data for prolonged periods, and based on this, identified the need for including participants with different experiences and backgrounds, and by doing so, ensuring variation and dimensionality of the core concepts. Measures were put in place to account for the accurate interpretation, reconstruction and recording of the meanings that participants attached to their words. When the researcher was unsure what respondents meant by particular statements during the interview, the researcher explicitly enquired about the true meaning of the respondents' words.

Transferability:

The transferability of the findings was done by providing sufficient information on the past and current educational context in South Africa, different models of schooling, socio-economic disparities, and differences in organisational capacity, among others. As such, readers and researchers should assess whether the results of this study are transferable to their local context. The researcher, throughout the process, paid attention to the responsibility to ensure that the process was logical, traceable and well documented to ensure the dependability of the study (Lambert, 2012).

Dependability:

Dependability is further enhanced by a clear description of the research design and its implementation, as well as operational detail of data gathering. The process as presented by the researcher was as clear and detailed as possible to produce the same or very similar findings given similar contexts (Creswell, 2003).

Confirmability:

To ensure confirmability, all information regarding the process and data collected was kept to serve as proof that the data and interpretations of the research enquiry were not fabricated and that the entire research process was scrutinised (Shenton, 2004). Furthermore, deep briefing sessions were held with a mentor. The researcher also kept a reflective diary to evaluate whether personal assumptions and biases influenced the analysis process.

5.11 ETHICAL CONSIDERATIONS

One of the key aspects of good research is to ensure sound ethical practices (Du Plooy-Cilliers et al., 2014). It is therefore crucial that ethical methods are implemented to enhance the quality, reliability and trustworthiness of the research.

Prior to submission of the research proposal, permission was obtained from the principals of the target schools, as well as the WCED to conduct the study. Permission was obtained from the Cape Peninsula University of Technology (CPUT) to conduct the study before it was undertaken. The researcher requested permission, in writing, to gain access to schools and prospective participants. Prospective participants' rights to privacy were assured and anonymity was guaranteed. Participants were assured that they could withdraw from the study at any time without any harmful consequences. They were asked to read the consent

forms carefully and were given the opportunity to ask questions before signing the consent forms.

In order to ensure anonymity, participants were assigned a pseudonym, which applied right through the entire study. This name was used as reference in all documentation. Participants were informed, prior to the data collection, that findings of the study would be published, but confidentiality and anonymity would be observed. The researcher assured the participants that the collected information from this study would be used for the sole purpose of this study, and would not be disclosed to any unauthorised parties (Babbie, 2011).

5.12 CONCLUSION

The study and research design were contextualised for this study. The whole process of data analyses was described in detail. Special attention was paid to promote and ensure validity and reliability of the methods and instruments used for this study. Sound ethical practices were adhered to in this study.

CHAPTER 6

PRESENTATION OF THE DATA

6.1 INTRODUCTION

This chapter discusses the process of data analysis aligned with the main themes presented in the conceptual framework in Chapter 4. The major themes are: profile of implementation, support from outside agencies, capacity factors, teacher experiences, and learner experiences. A deductive method of analysis was used in this research. This chapter presents the data as an initial application of the conceptual framework. The next chapter discusses the findings of this chapter in detail and makes inferences between the data collected and the literature explored in this study.

The study focused on Grades 10 to 12 mathematics teachers in the Cape Winelands district. Interviews were used as data-collection instrument. The main aim of the study was to investigate mathematics teachers' experience of the changing curriculum on their professional practice in ex-model C schools, ex-coloured schools and ex-black schools in the Cape Winelands district. The researcher interviewed six teachers at six different schools: two teachers at ex-model C schools, two teachers at ex-coloured schools and two teachers at ex-black schools.

6.2 PROFILE OF THE TEACHER RESPONDENTS

The table overleaf represents the demographic information of the participants. It sets the context in which the data was mined. The following items are presented in the table: pseudonyms, age, gender, qualifications, years of teaching experience in the FET phase, years of teaching mathematics in the FET phase and post level.

Table 6.1: Teacher profile

Respondent	School	Age	Gender	Qualifications	Years of teaching experience (FET)	Years of teaching in Mathematics (FET)	Post level
Respondent 1	School A	44	F	BCom (Maths)	23	23	HOD
Respondent 2	School B	61	F	BSc HED	38	38	HOD
Respondent 3	School C	49	M	BEd Hons (Math Education)	20	15	HOD
Respondent 4	School D	60	M	PTD 3 Phys Ed, DE4, BA, BEd	36	30	Senior teacher
Respondent 5	School E	49	M	BSc (Education)	24	24	Senior teacher
Respondent 6	School F	49	M	BSc (Education)	20	20	HOD

A total of six participants, two women and four men, participated in this study. Pseudonyms were given to the participants to ensure anonymity and throughout the data presentation and discussion of data reference is made to the respondents according to their pseudonyms and the pseudonyms that apply to the six schools. It is interesting to note that all the teachers, except two, shared more or less the same age and almost the same levels of experience in the profession. The average years of teaching experience was 27 years and the range 18 years. It was expected that similar opinions and perspectives would be found, especially among those who shared similar contexts. Also, all the respondents had experience of the major reform, OBE. All of the respondents met the inclusion criteria, having taught mathematics in the FET phase and having experienced curriculum change. One respondent had an honours degree in mathematics, three respondents had BSc degrees, one had a BCom mathematics degree, and one a primary teaching diploma, BA and BEd. Four respondents taught mathematics in the FET phase when they started working as educators. The other two respondents started teaching mathematics a few years after commencement of their teaching careers. Interesting to note is that four of the respondents presently hold

the position of HOD at their respective schools and the other two teachers are senior teachers, which could make for very informed data.

6.3 ANALYSIS OF THE INTERVIEWS

6.3.1 Theme 1: The profile of implementation

The profile of implementation encompasses the factors that will have an effect on how the process of implementation is enhanced or hindered. This section considered the following subthemes: coverage of learning areas, language of instruction, classroom interaction, and assessment practices.

6.3.1.1 Coverage of learning areas

The first sub-theme is concerned with all the learning areas in mathematics that are affected, and whether teachers are adequately equipped with content knowledge and appropriate methodological knowledge to deal with the areas effectively. It was also asked whether learners were sufficiently equipped with the prerequisite knowledge to cope with the new learning areas.

Teachers' knowledge regarding new learning areas in mathematics

All the teachers in the cohort expressed the need for well-qualified teachers that could deal with the complete mathematics curriculum. They were concerned whether college-trained teachers were fit for practice, especially when their teacher training did not go beyond the school mathematics curriculum. They cautioned against teachers in the new dispensation that were not trained in geometry. The concern was whether teachers who had not done geometry as part of their school curriculum could teach this component of the mathematics curriculum effectively.

Respondent 2 commented,

> "The teacher that never did it (geometry) in school, you get the teachers that matriculated in 2008 and they can teach a child geometry without having the background, so it must be very very difficult, you find yourself in a setup where your young teachers struggle to instruct geometry and probability that are difficult concepts. If you do not have senior teachers that could help those learners and teachers!"

The general perception is that mathematics is a subject that requires abstract thinking, because you are continually confronted with new ways or alternative ways of solving

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problems. Mathematics teachers are thus used to applying themselves in order to best teach their learners.

Respondent 3 remarked,

> "Ja you see sometimes the teacher training won't cover everything; you see it's up to the educator all the time to develop themselves; you see that's what you call teacher development. Lifelong yes, you need to be a lifelong learner forever so to speak the truth, you won't get everything in your training but you need to develop yourself. The point is to prepare well all the time. In maths there's always something that will amaze you."

Teachers' methods

All the respondents were aware of the different methodology that was required by OBE; however they primarily continued with the method they knew best, "talk and chalk". Their reasoning was that mathematics was a subject that needed to be explained and practised. Teachers therefore used a slideshow program, like PowerPoint, and allowed learners to help one another and to explain their methods to the class.

Respondent 1 commented,

> "I think we more or less instructed like the old teacher where you chalk and talk on the blackboard, where you go sit and bring in technology like PowerPoints and those things and it is still very hard work."

Respondent 5 concurred as follows:

> "By me there was no change to my learning and instruction, like I did before I still now do precisely the same, oh no, the way knowledge is transmitted, has really not changed. All that is different at this stage, I will bring in the computer, especially with graphs, I will show such things etcetera."

Respondent 6 remarked that the integration between themes in OBE posed considerable problems to learners that were not academically very strong. The different approaches that learners used to solve problems caused confusion to learners that had not yet mastered the basics.

Learners' knowledge to cope with the new Learning Areas

Geometry and particularly circle geometry was the topic in the mathematics curriculum that was most challenging to instruct and very difficult for learners to grasp at all of the

participating schools. One respondent claimed that only 15% of mathematics learners on average understood geometry, because it required a broad mindset.

Respondent 2 remarked,

> "Learners in front of you do not understand geometry, so they basically have to do it with recipes, recipes or they leave out these questions and these questions are answered the weakest if you look at the analysis, because they aren't well trained to have a wide vision of seeing what they should see."

Other concepts in the mathematics curriculum that learners found difficult were probability and graphs in algebra and trigonometry. Respondent 4 mentioned the teachers' need to empower themselves with knowledge and ways to explain graphs as they expected that learners would be challenged by it. Respondent 3 mentioned the particular problems that learners encountered at a school with word problems in probability, linear programming and financial maths when the language of learning and teaching was not their mother tongue.

Respondent 6 stated,

> "It's new, the other things that the probability is like financial maths, it's a lot of words. So then they have to read. They're reading yes yes yes. So those things make it more difficult to teach for example a Xhosa learner."

6.3.1.2 Language of instruction

The language of instruction of the school should be aligned to the needs of its learners and schools should make every effort to provide instruction in the language of preference of their learners, because it leads to better academic performance (Bohlmann, 2001). It is thus important that structures are put in place to deal with the problems associated with the language of instruction.

The issue of learners being instructed outside their mother tongue has not been adequately addressed and resolved. More should be done to assist schools in addressing this problem effectively. In this cohort, schools still predominantly maintained their historic language policy.

Respondent 2 stated,

> "We only have Afrikaans. We do not have any support structures in place. Everyone is just Afrikaans."

Most schools in the catchment area are Afrikaans medium or dual medium (Afrikaans and English). The respondents made no mention of any problems. Most problems arise for isiXhosa learners that are taught through the medium of English, where the only known method of assistance is code switching, given that the teacher is conversant in isiXhosa. Unfortunately no notes may be given in isiXhosa, because all question papers are only in Afrikaans or English.

Respondent 3 responded in the following way,

> "In Xhosa just to break down the content so that the learner could gain a better understanding of the work but we are not allowed to teach in isiXhosa. Because if you do that there will be questions in the maths paper being asked in English that the learner will now struggle to answer, because he was always taught in isiXhosa. So that helps a lot in teaching English. There's no exam papers in isiXhosa, everything is in English."

More problems are encountered by learners taught by teachers who do not speak isiXhosa. Likewise, these teachers find it hard to teach mathematics, which requires abstract thinking and especially certain themes that require a good understanding of the language in which the question papers are set.

6.3.1.3 Classroom interactions

Classroom interaction is strongly determined by the type of methodology that the new curriculum requires. Classroom activities and practices should be altered according to the curriculum demands. Teachers' training and their own experiences as learners serve as a good predictor for their own form of interaction in the classroom. All the respondents agreed that the interaction in the classroom definitely changed in some manner. They ascribed it to factors like being born into the technology age, where they instantly have access to information, which improves their critical thinking skills. Learners do not automatically accept the teachers' views and explanations. They also question the usability of certain content in real-life circumstances.

Respondent 1 stated,

> "I will say that it is not because of the changed curricula that learners are more outspoken and interactive, but more the way that they are raised. They ask more questions like why they have to do certain things or where they will use it and so forth. So the general tendency is that they will not just sit like dolls taking everything in, but are more curious than before."

The respondents ascribed the changed classroom interaction to a lack of discipline in the classroom because the tendency is that learners increasingly show disrespect towards teachers and are more outspoken.

Respondent 6 commented,

"I think it changed because now as I said in the beginning they showed a lot of respect but now not anymore. Ja, we are pals now."

In addition, Respondent 5 elucidated,

"That there in '94 or thereafter till 2000 you were still master and children still learners but today's learners are totally different, they have a different manner, a totally different attitude so that I can almost say that we have a weaker type of learner today in regard to attitude and manners."

The respondents agreed that learning through discovery was not workable, owing to time constraints, and the fact that learners could become more confused by different methods. They emphasised the importance of continuous exercises being drilled in, which led to better performance in tests and examinations.

6.3.1.4 Assessment practices

The assessment practices required by the new curriculum could be a strong determinant of the ease of implementation of the new curriculum. If assessment practices differ significantly from the previous curriculum, more problems could be encountered with the implementation process. For teachers, assessment boils down to the final exams and especially to the Matric final examination. OBE was very unclear about assessment and teachers more or less had free reign on how and what to assess. It was a phase of great uncertainty. NCS attempted to streamline assessment and the CAPS is very specific about how and when assessment should take place.

Respondent 3 commented,

"It did change for the mere fact that in the olden days educators were sort of deciding on their own what to teach and what to assess up to CAPS you see where by all educators now are given pace setters that dictates what to teach and what to assess."

All the respondents agreed on the benefits of the CAPS with regard to its assessment profile. Teachers were concerned about the format and weighting of the different areas

tested in the examination but also about the type of questioning. Because cognitive skills are increasingly tested, teachers have to develop skills to draw up challenging question papers to prepare their learners well for the final Matric question papers. Teachers then use this information as a platform to acquaint their junior learners with the same standards set for Matric learners. The respondents mentioned that the assessment for Grades 8 and 9 differed greatly from that of Grades 10 to 12. The formative-summative relationship for Grades 8 and 9 was 75:25 but for Grades 10 to 12 it was 25:75. This could account for the low pass rate in Grade 10. The problem with the high formative assessment mark is that it is not a true reflection of learners' abilities because they get help from peers and family and in some cases it is altogether not their own work. A few of the respondents shared the following remark from Respondent 5,

> "The tasks and projects that learners do with other learners do not reflect what they can really do, because they can copy others' work or can get help from each other or even from their family or parents."

6.3.2. Theme 2: Support from outside agencies

Support from outside agencies refers to the involvement of outside organisations, such as departments of education, aid agencies or teacher unions, to influence (either by support or sanction) implementation practices. In many developing countries, outside agencies may also refer to international development agencies and local or international NGOs. The sub-constructs are divided into two categories: material support and non-material support. Material support may include provision of physical resources such as buildings, books, or apparatus, and direct support to students (such as school feeding schemes). Non-material support is mostly provided in the form of professional development.

6.3.2.1 Teacher professional development

Unfortunately this construct is clearly underdeveloped in the South African context. Professional teacher development is only undertaken by the DoE and in our context, by the WCED. All the respondents mentioned that professional development by outside agencies was completely absent. Respondent 6 remarked,

> "There is no NGOs that give training or workshops here!"

6.3.2.2 Provision of physical resources

The respondents reported that support in the form of physical resources by outside agencies was very limited. It appears that there is a lack of information about available avenues that

could be explored by schools in search of sponsors for physical resources. Respondent 1 reported that her school had received extra mathematics textbooks only once, while respondent 2 could only think of the Pegasus programme that allowed all the best learners to be grouped in a class so that they could be stimulated. Respondent 3 was unaware of any provision of physical resources by NGOs. Respondent 4 mentioned that they had acquired minibuses through Wayne Ferreira, a well-known former tennis player. The school also received undisclosed resources from Mark Shuttleworth. Respondent 5 and 6 mentioned that their schools had not received any physical resources from any NGOs.

6.3.2.3 Monitoring

One way of bringing about change or reform is for outside agencies that support schools to exert pressure on these schools to perform well. The respondents reported an almost complete absence of any form of monitoring by NGOs. Only Respondent 3 remarked that an NGO had visited their school to ensure that its programme was used and to establish the extent of use.

6.3.3 Theme Three: Capacity factors

The construct *capacity factors* are concerned with factors that are likely to support or hinder the implementation of new ideas and practices in the new curriculum. This construct recognises that schools differ in terms of their capacity to implement innovations. Possible indicators fall into four categories: physical resources, school ethos and management, teacher factors, and student factors.

6.3.3.1 Physical resources

Physical resources are crucial as poor conditions and limited resources can limit the performance of even the best teachers and students.

Most of the respondents' remarks could be interpreted positively regarding the availability of physical resources to support their capacity to implement new curriculum reforms. All the respondents mentioned the availability of white boards and projectors that could enhance the learning and teaching experiences of learners and teachers. The education department provides a lot of teaching aids like extra books and guides, especially with new curriculum reforms. Furthermore, advantaged schools were in a position to claim whatever they needed from their school's budget and steps were continually taken to expand and develop the experiences of teachers and learners. One respondent mentioned that the provision of Wi-Fi by the WCED is in the pipeline, which will give access to the Internet at all times. Teachers at previously disadvantaged schools were excited about the innovations and new

technology, because under apartheid rule they were marginalised and overlooked. Teachers now need proper training in the new technologies. Teachers are also aware of online math programs that can be accessed on cell phones, but are still investigating their benefits. Two of the respondents referred to Geogebra, a graph math application, considered a handy tool to explain graphs. One respondent cautioned that the availability of resources did not guarantee success with implementation because the school could be in such disarray that the school's resources and teaching aids were "unproductively utilised".

Respondent 5 explained,

> "We have math programs, but not using the resources: You have a class of 45 so you cannot really work with the computers. Also you have 38 periods; when will the learners have the opportunity to gain access to use the computers? We have the computers, but the necessary planning to use them is not done. The computer has to be switched on and the correct program has to be uploaded."

6.3.3.2 School ethos and management

The school ethos and management are distinct concepts, yet they are considered together as they are closely intertwined, particularly at schools in developing countries. If the school is in disarray and not functioning well, innovation cannot or will not be satisfactorily implemented. The leadership role of the principal (at the head of management at school level) is crucial in the implementation of education reforms (Fullan, 2008). Four of the six respondents reacted positively that the school ethos was upheld and that their principals were instrumental in motivating the staff. The respondents made mention of their principals' supportiveness, openness to change and vision, with a strong academic inclination and a sincere interest in the curriculum, especially in the math curriculum. One respondent commented that the entire teaching staff collectively was responsible for the upholding of the vision and ethos of the school.

Respondent 2 declared,

> "He has extremely strong structures in place. His academic inclination is unbelievable, because in his budget he will firstly make provision for teachers' needs, for technology and teaching. The teachers' morale is high."

Two respondents described their schools as poorly functioning schools, and criticised the poor leadership of the schools for a lack of guidance, which negatively influenced the school culture. Furthermore the school was characterised as a 'loose' school, where learners walked around during teaching hours.

Respondent 5 testified,

> "I am going to be honest. At our school it is very weak. Here you as teacher have to fight for what you want in your class, because here is no vision at our school, my honest opinion, and the leadership is very weak. The teachers had to find their own way with no assistance from the principal."

6.3.3.3 Teacher factors

Many different factors concerning their teacher training, subject knowledge, professional development, motivation and beliefs and expectations influence teachers' capacity and willingness to implement change. The teacher can bring confidence with his/her teacher training and subject knowledge to the classroom, or a lack of it. Teachers can also be highly motivated or poorly motivated or could hold optimistic beliefs and expectations or negative ones. All of these factors could influence teachers' abilities to adapt to curriculum changes and reforms.

All six respondents declared that they were confident about their teacher training and subject knowledge. Furthermore, they were open to change, and even welcomed change.

Respondent 1 commented,

> "For me everything was still positive, so I am positive about change, but it should not be as frequent as the past 20 years. I had 4–5 syllabi in the last 20 years."

More than one respondent was even excited about the changes in the country and especially the changes in education and in the curriculum.

Respondent 3 enthused,

> "Clearly they are excited because really some of the educators were teaching during the time of apartheid."

Respondents who were not part of the former establishment were motivated by the political and curriculum changes in the sense that they could now operate on an equal footing with everyone else.

Respondent 3 elucidated,

> "I'm also a product of apartheid and the way learners were handled that time as far as curricula were concerned and everything and the fact that all the learners were forced into Afrikaans, so my intention was to make a mark in the teaching of

mathematics, to bring up the black society at least so that they also have geniuses in mathematics."

Concerning the morale of mathematics teachers, respondents contended that teachers always have to be excited about acquiring new knowledge. They should always promote the interests of their learners in order to ignore all the negative factors that influence their teaching. Teachers should always maintain a spirit of positivity, thus doing proper planning and also enjoying what they are doing.

Respondent 4 stated,

"Generally I believe that too much negativity seeps in; we should not allow that all the negative factors influence you or discourage you. Then there are learners coming from circumstances that you really should admire."

Teachers who are passionate about teaching and the teaching of mathematics will be in a better space to deal with reforms, even if they initially doubt the feasibility of the proposed reforms. Teachers who are indifferent towards their profession of choice are poorly motivated, and will bring an indifferent attitude to the classroom and will in all likelihood resist curriculum changes and reforms.

All the respondents acknowledged the importance of professional teacher development, especially in the face of curriculum reforms. Mathematics teachers come from different academic backgrounds and in a developmental context, teaching mathematics is considered a scarce skill, a skill that, however, can bring about great improvement if developed adequately. The WCED embarked on training sessions and workshops to try to fill the knowledge gap with mixed success, according to the respondents. One respondent claimed that these training sessions were not very successful because they did not differentiate between who needed the training and who did not benefit from the sessions.

Respondent 5 argued,

"It must really be focused on specific sections. Teachers that are in need must be asked with what they struggle so that they could focus on that section."

Respondent 6 remarked,

"They give training for only one day about the new content like probability from Grades 10 -12. They should prolong the thing; they should make it continuous throughout the year."

Another respondent felt that the mathematics subject team should direct the path that the implementation process at their school should take.

Respondent 1's comment,

> "So yes, it is basically what the school does, it depends truly on the subject teacher how you are going to handle the curriculum change and implement it."

Two of the respondents provided favourable comments on the initiatives of the education department and claimed that the department always endeavoured to provide good training for its teachers. One respondent praised the education department for its content workshops to help teachers with problematic content, after the results had been analysed.

Respondent 3 stated,

> "You see and what I love about the department now is that there are content workshops that are always focused on those topics that are problematic in all the schools."

The most unfavourable criticism was towards the training sessions for OBE, which envisaged a completely new methodology.

Respondent 1 quipped,

> "They want to perform outcomes-based education on us; we have to do a mind map on something, but I'm not into drawing pictures; I would have done arts if I wanted to draw pictures. We had one session, but when the tea break arrived, three quarters of the group walked out. We just could not take it."

The respondents claimed that everyone (representatives of the education department) was at sea with the new curriculum but as time passed, the teachers learned to cope better. Respondents also remarked that the quality of leading and supervision improved with time.

6.3.3.4 Learner factors

The backgrounds of learners and the kind of strengths and constraints they might bring to the school and the classrooms are crucial factors. Student attitudes to learning and responses to change are influenced by different factors, which include their home environments, parental commitment to education, health, and nutrition.

According to the respondents of this study, the greatest challenge that schools face is their learners' poor socioeconomic circumstances. Even the previously advantaged schools report

that some of their learners suffer poverty. One of the respondents claimed that about 80% of their learners lack the bare necessities of life and the food they receive from the feeding scheme could be their only reliable source of food. Most learners cannot come to school after heavy rains because everything in the shack is soaking wet. Another major problem in the teaching of mathematics is the paucity of scientific calculators and geometry instruments.

Respondent 5 explained,

> "But with time I encourage them as soon as they get to Grade 10 to buy a scientific calculator so that by the end of Grade 12 every learner is supposed to have a calculator. It is imperative for financial mathematics, but also for trigonometry and statistics."

Respondents from more advantaged schools reported that most of their parents were very involved with their children's education. They assist with their children's education and also with the school programme with regard to both curricular and extracurricular activities. Some schools require school fees, which could range from a meagre sum to a quite substantial amount. Other schools are free but require a small registration fee, which is augmented by regular school functions.

Respondent 3 noted,

> "Yeah, the learners of this school come from a very poor community and as a result our school is a no-fee school, you see, and so the government pays a certain amount per learner every year. There's a small contribution that we ask for registration; R100 for each learner to help with other things."

Even respondents from very disadvantaged schools agreed that mathematics was highly regarded in their communities and teachers tried to raise the level of involvement of the parents so that the learners could see that their parents were interested in their schoolwork and become more motivated.

Respondent 3 commented,

> "The parents are involved in a way, not 100% but we call them for grade meetings, where we discuss the learner performances, the grades per class. I call my class parents of 10A to come this side to discuss the progress of learners in mathematics. You know, mathematics is the thing, is the thing. We discuss and try to advise, so that those who can afford, please try to get a tutor to assist the learner and get the learners to do the homework, even if the parents aren't very educated but for the fact

that you can take that book, look through that book, sign or make a cross somewhere in that book – that will help the learner see that, hey my mother will check my book, so I must do my work."

The respondents noted that learners came with negative attitudes to the classroom because they were pushed by parents to do mathematics. Now they are pressured even more because they do not have a choice between Higher and Standard Grade.

Respondent 2 elucidated the situation,

"Where you earlier worked with learners who really wanted to study mathematics, you now have learners who do not want to. You now have this huge group who thinks differently. You do not have time to develop their insight into the work. You now have to deal with the terrible negativity of learners who did not really want to do the subject."

In addition, Respondent 4 remarked,

"Eighty percent of the learners come from such low socioeconomic backgrounds that what they have, they break down. They steal, they stay [away] from school, and they leave their books at home."

6.3.4 Theme 4: Curriculum reform

Teachers' involvement in the planning of the curriculum

The teachers are central to teaching and learning as they are the primary facilitators and assessors of student knowledge. It is therefore wise to value and hold their expert opinion in high regard. Education departments could save considerable effort, time and financial resources if they do not neglect to include teachers across a wide spectrum in the decision-making process regarding the proposed curriculum changes and reforms. One respondent has been involved across a wide spectrum throughout the reform process. Not only is the respondent on the national examination panel, but is also the chief examiner of the Grade 12 mathematics first paper, which is very beneficial to the specific school where the positions of subject head and head of department are held. All the other respondents denied that they had any say or involvement at all at any stage of the reform process. Anecdotally, a few selected teachers, who are actively involved in teaching, are involved in the process of curriculum change and reform.

Initiatives and structures to enhance the implementation process

The general perception was that more could be done by those who initiated the curriculum changes and reforms to enhance and ease the implementation process. The respondents of this research study could mention only limited attempts by the WCED in the form of initiatives and structures. The most common initiatives employed by the education department for mathematics are short courses and workshops. All the respondents reacted to the OBE initiatives in completely unfavourable terms.

Respondent 5 summed OBE up with the following words,

> "I'll first speak about the outcomes-based one. That workshop that they presented – oh no! A lot of them really didn't know a thing, because they do not stand in a class and they do not know the circumstances in the class situation. They are a little out of touch and this is why OBE did not work."

Another initiative was the exemplars that were made available to schools. Respondent 1 commented,

> "The exemplars are of a good standard, but did not prepare the students for what awaited them in November. It is good preparation, but we have to tell the learners that they cannot only learn from question papers."

Some of the respondents also referred to the help that could be acquired from the subject advisors. Respondent 1 continued,

> "Then there are the subject advisors that you can contact when you are unsure. You can telephonically call them or email them if you do not know how to interpret the CAPS document."

Teachers' perceptions of curriculum change and reforms

Teacher's perceptions should be interpreted against the backdrop of where they come from. Before the democratic elections of 1994, different education departments existed, with separate curricula, assessment profiles and examination boards. These departments were divided along racial lines. White education was superior to the education of the other racial groups. Along the continuum, black people, who constitute the majority of the South African population, were served by the Department of Education and Training, which was considered the worst of the education departments. As far as mathematics was concerned, the gap was even wider, because whites were prepared for careers that required a high level of mathematical thinking, like engineering and aviation. All the respondents welcomed the

curriculum change for different reasons. Respondent 2 mentioned that he/she could not complain about the curriculum changes because he/she had been part of the entire process and had first-hand knowledge of these changes. He/she had very favourable opinions about the WCED. One respondent pointed out that reforms in education should be well thought through and well planned, and should never be superficial.

In this regard Respondent 5 exclaimed:

> "The changes that are made should not be just to make changes, as I have gained the impression that it was with the changes brought about in mathematics. Why is all the content that was left out after 1994 back with CAPS? My feeling is that if changes have to be made, the universities should determine what should be taught in mathematics for those students who will study in engineering [or for] a medical career or a business career."

Experiences of teachers and learners as they engaged with the curricula

Two respondents mentioned that the one grade mathematics curriculum post 1994 was problematic in the sense that learners with little ability were grouped together with learners of exceptional ability. Furthermore, many learners did not want to study mathematics; however they persisted at the insistence of their parents. Also teachers who were used to teaching on the higher grade found the teaching of mathematics in the senior groups less stimulating and rewarding.

Another major problem with the new curriculum was the huge gap in the level of difficulty between Grades 9 and 10. In addition, Grade 10's lacked certain knowledge that they should have acquired in Grades 8 and 9 and did not gain, which led to many failing maths in Grade 10.

Respondent 1 commented,

> "The gap between Grade 9 and Grade 10 is extremely great; I would say that they should make provision for these changes from Grade 1. But now they have to start in the middle of nowhere. These gaps are hopelessly too big, and demotivate the children."

Geometry was omitted from the curriculum post 1994, but analytical geometry was kept in the curriculum. All the respondents are of the opinion that learners need some knowledge of geometry to do analytical geometry. It is thus clear that with the proposed changes, adequate consideration was not given to all aspects that should have been considered.

The problem that respondents had with the NCS was that there was no prescribed sequence in which content should be taught; therefore learners that moved from one school to another could encounter great difficulties. The CAPS also poses certain problems in that content that learners found easier (like transformations) was removed, while difficult content (circle geometry) was reinstated in the curriculum. These changes made the curriculum overloaded with content. The CAPS provides pace setters that teachers find difficult to keep up with.

Respondent 1 noted,

> "It is difficult because they work with weeks and we work with cycles. Even if you drive yourself you sometimes cannot complete the quarter's work. It must then stand over for the next quarter."

One respondent mentioned that with the inclusion and exclusion of content, teachers were confronted with content that was not covered in their teacher training. The education department arranged for courses for teachers to acquaint themselves with those topics.

6.4 CONCLUSION

This chapter presented the data according to the constructs that underpinned the study as set out in the conceptual framework designed for this study. The next chapter accordingly discusses the data as presented in this chapter by making inferences between the data collected and the literature explored in this study.

CHAPTER 7

DISCUSSION OF THE DATA

7.1 INTRODUCTION

Chapter 6 deals with the presentation of the data. The conceptual framework was used to sift the data as a sense-making process of the respondents' words. Four main themes, namely, profile of implementation, support from outside agencies, capacity factors and curriculum reform, were distilled. In this chapter these four themes are discussed. Social Constructivism was employed as a broader theoretical backdrop against which the interpretation was conducted. Each thematic discussion consists of two parts: first, a reflection on the findings, and second, a discussion of the findings. This chapter presents a detailed discussion and make inferences between the data collected and the literature explored in this study.

7.2 DISCUSSION OF THE FINDINGS.

7.2.1 Theme 1: The profile of implementation

The profile of implementation encompasses the factors that will have an effect on how the process of implementation is enhanced or hindered. In this section attention was paid to the following subthemes: coverage of learning areas, the language of instruction, classroom interaction, and assessment practices.

7.2.1.1 Coverage of learning areas

Teachers' knowledge regarding new learning areas in mathematics

This sub-theme investigated the learning areas in mathematics affected by the curriculum change. Various researchers, like Darling-Hammond (2000) accentuate teacher content knowledge as a key predictor for learner success in the classroom. Furthermore, teachers should possess sound pedagogical knowledge and skills to deal efficiently with the proposed new learning areas.

The first sub-theme is concerned with all the learning areas in mathematics that are affected, and the question is whether teachers are adequately equipped with knowledge and appropriate methods to deal with the areas effectively and whether learners are sufficiently equipped with pre-knowledge to cope with the new learning areas.

In South Africa poor mathematical content knowledge of teachers is advanced as one of the reasons for learners' poor results in national and international assessments (Centre for

Development and Enterprise, 2011). It was found that teachers' poor understanding of concepts resulted in incoherent and illogical explanations, which learners found difficult to comprehend (Bansilal, 2012).

Central to this debate is whether teacher training at South African education institutions yields mathematics teachers that are fit for practice. In addition, the enormous discrepancies in teacher qualifications between the previously advantaged and disadvantaged cannot be ignored. Various factors account for these discrepancies. The worst scenario in disadvantaged schools is that some mathematics teachers have no formal tertiary education in mathematics, which could be a consequence of the former segregation of education (Rogan & Grayson, 2003). Furthermore a very small proportion of learners take mathematics as subject, therefore in many disadvantaged schools only one teacher is responsible for the senior classes. As a result it frequently happens that newcomers to the profession teach Grade 12 mathematics, which could be very challenging in the sense that they are not afforded the time to develop with the curriculum.

Respondent 2:

> "You find yourself in a setup where your young teachers struggle to instruct geometry and probability; that isn't easy, [they] are difficult concepts and uhm if you do not have senior teachers that could help that learners and teachers."

All respondents in this study but one have a university qualification with mathematics as subject. They are all confident with regard to their teacher training, which was on a higher level than the school mathematics curriculum. One of the respondents raised the opinion that mathematical content cannot change, but that curriculum change is merely a process of inclusion and exclusion of content. They are concerned whether college-trained teachers are fit for practice, especially when their teacher training did not go far beyond the school mathematics curriculum. They question whether teachers, whose school curriculum did not include geometry could effectively teach this component of the CAPS mathematics curriculum. The respondents concur that mathematics requires abstract thinking and teachers are used to finding new or alternative ways of solving problems. The notion of a lifelong learner has to be embraced, since other themes as probability and graphs in algebra and trigonometry are more difficult content for learners as well as for some teachers.

Teachers' methods:

Bantwini (2009) claims that South African teachers fall short on pedagogical content knowledge, lesson planning skills and instructional and assessment approaches. Carr and Skinner (2009) call for a repertoire of effective teaching strategies to inform their teaching programmes and lessons. Backhouse et al. (1992) warn that traditional teaching methods discourage learner input, which would be valuable for teachers to ascertain why learners make errors.

All the respondents in this study were aware of the different methodology OBE required, yet they persisted with the traditional method of "chalk and talk". They reasoned that mathematics is a subject that has to be explained and exercised. They furthermore allowed learners to help one another and to explain their solutions to the class. It is difficult to ascertain whether the teachers lacked the pedagogical knowledge and skills to shift to a role of facilitator or whether they resisted the new methodology for valid, informed reasons. The researcher, however, experiences warning lights for education and the teaching of mathematics in South African schools, if the school system has resisted any sustained reform.

Learner knowledge to cope with the new learning areas:

South African learners perform poorly in mathematics and physical sciences, compared with other developing countries (Howie, 2003). Mathematics requires prerequisite learner knowledge to deal efficiently with certain content. This lack of this prerequisite knowledge might be a key factor to the poor performance of learners, as expressed by Howie (2003).

One of the major problems that learners face with the new curriculum is analytic geometry, which requires some knowledge of geometry that had been omitted from the previous curricula. Geometry, which is again included in the new curriculum, poses many challenges to learners because many believe that it requires abstract reasoning. Teachers also find it difficult to instruct. To further complicate matters, there are teachers in the stream who were not instructed in geometry at school or during their teacher training. It is therefore debatable whether such teachers could effectively teach geometry.

Respondent 2 remarked,

> "Learners in front of you do not understand geometry, so they basically have to do it with recipes, recipes or they leave out these questions and these questions are answered the weakest if you look at the analysis, because they aren't well trained to have a wide vision of seeing what they should see."

It is well recorded that learners generally encounter more challenges with geometry than with any other mathematical content. The solution could be more than one level of difficulty for mathematics to also prepare students for higher careers.

Probability is another area that learners do not find easy. Word problems pose considerable challenges to learners, but more serious ones if learners are not instructed in their mother tongue.

Respondent 6 noted:

> "It's new, the other things that the probability is like financial maths, it's a lot of words. So then they have to read. They're reading yes yes yes. So those things make it more difficult to teach for example a Xhosa learner."

It is clear from the above quotation that language poses serious challenges to learners, especially the ability to read with comprehension. More problems arise for learners who receive instruction outside their mother tongue, which will be discussed next.

7.2.1.2 Language of instruction

The reality in South African schools is that a vast number of learners receive their teaching in a language that is not their mother tongue. The Constitution, however, stipulates that the language of instruction of the school should be aligned to the needs of their learners, and schools should make every effort to provide instruction in the language of preference of their learners. It is widely believed that mother tongue instruction leads to better academic performance. It is thus important that structures are put in place to deal with the problems associated with the language of instruction.

The issue of learners that are not instructed in their home language, has not been adequately addressed, therefore investigation in search of integrated programmes to deal with this matter is needed. A subject like mathematics poses even more challenges because of its highly specialised terminology. Mathematical information is available in a language like English, considered a language of wider communication (Kazima, 2008). Language is the key to communication of mathematical ideas (Thurston, 1995), by which teachers introduce and convey mathematical concepts and procedures (Bohlmann, 2001). Proficiency in conversational English may not be sufficient as mathematics learners are required to be familiar with scientific English (Lemke, 1990).

In this cohort, schools still predominantly maintain their historic language policies.

Respondent 2 stated,

> "We only have Afrikaans. We do not have any support structures in place. Everyone is just Afrikaans."

Most schools in the catchment area are Afrikaans medium or dual medium (Afrikaans and English). More problems arise for isiXhosa-speaking learners, who are taught through medium of English. The only known method of assistance is code switching, where teachers break down the content so that learners may gain a better understanding of the work. Isi-Xhosa-speaking learners experience great difficulty with word problems. This is in agreement with the literature that suggests that the more proficient learners are in English, the better their understanding of word problems is (Bunyi, 1997). When these learners do not understand the words, they resort to finding cues like "more", "less" or "share", and will then add, subtract or divide, even though the questions do not ask for those arithmetic operations (Fasi, 1999). One of the respondents mentioned that word problems are as a rule poorly answered by all learners, despite the level of proficiency of the language of instruction. This perspective opens the possibility for further research to determine the impact of language of instruction on academic performance in word problems in mathematics.

7.2.1.3 Classroom interaction

Classroom interaction is inextricably part of the professional practice of teachers globally. The kind of interaction between teachers and learners and learners among themselves is strongly determined by the methodology that applies to the specific curriculum. Teacher-centred methodologies like CNE left little room for classroom interaction. Teaching equated to telling and learning to absorption in an environment that could be described as coercive. The shift from a teacher-centred methodology to a learner-centred one posed many challenges to teachers that were used to being in full control of the classroom situation. Coupled with this, teachers and principals inflicted corporal punishment on disobedient learners. Respondents noted that teachers were ill prepared for a process of self-discovery. Mathematics teachers were used to chalk and talk, and believed that drilling learners by well-established methods would yield the best results.

Respondent 1,

> "I think we more or less instructed like the old teacher where you chalk and talk on the blackboard, where you go sit and bring in technology like PowerPoints and those things and it is still very hard work."

Cochran-Smith and Lyle (2009) note that an important aspect of teachers' practice is the engagement of learners in classroom activities. They should create an environment conducive to learning, questioning and exploration. Classroom interaction is strongly determined by the type of methodology that the new curriculum requires. Classroom activities and practices should be altered according to the curriculum demands. Teachers' training and their own experiences as learners serve as a good predictor for their own form of interaction in the classroom. All the respondents agreed that the interaction in the classroom definitely changed in some manner after 1994. They ascribed it to factors like being born into the technology age, where they instantly have access to information that improves their critical thinking skills. Learners do not automatically accept the teachers' views and explanations. They also question the usability of certain content in real-life circumstances.

Respondent 1 stated,

> "I will say that it is not because of the changed curricula that learners are more outspoken and interactive, but more the way that they are raised. They ask more questions like why they have to do certain things or where they will use it and so forth. So the general tendency is that they will not just sit like dolls taking everything in, but are more curious than before."

Even though OBE laid such emphasis on methodology so that teachers should assume the position of facilitators to help learners navigate their way by means of exploration and discovery, teachers in general adhered to the traditional way of teaching.

Respondent 5 concurred as follows,

> "By me there was no change to my learning and instruction, like I did before I still now do precisely the same, oh no, the way knowledge is transmitted, has really not changed. All that is different at this stage, I will bring in the computer, especially with graphs, I will show such things, etcetera."

The respondent confirms that there was no significant, if any, shift in methodology as envisaged by OBE.

7.2.1.4 Assessment practices

Effective teaching cannot do without appropriate assessment. Assessment is crucial to teaching and learning and acquires no special place, time or materials to be applied (Schiro, 2013). Continuous assessment of learner knowledge and understanding is imperative to

ascertain whether learners are ready to proceed to further learning. Teachers' own assessment of their learners has increasingly succumbed to the externally determined Standard Assessment Tasks and also the public examination system (Kelly, 2009). Within the learner-centred ideology, assessment is done through portfolio assessments for every learner, teachers' notes and diaries, developmental checklists, learning logs and journals, student self-assessments and peer assessments (Schiro, 2013). Summative assessments are apparently downplayed.

The traditional, teacher-centred ideology is concerned with content, objectives and mastery of learning, therefore summative assessment is the rule rather than the exception. Assessment is therefore more a process of measurement than a judgemental one, which gives the impression of accuracy and precision, and which is easily refuted (Kelly, 2009). The respondents in this study concur with this stance and noted that teachers had to develop skills in drawing up challenging question papers for all the grades in the senior phase, which had to correspond with the format, type of questioning and level of difficulty of the final matriculation mathematics question papers. It is clear that assessment does not follow the form and nature of the curriculum, but that assessment will determine how the curriculum will emerge.

Assessment of learner knowledge and skills is a complex task, but an important aspect of teachers' professional practice.

The OBE assessment design is relatively complex, given that different level outcomes should be achieved without a clear epistemology, which could give the impression that content is not important in achieving learning outcomes. Spady (1994) noted that all assessment tasks had to be vividly linked to well-defined learning outcomes to determine the learners' learning and achievements. The process of developing outcomes, which range from short-term to more complex outcomes until the exit outcomes are reached, determines that teachers should be able to describe the purpose of every task in order to provide information about learners' current understanding and their readiness to advance to more complex learning.

C2005 endeavoured to provide a holistic assessment of learners' abilities in certain areas and therefore resorted to continuous assessment, which provides a cumulative perspective of learners learning (Le Grange & Reddy, 1998).

The assessment practices of the new curriculum also contribute significantly to how readily the new curriculum will be implemented. C2005 provided no clear guidelines on when and how assessment should take place, therefore teachers struggled to make sense of the

proposed assessment design. Because the facilitators and head teachers could not provide effective training, teachers did not believe that C2005 was feasible in the South African context. The individualistic nature of assessment made it almost impossible to apply because of the high learner-to-teacher ratio. The NSC attempted to provide clearer guidelines in streamlining the assessment practices, while the CAPS appeared to resort to the traditional assessment design. Pacesetters are even provided that dictate what should be taught, what should be assessed, and when. The respondents of this study reacted positively to the structure provided by the CAPS pertaining to assessment.

Respondent 3 commented,

> "It did change for the mere fact that in the olden days educators were sort of on their own what to teach and to assess up to CAPS you see where by all educators now are given pace setters that dictates what to teach and what to assess."

This response succinctly draws the above analysis together and indicates the nature of the change that was experienced by teachers.

7.2.2 Theme 2: Support from outside agencies

7.2.2.1 Teacher professional development

Professional teacher development in the form of teacher training, workshops and conferences is presently only performed by the education department. There is a lot of criticism of NGO-led professional development, since NGOs lack the insider's knowledge and perspectives to effectively lead curriculum innovation. All the respondents agreed that no NGOs had given them training or workshops. The researcher contemplates the possibility that universities embark on such initiatives, which could greatly enhance change initiatives.

Respondent 6 remarked, "There is no NGO's that give training or workshops here!" This underscores the potential for universities to enter the domain of providing additional training and development of teachers.

7.2.2.2 Provision of physical resources

Community institutions, local business and other agencies can do much to improve the morale of schools by financially contributing to schools, especially disadvantaged schools that are in great need of support. It is believed by researchers that support from outside agencies could enhance schools' abilities to implement innovations in education. These agencies have the potential to provide different opportunities to the school community (Cord

communications, 1999). The respondents to this study reported limited support by outside agencies in the form of physical resources.

Respondent 1 reported that the school only once had received extra mathematics handbooks; Respondent 2 could only recall the Pegasus programme that allowed all the best learners to be placed in one class so that they could receive special attention. Respondent 3 was unaware of any provision of physical resources by NGOs and Respondent 4 mentioned that they had acquired minibuses through Wayne Ferreira, a well-known former tennis player. The school also received undisclosed resources from Mark Shuttleworth. Respondents 5 and 6 mentioned that their school had not received any physical resources from any NGOs.

It appears that schools have to acquire connections with influential individuals or charity organisations to gain access to possible funding. One of the respondents reported that the school had received much-needed vehicles and other resources from two different sources and further declared that the school did not capitalise on the opportunities available to them. It appears that support from outside agencies is available; however, school management should prioritise the exploration of such agencies.

7.2.2.3 Monitoring

Apart from the monitoring of the education department, monitoring from NGOs that support schools with physical and non-physical resources will put pressure on schools to improve learner performance. Five respondents of this study reported that monitoring from outside agencies was non-existent, and one respondent mentioned that the NGO only visited the school to ascertain whether their programme was still in use.

Only Respondent 3 remarked that an NGO visited their school to ensure that their programme was used and the extent of its use.

7.2.3 THEME 3: CAPACITY FACTORS

7.2.3.1 Physical resources

The literature highlights the importance of adequate physical resources as a prerequisite for the implementation of new or revised curricula (Remillard, 2005). A dearth of physical resources can limit the performance of the most outstanding learners and teachers (Chisholm et al., 2000). Dean (1998) mentions that schools in disadvantaged areas are still faced with poor facilities and shortages of resources. It is important to note teachers' perceptions on a concept like resources are based on what they are used to in their own

contexts. What is adequate for teachers at disadvantaged schools would in all likelihood be judged as deficient for teachers at advantaged schools. Furthermore, teachers at previously disadvantaged schools are excited by the new technologies and innovations made possible by the education department. The respondents mentioned the availability of white boards and projectors and are aware of mathematics online programs, like GeoGebra that can be accessed on a cell phone. They anticipate open access to Wi-Fi that is to be made available to all schools in the near future. Even so, one of the respondents noted that the availability of resources could not ensure that the resources are effectively used. Schools could be in such disarray that the school infrastructure is not conducive to any innovation. Furthermore teachers need to be effectively trained in the innovation to be able to implement it in the classroom.

7.2.3.2 School ethos and management

The school ethos undoubtedly influences teachers' professional practice and explains why teachers' actions and attitudes differ from school to school (Munn, 2008). Glover and Law (2004) found a link between school ethos and school effectiveness, while Kukla-Acevedo (2009) and McGinty et al. (2008) state that school culture creates a learning environment that positively influences teachers' behaviours, identities, retention and professional development.

It is believed that the principal should play an instrumental role in curriculum change and reform. Critical to change initiatives are the following management features: open communication, staff development programmes, planning and organisation, and financial and human support (Jenkins & Pfeifer 2012). The researcher perceives a big difference in attitude towards the principal and the role of the principal between teachers from previously disadvantaged and those from advantaged schools. Most previously disadvantaged schools formerly dealt with the disruption of the school programme during the struggle for political freedom, which most likely accounts for this discrepancy in attitude.

The school ethos and management are distinct concepts, yet they are considered together as they are closely intertwined, particularly in schools in developing countries. If the school is in disarray and not functioning well, innovation cannot or will not be satisfactorily implemented. The leadership role of the principal (at the head of management at school level) is crucial in the implementation of education reforms. Four of the six respondents reacted positively that the school ethos was upheld and that their principals were instrumental in motivating the staff. The respondents noted their principals' supportiveness, openness to change, vision, strong academic inclination, and sincere interest in the curriculum, especially in the mathematics curriculum. One respondent commented that the

entire teaching staff was collectively responsible for the upholding of the vision and ethos of the school.

Respondent 2 declared,

> "He has extremely strong structures in place. His academic inclination is unbelievable, because in his budget he will firstly make provision for teachers' needs, for technology and teaching. The teachers' morale is high."

Two respondents described their schools as poorly functioning, and criticised the weak leadership of the schools for lack of guidance that negatively influences the school culture. Furthermore the school is characterised as a 'loose' school, where learners walk around during teaching hours.

Respondent 5 testified,

> "I am going to be honest. At our school it is very weak. Here you as teacher have to fight for what you want in your class, because here is no vision at our school, my honest opinion, and the leadership is very weak. The teachers had to find their own way with no assistance from the principal."

The lack of vision and support from the principal clearly presents a serious challenge to the teachers and to the establishment of an environment that is conducive to teaching and learning.

7.2.3.3 Teacher factors

The teacher is the key agent to implementing change and reform of the school curriculum. Many factors, namely, teacher training, subject knowledge, motivation, beliefs, and expectations influence teachers' capacity and willingness to implement the proposed change initiatives (Van Veen et al., 2005). If teachers are negative regarding these factors, these negative attitudes will filter through to the learners and will in all likelihood stifle the implementation process.

Respondent 4 comments,

> "Generally I believe that too much negativity seeps in; we should not allow that all the negative factors influence you or discourage you.

Conversely, if teachers bring positive attitudes to the classroom, implementation of change initiatives will in all likelihood be promoted. Fullan (2007) states that teachers react to curriculum change depending on what point they are in their personal lives and their careers.

Anecdotally it seems that teachers close to their retirement date will actually exit the profession if reform initiatives are too radical.

The teacher training of mathematics teachers is of great concern in South Africa because research indicates that mathematics teachers lack content knowledge as well as methodological knowledge and skills. Rogan and Grayson (2005) note that a number of mathematics teachers in the system have no tertiary education in mathematics, which is of great concern to the education authorities.

Motivated teachers, who hold positive beliefs about teaching and are open to change, will in all likelihood cooperate in respect of the reforms. All six respondents declared that they were positive about the future of mathematics.

Respondent 1 claims the following,

> "For me everything was still positive, so I am positive about change, but it should not be as frequent as the past 20 years. I had 4–5 syllabi in the last 20 years."

Beliefs are extremely influential in teachers' classroom practices as they influence the way knowledge is utilised, organised and retrieved. These beliefs are instrumental in reinforcing teacher behaviours consistent with their beliefs (Gess-Newsome, 1999). In this study, teachers' passion for the profession and for reform has different origins. For some teachers it has to do with how the school is functioning and the support and attitudes of the school community, especially the principal.

For others, who had been marginalised by the former oppressive regime, the opportunity to regain their human dignity for themselves and for their learners was seized.

Respondent 3 states,

> "I'm also a product of apartheid and the way learners were handled that time as far as curricula were concerned and everything and the fact that all the learners were forced into Afrikaans, so my intention was to make a mark in the teaching of mathematics, to bring up the black society at least so that they also have geniuses in mathematics."

The education department has to take great care in bringing stability, trust, equity and equality to the education environment to address the wrongs of the past.

7.2.3.4 Learner factors

The efficacy of teaching, instruction and learning at school is also influenced by the backgrounds of learners. They bring strengths but also constraints to the school, as well as to the classroom. Student attitudes towards education and learning are influenced by their home environments, parental commitment to education, health, and nutrition. Textbooks, which are appropriate to the reform, are one of the most important sources that learners have to access in supporting engagement in the classroom. Outdated textbooks are frequently used by previously disadvantaged schools (Chisholm et al., 2000). It appears that the socioeconomic backgrounds of learners play a significant role in learning and instruction. Learners that are hungry or not in good health cannot perform optimally. Furthermore, learners that lack necessities, like scientific calculators in the mathematics classroom, will not learn how to use these devices, and will lose a lot of marks in tests and examinations.

Respondent 4 remarked,

> "Eighty percent of the learners come from such low socioeconomic backgrounds that what they have, they break down. They steal, they stay [away] from school, and they leave their books at home."

All the respondents that taught in underprivileged schools concurred that socioeconomic status impacts on learner attitudes and academic performance.

Studies on the relationship between learners' attitudes and academic performance show a positive relationship (Bramlett & Herron, 2009; Mohd et al., 2011). Varous factors influence learners' attitudes towards mathematics. The literature documents the following factors: students' mathematics achievement scores (Köğce et al., 2009), anxiety towards mathematics, learners' extrinsic motivation, and learners' high school experiences (Tahar et al., 2010). Furthermore, the role the teacher plays regarding learners' attitudes towards mathematics pertains to the teacher's classroom management skills, content knowledge, pedagogical skills, personality, and teacher beliefs and attitudes towards mathematics (Yilmaz et al., 2010). Ernest (2003) claims that mathematics is generally portrayed as cold, difficult and abstract, while factors in the home environment and society could also influence learners' attitudes towards mathematics. These factors are educational background of parents, parental expectations, and occupations of parents (Köğce et al., 2010). Two respondents from previously advantaged schools reported that most of their parents are very involved with their children's education. They provide direct assistance to their children's education and also to the school programme with regard to curricular and extracurricular activities. Respondents from disadvantaged schools concur with respondents from

advantaged schools that mathematics is held in high regard. Thus, teachers endeavour to leverage parental involvement to improve learner performances. The learning environment plays a key role in determining the learner's attitude to mathematics. The classroom environment should be supportive and should evoke confidence in learners' abilities and spontaneous learner-to-learner interaction (Maat & Zakaria, 2010).

7.2.4 Theme 4: curriculum change and reform

Major curriculum reforms in education were instituted after the democratic elections of 1994 in the Republic of South Africa. OBE replaced CNE, which had instituted different education departments for each racial group. This segregation of education resulted in different curricula, assessment profiles and examination boards responsible for the Junior and Senior Certificate examinations. OBE constituted a totally different methodology, one learner-centred in self-discovery and negotiation. Teachers became fixated in their roles as experts, which resulted in a lack of knowledge and skills to rearrange the classroom in such a way that the learners could assume co-responsibility for their learning. Contrary to CNE, OBE was specific pertaining to the methodology to be applied, but non-specific pertaining to the content to be taught. Teachers had to devise their own subject content and assessment in accordance with the specified learning outcomes and assessment standards. The administrative burden that accompanied OBE was enormous, as learner profiles had to be kept. Hoadley (2012) noted that teachers were expected to reinvent themselves by engaging with the new curriculum, selecting and sequencing content, and devising their own teaching materials.

For innovations to be successful, change facilitators had to be well grounded in the innovations to convince others to buy into the innovations. The respondents of this study had opposing views on the efficacy of the facilitators of the education department. They drew a clear distinction between the facilitation of C2005 on the one hand, and NCS and the CAPS on the other.

Respondent 5 stated,

> "That workshop that they presented, oh no. A lot of them really didn't know a thing, because they do not stand in a class and they do not know the circumstances in the class situation. They are a little out of touch and this is why OBE did not work."

The facilitation for NCS and the CAPS was better.

Respondent 3 stated,

> "Yes the CAPS is the amendment of the NCS … Ja, to make the curriculum more
> accessible for the educators … And now educators know what content to teach and
> when to assess; ja, you see so things become more clearer now."

It appears to the researcher that OBE never gained momentum, because most schools lacked the capacity to implement the proposed changes. Even teachers from the former Department of Education and Training, who would welcome any change to no change, declared that OBE did not work. Likewise advantaged schools that possessed the capacity to impose the curriculum reforms were hesitant to apply the innovations because they were satisfied with their achievements under the old curriculum system.

The respondents of this study indicated that OBE failed because of different contributing factors. The literature reveals a low take up of reforms if they differ radically from previous curricula.

In addition, if teachers are not represented on a large scale in all phases of curriculum change, low take up of the innovations is expected. Most of the respondents in this study mentioned that they were not consulted at any stage of the planning or implementation phase.

To complicate this matter even further, the literature shed light on an important issue that should be considered, namely the inevitable gap between curriculum planning and implementation. It is thus anticipated that a bridge will exist between the planned/intended curriculum and the implemented curriculum. Sethole (2004) warns that deliberation between curriculum planners and curriculum implementers could be hazardous, because of the distinct challenges that they address.

Research reveals that curriculum plans go awry because of limitations in the implementation process (Rogan & Grayson 2003; Bantwini, 2009).

As far as mathematics was concerned, a huge chasm existed between the experiences between advantaged and disadvantaged schools. Historically the white minority was prepared for professional careers like engineering, while the curriculum for black South Africans catered for unschooled labour. Twenty years of so-called equal opportunities for all South Africans did not alter the mathematics landscape significantly. Previously disadvantaged schools still have only a small number of their senior learners enrolled for mathematics, while the majority of learners are forced into studying mathematical literacy.

A major problem that the respondents in this study expressed about the curriculum changes was that changes were not always well considered but made for the sake of making changes. The one grade for mathematics went against the grain of the South African education reality, where most schools are under-resourced and do not function well. A great number of mathematics teachers are inadequately qualified and lack content knowledge, which does not auger well for the teaching of the subject (Chisholm, 2005). The single grade mathematics curriculum also poses problems in certain schools, where parents do not allow their children to take mathematical literacy, which they believe will ruin their children's chances of a decent tertiary education. Teachers are confronted with learners of weak mathematics ability grouped together with learners of exceptional ability.

Another problem was the level of difficulty between the Grade 9 and Grade 10 mathematics curriculum. Learners had to negotiate certain content without adequate prior knowledge to understand the subject matter and became demotivated. Furthermore, geometry was omitted from the new curriculum, while analytic geometry remained. One respondent claimed that his/her teaching task was obstructed because learners should have some knowledge of geometry to do analytic geometry.

More than one of the respondents criticized the NCS for the lack of sequencing. Teachers therefore chose the themes that they wanted to teach, which interfered with the continuity of the curriculum and posed serious threats to learners that moved from one school to another.

The CAPS mathematics curriculum is considered a back to basics curriculum and welcomed by most of the respondents owing to its clarity of content and assessment. It is, however, criticised for having too much content and is more difficult, with the exclusion of transformations and the inclusion of circle geometry.

Teacher professional development

The quality of teacher professional development is essential to ease the implementation of the new curriculum. The literature points to the importance of ongoing professional development for all teachers to improve their content knowledge, teaching methods and practices. How this should be attained is, however, a very complex process (Lessing & De Witt, 2007). Education is context bound, and in a developing country like South Africa, many different factors determine the efficacy of educational reforms. Richardson (2003) noted that the desired goals in education reform had not been met because of the incongruence between classroom practices and the proposed curriculum changes.

All the respondents in this study agreed to the importance of professional development in the form of training and workshops, given that the education department strongly emphasises differentiation between the needs of the teachers at different schools.

Respondent 5 remarked,

> "It must really be focused on specific sections. Teachers that are in need must be asked with what they struggle so that they could focus on those sections."

Facilitators and representatives of the education department should be well coached and well prepared for workshops, training sessions and educational conferences, so that teachers feel that they benefit from these sessions. The teacher training of mathematics teachers could vary quite significantly, therefore careful attention should be paid by the education authorities to assist those teachers that lack specific content knowledge and methodological skills.

Fullan (1991) and MacNeil (2004) noted that the many workshops and conferences led to few significant changes in teachers' practice when they returned to their classrooms. Richardson (2003) affirms that professional development is a complex enterprise, which could create, among others, cultural, structural and ethical dilemmas. The respondents of this study agreed that they did not benefit much from the courses and workshops of the education department for various reasons. One reason may be the brevity of these initiatives. Marsh and Willis (2007) note that rural teachers received a three- to five-day in-service training session before the implementation of the new curriculum. Lumadi (2014) argues in favour of an extension of these training sessions or for the training process to become continuous.

Respondent 6 responded,

> "They give training for only one day about the new content to teach probability there from Grade 10 to Grade 12. They should prolong the thing; they should also maybe throughout the year."

The proposed innovations are often ineffective if teachers reject or do not understand the innovations. A better scenario would be if teachers could acquire some sense of ownership of the innovations (Pinto, 2005) and if they could play an active part in developing the innovation (Ware, 1999). Furthermore, communication pertaining to the innovations should be unambiguous, or else the receivers of the innovations will interpret them in their own way (Ogborn, 2002).

The space of interaction

The classroom is in the centre of where curriculum development takes place. The teacher is the chief executor of the planned curriculum; therefore the teacher's understanding of and attitudes to the innovation will determine how the curriculum will be enacted. Teaching is an active and reactive process and the teacher is not a static downpipe through which knowledge is transmitted. As teachers engage with the curriculum and interact in the classroom with learners, teaching and learning are shaped. The teacher has to improvise, making spur-of-the-moment decisions. Furthermore, various factors influence the teaching and learning experience of both teachers and learners. Central to this interaction are the positives and negatives that teachers as well as learners bring to the classroom. The requirements of the curriculum and the teacher's efficacy in the application of the curriculum could greatly influence learner experiences and performance. The implemented curriculum could never be a facsimile of the planned curriculum, because one school differs from another school in various respects.

7.3 Conclusion

In conclusion, teachers conclusively advanced that they accepted curriculum change as part of their professional practice, with the proviso that change initiatives were not too radical and the curriculum not changed too frequently. The researcher questions the genuineness of their utterances, based on their own responses to other questions. Even though the post-1994 curriculum called for a new methodological approach, all the respondents persisted with the methods and approaches they knew best, namely, chalk and talk, without any reasonable effort to implement the proposed initiatives. The latest curriculum statement, namely the CAPS, is considered a back-to-basics curriculum, which clearly directs the future route that education in South Africa is taking.

Also teachers posit that consideration should be given to the reality that most teachers still face amongst others, poor facilities, resources and teaching aids, weak leadership and management at schools, and inadequate facilitation and teacher development prior to curriculum implementation. The next chapter presents recommendations distilled from all the constructs of the conceptual framework. The limitations of the study and its implications for future research are also addressed.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This chapter provides a brief overview of the field of study, followed by the research questions. Recommendations are made under each theme as discussed in Chapters 6 and 7. The limitations and significance of the study are then presented. Finally this chapter presents some conclusions.

8.2 OVERVIEW OF THE STUDY

Education in South Africa is of great concern to the country because of the poor academic performance of learners and students in national and international assessments. Even compared with other developing countries on the continent, the picture looks bleak. Learners and students presently in the system are mockingly referred to as the generation that cannot read and do arithmetic. The researcher was intrigued by the role that curriculum change could have played in this state of affairs. Because teachers are at the centre of this debate and the prime agents of teaching and instruction, the researcher endeavoured to explore the depth and breadth of teachers' perceptions and experiences of constantly changing mathematics curricula and how their professional practice was influenced by these changes.

The entire research process was informed and guided by the research questions. The questions for the interview schedule were formulated in accordance with the research questions and also refined in accordance with the theoretical framework designed for this study. The researcher ensured that all the constructs were covered. The open-ended nature of the questions and the probing technique used in the interviews enhanced the quality of the responses.

Qualitative design was used as the methodology of choice as this study was explorative in nature. This design lends itself to the acquisition of rich and thick descriptive data, which was the purpose of this study.

The purposive selection method employed in this study enabled the determination of the characteristics of the population who qualified for this study (Du Plooy-Cilliers et al., 2014). In this study the population consisted of 58 public high schools, which yielded 107 FET mathematics teachers who potentially qualified for the study. Furthermore, the researcher used a convenience sampling method, accessing the schools that reacted to the electronic mail invitation extended to all the schools in the geographic area that met the inclusion criteria (Punch, 2009). Schools from both socioeconomic backgrounds, either previously

advantaged (ex-Model C schools) or previously disadvantaged schools (ex-coloured and ex-black schools) were selected to obtain an inclusive and realistic view of teachers' experiences. The researcher recruited six teachers at six different schools (two ex-Model C schools, two ex-coloured schools and two ex-black schools). Apart from these interviews, the researcher had a pre-run (pilot) session by interviewing two senior mathematics teachers in the form of a panel discussion. The purpose of this pilot discussion was mainly to determine whether the researcher displayed adequate skills and techniques at interviewing. The researcher audio-recorded the proceedings and listened intently to the responses. The researcher made minor adaptations to the interview schedule and was cautioned to eschew flippant remarks to responses and to maintain a very neutral stance during the duration of the interviews. Furthermore, only teachers who had experienced curriculum change during their teaching tenure qualified for this study.

A conceptual framework, which combined the work of Rogan and Grayson, in which the prime constructs were quantitatively validated, and the work of Remilliard, which highlighted the interaction between the teacher and the new curriculum requirements, was compiled. The researcher used those constructs to qualitatively enquire about teachers' experiences of these constructs and the changing curriculum to gain a different perspective while employing the same constructs. A deductive method of analysis was employed, whereby the constructs from the theoretical framework were used as themes. Room was made for possible new themes to emerge.

Social Constructivism, and particularly the work of Vygotsky, guided the researcher's understanding of how learning is encapsulated. Mathematics is a social endeavour and mathematical reasoning could only be explained as a product of social interaction and the conception and experience of that social reality.

8.3 CONCLUSIONS

The conclusions below are based on the results of this particular study and are discussed under the themes used in Chapters 6 and 7 as presented in the conceptual framework. Finally, a conceptual conclusion is presented of the most pertinent construct of the conceptual framework, that is, the interaction space.

8.3.1 Profile of implementation

8.3.1.1 Coverage of learning areas

Teacher knowledge *regarding the new learning areas in mathematics:*

The DoE should invest in incentive initiatives, like bursaries for mathematics teachers to further their mathematics education. Teachers should be urged to make use of all the initiatives and programmes such as training sessions, conferences and workshops for their personal growth and development in mathematics to embrace the notion of the lifelong learner.

The departmental workshops and training sessions should include contact sessions with teachers that encounter problems with certain areas and topics. It would be a good idea if the DoE were to embark on short courses by singling out the learning areas that are most problematic. Teachers should be encouraged to actively engage in their cluster groups, since peer support and guidance could be very beneficial to teacher development.

Principals and school governing bodies should be committed to appointing adequately qualified teachers to teach mathematics, which is a specialisation subject, in the FET phase. Since the groundwork takes place in Grades 8 and 9, equally qualified teachers should be appointed for the entire high school phase.

Teachers' methods and classroom interactions:

Teachers' instruction methods, techniques, approaches, and class management skills cannot remain unchanged in the midst of the globalisation of trade and the economy and the immense growth and development of technology, especially information technology. The changes concerning cultural diversity, political structures and social networking further compel the DoE and the entire school community to take hands towards achieving the same goal – to be agents of change and innovation. This study pointed to a strong affinity with the traditional approaches and methods that presumably best suit teachers that have to cope, amongst others, with a lack of resources, overcrowded classrooms and poor leadership and management by the DoE, principals, and senior staff. The DoE should accelerate its attempts to effect change in this regard by focusing on specific workshops and short courses on preferred methodological styles, approaches and techniques. Teachers should be convinced that methodological change is inevitable in a changed and changing world and society.

Teachers should create an environment conducive to learning, questioning and exploration. Interaction between teachers and learners and among learners should be strongly encouraged.

Learner knowledge to cope with the new learning areas:

Mathematics is an applied subject and therefore curriculum planners and developers should ensure that the curriculum deals with the concepts and procedures to be attained in a sequential manner. They should make sure when excluding and including content in the new curriculum that learners will possess the prerequisite knowledge and skills to cope with the required content.

Principals and teachers should stress the importance of learner attendance at extra classes provided by the WCED, higher institutions and teachers. Learners should be encouraged to seek support from peers or other qualified mathematics teachers, which should improve performance.

8.3.1.2 Language of instruction

Experts in the field of mother tongue instruction have ascertained that mother tongue instruction leads to better academic performance (Kazima, 2008). *The Constitution of the Republic of South Africa, Act No. 108 of 1996*, lists eleven official languages with equal status. The government should thus make every effort to ensure mother tongue instruction for all learners. In the interim phase the DoE and school communities should address the problem and reach solutions to these challenges bilaterally. The problems that isiXhosa-speaking learners encounter with word problems and probability could be alleviated by providing question papers in the language of preference. Teachers who are proficient in isiXhosa can therefore instruct in isiXhosa and provide learners with notes in their mother tongue.

In addition, it would be of great value if the DoE were to appoint experts in the area of mathematics to develop and curriculate modules to help learners understand the content better. The use of illustrations, graphs and video clips in the various languages would make mathematics more practical and ensure links with the real world.

8.3.1.3 Assessment practices

The DoE should ensure that with every change in the curriculum they provide clear guidelines in terms of what to assess, when to assess it and how to assess it, in order to assist, support and ease the implementation process for mathematics teachers. Teachers will not buy into any initiatives if they are unsure of the assessment profile of the proposed initiatives.

8.3.2 Support from outside agencies

8.3.2.1 Teacher professional development

Universities are in the ideal position to determine the requisite mathematics knowledge that school leavers should possess to be able to negotiate the university mathematics curricula.

8.3.2.2 Provision of physical resources

This is an avenue that is currently underutilised by schools. The principal and the extended school community should build good public relations and make every effort to promote the image of the school regarding its academic performance, sporting, and artistic and cultural achievements to motivate influential individuals and NGOs to invest in the school.

8.3.3 Theme 3: Capacity factors

8.3.3.1 Physical resources

The DoE should continue to be committed to attend to the needs of disadvantaged schools, since the discrepancies between schools are still paramount. The issue of overcrowded classrooms is still a concern. More classrooms should be equipped with the necessary equipment and teaching aids to enable teachers to teach mathematics effectively. It is of utmost importance that the DoE should provide training for teachers on how to properly utilise resources and make optimal use of the new technology to teach mathematics effectively in the new era (being able to use all the gadgets, programs and the smart board).

8.3.3.2 School ethos and management

The DoE and school governing bodies should ensure that able and qualified principals are appointed who possess the required visionary, managerial and leadership skills. Principals play a key role in change initiatives and should be agents of change and an inspiration to their colleagues and learners through leading by example. A well-functioning school will in all likelihood have the capacity to implement change initiatives.

8.3.3.3 Learner factors

The DoE and school principals should provide accommodation after school for learners who do not have the amenities at home to study or do their homework. Support systems, programmes and initiatives should be in place to help students that experience difficulties in mathematics. Professional and community support should be available to deal with learners' personal problems. Parental involvement should at all times be encouraged as it leads to improved academic, sporting and other performance.

8.3.4 Theme 4: Curriculum change and reform

It is imperative for the DoE to ensure that experts in the field of mathematics are appointed as facilitators and curriculum advisors. They should be handpicked and highly skilled, with exceptional content knowledge as well as pedagogical skills and techniques. The facilitators and curriculum advisors should be grounded in the new curriculum to convince teachers of the merits of the initiatives.

The DoE should make sure that teachers take an integral part in the curriculum-planning process by encouraging teacher input. Before the Department implements a curriculum, it should ensure that all teachers are adequately trained to deal with the changed curriculum by providing training on a continuous basis and for a prolonged period of time.

The DoE should show vision in making these changes, which should be based on scientific research.

Schools and the DoE should work together to raise an awareness that mathematics is the gateway to most of professional careers that can be studied at university to ensure that an increased number of learners take mathematics as subject.

Conceptual conclusion

In the subsection that follows, the theoretical assumptions of the interaction space as presented in the theoretical framework of this study are discussed. The interaction space is the space where all the other constructs interact with one another and where the research question is answered. Social Constructivist theory is advanced in this study as the best fit in describing how teaching and learning in the context of classrooms in South Africa should take place. The dynamic nature of teaching and learning and of the classroom as centre of curriculum development and reform, is central to this discussion. According to social constructivists, mathematics is a social activity and learning is a product of social activity. In any classroom, certain knowledge is taken as shared, even though one has no access to the

knowledge of another. It is through this understanding that knowledge is advanced as being co-created. The teacher's academic background; content and methodological knowledge and skills; the profile of the school; facilities, resources and teaching aids; the quality of leadership and management; and the strengths and constraints that learners bring to the school are among others factors that enhance or hinder teachers' professional practice and also influence the ease with which curriculum change is implemented. Teachers are still confronted with a dearth of resources, overcrowded classrooms and socioeconomic problems that create marginalising consequences for teachers and school communities.

Despite all these limiting factors, teaching must be progressive and emergent, therefore teachers should create a classroom setting where learners could accept co-responsibility for their learning and the learning of others.

8.4 Recommendations

The recommendations cover two types. Firstly, more practical recommendations are presented in an attempt to improve practice. Secondly, recommendations in terms of future research are presented.

Recommendations on improving Practice:

1. Mathematics teachers should be adequately equipped with content subject knowledge and appropriate teaching methods to deal with all the different learning areas in mathematics.

2. If teachers' teacher training did not cover all the learning areas, a concerted effort should be made to fill the knowledge gap.

3. Teachers should be encouraged to share their innovative or alternative ideas, creating an environment for peer support and peer-to-peer mentoring.

4. For mathematics teachers who are not proficient in isiXhosa, a teacher who is proficient in isiXhosa should be appointed to help learners to better understand the texts.

5. The DOE should encourage NGOs to deliver professional development initiatives in planning and implementation processes regarding curriculum change and reform.

Recommendations for future studies in this area:

1. This study endeavoured to provide a wide scope of teacher experiences and perceptions on curriculum change, having included teachers from three former departments of education.

Future research could compare the specific challenges of teachers from these different backgrounds.

2. Specific to mathematics, word problems and probability are answered the weakest in Grade 12 examinations and pose serious challenges to those learners instructed in their second or third language. A quantitative enquiry could determine whether a causal relationship exists between mother tongue instruction and academic performance in mathematics.

8.5 Limitations

1. The sample size for this study was relatively small. Future studies using a longitudinal design may render richer description.

2. The nature of this study required impromptu responses to times and events dating back as far as 30 years and earlier. This could lead to recall bias that could limit the clarity of responses in some of the cases.

8.6 Significance

The strength of this study is the inclusivity of respondents from varied social settings and socioeconomic backgrounds, which led to a rich and varied portrayal of experiences and perceptions of the phenomena under study. The findings can therefore apply to different contexts and backgrounds. The study also presents with valuable recommendations for the education fraternity (the DOE, subject advisors, facilitators of change initiatives, principals, teachers, and learners).

Two models, one by Rogan and Grayson and another by Remillard, were combined and constructed into a conceptual framework for this study. Both these models were used in quantitative studies. This conceptual framework was applied to a qualitative study, which presented different insights into the constructs under investigation.

8.7 Conclusion

In conclusion, the educational landscape in South Africa is extraordinarily varied, from highly advantaged to extremely disadvantaged, yet all the respondents argued in favour of curriculum change and reform. Teachers as the primary executors and developers of change initiatives call for realism, in that change initiatives should not be too radical or too vast. The teachers pleaded for more involvement in the planning and implementation process. Outcomes-based education had a strong political agenda, and all respondents agreed that it never gained strong momentum. The strong shift back to traditional education with the

CAPS, which the respondents of this study find a better fit, do not however, auger well for the future of education in South Africa. The researcher argues for thoroughly planned and executed alternative methodological approaches to be introduced in schools. Teachers should be thoroughly trained in these initiatives by facilitators who are grounded in the innovations. Reform does not happen overnight; therefore the lessons learned and mistakes made should guide education in South Africa into the future.

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APPENDIX A: Permission letter WCED

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
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Private Bag x9114, Cape Town, 8000
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REFERENCE: 20150715-1278
ENQUIRIES: Dr A T Wyngaard

Ms Jenéad Joseph
6 Mettler Street
Wellington
7655

Dear Ms Jenéad Joseph

RESEARCH PROPOSAL: MATHEMATICS TEACHERS' EXPERIENCES OF THE CHANGING CURRICULUM ON THEIR PROFESSIONAL PRACTICE

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:
1.   Principals, educators and learners are under no obligation to assist you in your investigation.
2.   Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3.   You make all the arrangements concerning your investigation.
4.   Educators' programmes are not to be interrupted.
5.   The Study is to be conducted from **01 February 2016 till 24 June 2016**
6.   No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7.   Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8.   A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9.   Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10.   A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11.   The Department receives a copy of the completed report/dissertation/thesis addressed to:
          The Director: Research Services
          Western Cape Education Department
          Private Bag X9114
          CAPE TOWN
          8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: **20**   **January**   **2016**

APPENDIX B: Permission letter CPUT

	***For office use only
	20/08/2015
	n/a
Approval	**P/Y√/N**
Date submitted	**EFEC 1-**
Meeting date	**10/2015**

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 form in MS Word – no handwritten forms will be accepted.
- All attachments are to be included in this document – your email submission should include only **one** MS Word attachment.
- 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):	Jenéad Diana Nicole Joseph
Project/study Title:	Mathematics teachers' experiences of the changing curriculum on their professional practice.
Is this a staff research project, i.e. not for degree purposes?	No
If for degree purposes:	Degree: M. Ed (FET) specialisation Supervisor(s): Dr. V. Bosman
Funding sources:	

2   Abstract of study

Insert a brief summary of the intended project/study in this block.

Indicate clearly what the research entails and how it will be conducted, using a maximum of 500 words.

Mathematics teachers' experiences of the changing curriculum on their professional practice.

Education in South Africa has become a concern to stakeholders such as the government, teachers, teacher unions and non -governmental organisations, due to the poor academic performances of learners. Mathematics teachers, the focus of this study, are confronted with a constantly changing curriculum (Jansen &Taylor, 2003). Teachers are often targeted by the education authorities and the general public as the primary cause for the poor outcomes of education in South Africa. This research project researches the experiences of grades 10-12 Mathematics teachers in the Cape Winelands district of the in relation to the professional practice of teachers. The Conceptual analysis framework, which was developed by combining the work of Rogan & Grayson and the work of Remillard will guide the

interpretation and analysis of the data. Being explorative in nature this study is a qualitative design and hence an Interpretive methodological approach is followed. A purposive and convenience sampling method will be used whereby nine schools' teachers will be pre-selected: three ex-model C schools, three previously disadvantaged Black schools and three previously disadvantaged Coloured schools. Semi- structured interviews will be conducted. Data collection is still to commence, therefore the results are still awaited. This study aims to provide Mathematics teachers and the Education Department with recommendations regarding curriculum development and – change and how their professional practice could be improved.

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?

At least one grade 10-12 mathematics teacher at the nine different schools under study will be invited for participation.

Participants must give informed consent after having been informed about all the procedures and their rights to privacy,

anonymity and withdrawal from the study.

3.2   How will participants be made aware of what is involved in the research [prior to, during and after data collection]?

I will give them a brief overview of the proposed study and which methods will apply during data collection. After

the data collection process the researcher will make sure whether his/her interpretation of the participants' words

were correctly interpreted and whether the participant would like to add to their words.

3.3   How will you ensure that participants really do understand their rights?

I will make sure that the participants are informed about their rights in the language of preference.

3.4   How will you collect data?

I will collect my data by using in-depth semi-structured interviews for data collection, using open ended questions that will reveal

themes which could be probed. The interview schedule will include the following themes: Professional practice, teacher training

and- development, available resources and facilities at the school, teacher support (parental, governing body, senior personnel,

Education Department), curriculum change, content knowledge and viability of the curriculum.

Attach your data collection instrument(s) to the end of this document.

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?

I am unaware of any possible harm to any of the above mentioned stakeholders.

   3.6 What plans do you have for managing the confidentiality and anonymity of participants in this study?

A pseudonym will be used to every participant that will only be known to the researcher. That name will apply on all documentation.

3.7   Are there any potential conflicts of interest for you in undertaking this study?

I am not aware of any possible conflicts of interest.

3.8   How will the findings be used on completion of the study?

It will be submitted to the department of education to help them with future policy reform and implementation. Also to the participants of this study, mathematics teachers in the Western Cape and researchers who gain access to the thesis.

3.9   Does this work raise any other ethical issues and if so, how will you manage these?

No.

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?

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)	

Signatures:

Researcher/Applicant:		Supervisor or Senior investigator (if applicable):	
Date:	17. 08. 2015	Date:	17. 08. 2015

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.

Comments by Education Faculty Ethics Committee:

Cleared		
Approved: X	**Referred back:**	**Approved subject to adaptations:**
Chairperson:		**Date: 01/10/2015**
Approval Certificate/Reference: EFEC 1-10/2015		

APPENDIX C: Request for permission WCED

<div align="right">
6 Mettler Street

Wellington

7655

1 March 2016
</div>

The District Senior Manager

The Department of Education

Western Cape

P/Bag x9114C

8000

Dear Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT HIGH SCHOOLS IN THE CAPE WINELANDS DISTRICT.

I am Jenéad Joseph, and I am a student at the Cape Peninsula University of Technology, currently doing my master's degree in education, specialising in mathematics.

The research I wish to conduct explores Grades 10–12 mathematics teachers' experiences of curriculum change and its influence on their professional practice. This research could help improve the effectiveness of implementing the mathematics curriculum in the classroom. The duration of the research is approximately two months, from February to March. The sample comprises FET mathematics teachers in the Cape Winelands district who will be interviewed. Confidentiality and anonymity are guaranteed. Participants have the right to not participate and to withdraw at any time. All the information gathered during the process will be dealt with as highly confidential.

I hereby seek your consent to conduct the research. Thank you for your time and consideration in this matter.

Yours faithfully

J. Joseph

……………….. 	01.03.2016

APPENDIX D: Invitation to participate letter (principal)

<div align="right">

6 Mettler Street

Wellington

7655

1 March 2016

</div>

The Principal

…………………..

…………………..

…………………..

Dear Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

I am Jenéad Joseph, and I am a student at the Cape Peninsula University of Technology, currently doing my master's degree in education, specialising in mathematics.

The research I wish to conduct explores Grades 10–12 mathematics teachers' experiences of curriculum change and its influence on their professional practice. This research could help improve the effectiveness of implementing the mathematics curriculum in the classroom. The duration of the research is approximately two months, from February to March. The sample comprises FET mathematics teachers in the Cape Winelands district who will be interviewed. Confidentiality and anonymity are guaranteed. Participants have the right to not participate and to withdraw at any time. All the information gathered during the process will be dealt with as highly confidential.

I hereby seek your consent to conduct the research at your school. Thank you for your time and consideration in this matter.

Yours faithfully

J. Joseph

APPENDIX E: Invitation to participate letter (school governing body)

6 Mettler Street
Wellington
7655
March 2016

School Governing Body

…………………..

…………………..

…………………..

Dear Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

I am Jenéad Joseph, and I am a student at the Cape Peninsula University of Technology, currently doing my master's degree in education specialising in mathematics.

The research I wish to conduct explores Grades 10–12 mathematics teachers' experiences of curriculum change and its influence on their professional practice. This research could help improve the effectiveness of implementing the mathematics curriculum in the classroom. The duration of the research is approximately 2 months, from February to March. The sample comprises FET mathematics teachers in the Cape Winelands district who will be interviewed. Confidentiality and anonymity is guaranteed. Participants have the right to not participate and to withdraw at any time. All the information gathered during the process will be dealt with as highly confidential.

I hereby seek your consent to conduct the research at your school. Thank you for your time and consideration in this matter.

Yours faithfully

J. Joseph

……………..   1.03.2016

APPENDIX F: Invitation to participate letter (teacher)

6 Mettler Street

Wellington

7655

3 March 2016

Dear Participant (Teacher)

I kindly request your participation as an educator to avail yourself for participating in a research study at school.

Please note that any information gathered during this research study will only be used for research purposes. This study and your participation are independent of your academic record and/or your future at school and will not be used in any way to prejudice any participant at school. Your participation in the study will be completely confidential and anonymous. Your dignity will not be compromised and your name will not be mentioned. Any information you give will only be used to the benefit of the programme and will not be traced back to you.

At any stage, if not comfortable with the study, you have the right to withdraw from the process.

Please complete the slip below as proof of your written consent to participation in the study.

Your consideration is highly appreciated.

Thanking you in advance.

Ms J. Joseph (student no. 209126752)

....

RETURN SLIP

I …………….….... (name of participant in print) agree to be a participant in the study. I understand the content of the consent letter. I further understand what the study is about as explained to me by the researcher. I understand that I may exercise my right to withdraw from the process at any point of time.

Signature of participant...

APPENDIX G: Interview schedule

Biographical Data:

Teacher profile:

Age:

Gender………………

Tertiary institution(s) where studied:

Qualification(s)……………………….

Post level………………….

Years of study in mathematics……………..

Number of years teaching in school sector………………..

Number of years teaching mathematics in FET band …………………

Pseudonym……………………………..

Establishing rapport

1. The interviewer greets the interviewee with a firm handshake and direct eye contact. The interviewer conveys her gratitude to the interviewee for her or his willingness to participate in the study and explains the selection process to the participant.
2. The purpose of the study is to explore your perceptions and experiences of curriculum change and the influence on your professional practice.
3. The participant is reassured that anonymity will be protected at all cost and that pseudonyms will therefore be used. Furthermore no information will be disclosed to any unauthorised person or party. Recommendations will be made to the Education Department regarding the influence of curriculum change on teachers' professional practice.
4. The duration of the interview will be between 45 and 60 minutes.
5. The interviewer will ask whether the participant is ready to answer the questions.

Interview Questions

(The interview questions relate to the concepts of the conceptual model and the themes that emerged from the preliminary literature review).

1. (**A general question to get the interview going**)
    1.1 Why did you become a teacher?
    1.2 Why did you choose mathematics?
    1.3 How do you experience teaching mathematics in general?

2. *Curriculum reform:*

2.1 How did you experience teaching mathematics before 1994 under Christian National Education?

Outcomes-Based Education (C2005):

2.1.1 Curriculum content.

2.1.2 Pedagogical methods and techniques and their application.

2.1.3 The role of the teacher.

2.2 How did the changes made to C2005 in the NCS influence the teaching of mathematics in terms of?

2.2.1 Curriculum content.

2.2.2 Pedagogical methods and techniques and their application.

2.2.3 The role of the teacher.

2.3 How did the changes made to NCS in the CAPS influence the teaching of mathematics in terms of?

2.3.1 Curriculum content.

2.3.2 Pedagogical methods and techniques and their application.

2.3.3 The role of the teacher.

2.4 How would you describe the general morale of the mathematics teachers at your school throughout these curriculum changes and reform?

2.5 How was the process of curriculum change done to your satisfaction or dissatisfaction by the Education Department?

2.6 *Were you part of the process of curriculum change at any stage? If yes, explain when and how. The interviewer should ascertain the position of the participant on unilateral and bilateral decision making).

2.7 *Were there any problematic areas in the different curricula that were problematic? Please explain or substantiate your answer.

2.8 What recommendations would you make for future curriculum reform and change?

3. *Capacity factors:*

3.1 Would you describe your school as well functioning or not well functioning? Please substantiate.

3.1.1 Is your school suitably equipped with the necessary facilities and resources to function effectively? If not, mention which resources you lack to effectively teach mathematics.

3.1.1 Do your learners possess the necessary equipment and necessities to make learning possible?

3.2 Does the principal uphold the spirit, vision and culture of your school? Substantiate.

3.2.1 In which ways does the principal enhance or hinder the effective management of the school?

3.2.2 Which structures and initiatives does the school have in place to deal with curriculum change (if any)?

3.3 Has your teacher training covered all the relevant content as stipulated in the different curricula? If not, mention the parts that were not covered.

3.3.1 Did you find it necessary to alter your teaching methods and pedagogy to align them to the different new curricula? Substantiate.

3.3.2 What is your opinion on the continuously changing of the mathematics curricula?

3.4 What is your philosophy of the teaching profession and of mathematics teaching?

3.4.1 What is the language instruction policy of your school?

3.4.2 Are there structures/support programmes in place to assist learners who receive instruction in a language other than their mother tongue?

 3.4.3 Describe the socioeconomic backgrounds of your learners.

3.4.4 In which ways do these backgrounds impact on instruction and academic performance?

3.4.5 How do parents and the community contribute to the success of the school and their children's academic performance?

4. *Support from outside agencies*

4.1 Do you receive any form of assistance from NGOs regarding professional development and training? Mention which forms and quality of assistance if any.

4.2 Does your school receive any assistance from NGOs that pertains to mathematics resources, materials, equipment and buildings? Please explain.

4.3. Which structures are in place to monitor development in the areas of teacher development and training and performance of learners? What about mathematics?

5. *Profile of implementation*

5.1 *How was the level of interaction and engagement between learners in the classroom situation affected as the mathematics curricula changed?

5.2 *How did the assessment criteria change in the different curriculum statements?

5.3 *Who assisted you with the transition to implementation of the new curricula?

5.4 *What made the implementation of the new curricula viable or not practicable at your school?

5.5 *In which ways did the WCED assist in preparing teachers for the implementation of the new curricula?

5.6 In which ways do you benefit from these initiatives by the WCED?

5.7 What would you recommend the WCED do to improve the effectiveness of their initiatives?

5.8 What do you consider the most important aspects of your professional practice?

5.9 How do curriculum reforms influence your professional practice?

5.10 *Provision for new themes to emerge.*

In all the questions marked with* the interviewer will make sure that the participant distinguishes between the different curricula.

At the end of the interview:

1. The interviewer will thank participants for their participation in the study and inform them a copy of the transcription will be supplied to them to ascertain whether those words were their exact words and whether they persist with their perceptions.

APPENDIX H: Coding template

Achievement goals	Change in assessment criteria	Curriculum advisors	Facilitating role	Language of instruction
Administrative burden	Change – learners	Curriculum advisors' knowledge	Factors hindering academia	Learner experiences
Apartheid curriculum	Change – good	Curriculum change	Feeding scheme	Learner factors
Assessment	Change – methodology	Curriculum content	Few adjustments	Learner support
Assessment practice	Changes – curriculum	Curriculum planners	Gifted learners	Learners' attitude
Assessment weightings	Classroom interactions	Curriculum planning	Good content knowledge	Learners' attitude towards maths
Assistance	Clear assessment guidelines	Decision making	Well-functioning school	Learners' circumstances
Attitudes – learners	CNE – apartheid curriculum	Departmental officials	Inclusion of topics	Learners' interaction
Attitudes – teachers	CNE – methodology	Departmental workshops	Initiatives for teacher development	Levels of questioning
Benefits – initiatives	CNE – no resources	Different methods	Initiatives from the department	Limitation of resources
Benefits – workshops	CNE – textbook driven	Different schools	Initiatives for less fortunate learners	Maths future
CAPS – accessible	CNE – under-qualified teachers	Differentiate between subject levels	Initiatives from NGOs	Mentoring learners
CAPS – administrative burden	CNE – vague	Disadvantaged learners	Innovative teaching methods	Methodological drives
CAPS – clear guidelines	Code switch	Disciplinary challenges	Integration of topics	Methodology
CAPS – reduced workload	Content knowledge	Exam papers	Interest in maths	Methods
Challenging topics – learners	Coverage of learning areas	Exclusion of topics	Lack of resources	Monitoring systems
Challenging topics – teachers	Curriculum	Extra classes	Language challenge	NCS curriculum

APPENDIX I: Sub-constructs template

Teachers' methods:

Respondent 1:

I think we more or less instructed like the old teacher where you chalk and talk on the blackboard, where you go sit and bring in technology like PowerPoints and that things and it is still very hard work, because mathematics is basically an explaining subject and a practice subject. I explain the first half of the period and the other half of the period is for practice. I motivate my students to make use of other methods as well, but don't ask them to show their methods on the board, because it can only cause confusion.

Respondent 2:

For me its chalk and talk. You have to drill in the basics and the learners have to practise. If you have a strong group of learners then you can integrate two or more topics, but it is not possible to integrate topics with learners that didn't master the basic skills of a certain topic. I stress the importance of integrating topics at Grade 8 already to enable the students to answer these types of questions in the question papers of the Department of Education.

Respondent 3:

Uhm not much have changed because we are still doing the chalk and talk. Yes there are always new ways. You had to change like now with the technology you had to change now and teach the way that the learners learn nowadays, because learners they learn better with technology. So I need to be computer literate and I had to use the latest technology to present my lessons you see what I mean? So meaning that we don't know what curriculum they would bring after CAPS that's why I had to align with that as well. You see I must be a lifelong learner myself.

Respondent 4:

It is very difficult to work with learners that don't focus on what they should do and sometimes you have to force them to do their work, you have to repeat over and over the same thing and you must make sure that they did their work and that they understand their work; give them more work and revise the work with them. The educator should still drill in the work and if you try to bring in the mentality of facilitation, which the department expects of you, then you lose your learners and they lose you.

Respondent 5:

By me there was no change to my learning and instruction, like I did before I still now do precisely the same, oh no, the way knowledge is transmitted, has really not changed. All that is different at this stage, I will bring in the computer, especially with graphs; I will show such things, etcetera. I will still go back to the board and work on the blackboard, but most of the time I will make use of the data projector. In general I always believe that learners should engage and participate in my lessons on a very disciplined manner. I am a firm believer that students learn from one another. I explain the work the first half of the period and work out a few problems, then they have to work on their own and afterwards help one another and work out problems on the board.

Respondent 6:

So instead of you being the master okay master being the teacher then you have to now also take into consideration the knowledge of the learners, so you start form there. You come to the class, you know what you do you going to teach them and you teach them what you know. But now with more or less outcomes-based education you have to think and be prepared, for you have to first get what they wanted so it was not teacher centred it is more learner centred. In a way I think I get used to it because in a class I always come and I say you just introduce something and ask them what you know about this.

Language of instruction:

Respondent 1:

Ja we basically only have a few isiXhosa learners, but they accept that they will be placed in an English class. We have no structures in place to help isiXhosa learners, because they are fully aware that they will write the exams in Afrikaans or English. English or Afrikaans is our language policy.

Respondent 2:

We only have Afrikaans. We do not have any support structures in place. Everyone is just Afrikaans.

Respondent 3:

In Xhosa just to break down the content so that the learner could gain a better understanding of the work but we are not allowed to teach in isiXhosa. Because if you do that there will be questions in the maths paper being asked in English that the learner will now struggle to answer because he was always taught in isiXhosa. So that helps a lot in teaching English. No, there're no exam papers in isiXhosa; everything is in English.

Respondent 4:

We only cater for English and Afrikaans. Our mainstream learners are Afrikaans. We have a structure in place to help isiXhosa learners: every week there comes a person that assists isiXhosa learners to understand the English and Afrikaans language better. IsiXhosa learners can choose the language of instruction, which is either Afrikaans or English.

Respondent 5:

We are an English and Afrikaans school. Most of our English learners' first language is isiXhosa. English becomes their first language in the school and Afrikaans their second language. It is really very challenging and difficult for them. There are no structures in place to help isiXhosa learners.

Respondent 6:

Our school is English medium. Mathematics can be very difficult for isiXhosa learners to understand because of its extremely difficult terminology. The only structures that we have in place are to co-switch [*sic]* (code switch) and explain the difficult concepts in isiXhosa. Unfortunately we have to stick with English as far as possible, because the exam papers are not available in Afrikaans.

Appendix J: Declaration of Editing

E S van Aswegen
BA (Bibl), BA (Hons), MA, DIJtt, FSAILIS

language and bibliographic consultant

11 Rosebank
Place Oranjezicht
Cape Town

Tel: 021 461 2650
Cell: 082 883 5763
Email: limanas@mweb.co.za

ACADEMIC WRITING

Language and technical editing

Research proposals
Conference and journal papers
Theses, dissertation, technical reports
Bibliographies
Bibliographic citation
Literature searches

The MEd thesis by Jenéad Diana Nicole Joseph, 'Mathematics teachers' experiences of the changing curriculum on their professional practice' has been edited, and the candidate has been advised to make the recommended changes.

Dr ES van Aswegen 16
October 2016

final final thesis By Jenead Sunday
Last Joseph

2% match (publications) bange in Uganda: Teacher perspectives on the new thematic curriculum", International Journal of Educational Development, 201003	Similarity Index **9%**	**Similarity by Source** Internet Sources: N/A Publications: 6% Student Papers: 6%

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Boris Handal. "Mathematics teachers' beliefs and curriculum reform", Mathematics Education Research Journal, 05/2003

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Bantwini, B.D.. "How teachers perceive the new curriculum reform: Lessons from a school district in the Eastern Cape Province, South Africa", International Journal of Educational Development, 201001

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Submitted to University of Johannsburg on 2016-03-08

<1% match (publications)
"International Handbook of Research in History, Philosophy and Science Teaching", Springer Nature, 2014

<1% match (publications)
John Rogan. "Towards a theory of curriculum implementation with particular reference to science education in developing countries", International Journal of Science Education, 10/1/2003

Appendix k: turnitin originality report