TOWARDS THE DEVELOPMENT OF A QUALITY EXTERNAL SUPPORT FRAMEWORK FOR THE FURTHER EDUCATION AND TRAINING (FET) PHASE PHYSICAL SCIENCES TEACHERS IN THE LEJWELEPUTSWA DISTRICT- FREE STATE PROVINCE.

by

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DECLARATION WITH REGARD TO

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I, Mpofokaze Bokhatsi Maope, Identity number: , and Student number: , do hereby declare that this research project submitted at the Central University of Technology, Free State for the degree of Doctor of Education is my own independent work and it complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State and has not been submitted before to any institution by myself or any other person in fulfilment or partial fulfilment of the requirements for the attainment of any qualification.

Signature

21 September 2018

Date

DEDICATION

I would like to dedicate this study to my late parents, ntate Tjotsane Elliot Bokhatsi and mme ‘Mamaope Belina Bokhatsi, their love of education pushed me even when I was about to lose hope. I know that they would be very happy to finally have a doctor in the family.

It would not be correct if I were to exclude my late nephew, Lisema Masike, who died last year (2017), just after he submitted his thesis at the Tshwane University of Technology. We would have been celebrating our success together, but I know that his spirit is with me.

Above all, I would like to dedicate this piece of hard work to God the Almighty, who gave me perseverance, strength, wisdom, willpower, and courage to carry on with this study against all adversities. This thesis has taught me that:

‘EVERYTHING IS POSSIBLE WITH GOD’

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‘*May this thesis be a source of inspiration and encouragement to you and your children - my nieces and nephews”*

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ABSTRACT

TOWARDS A DEVELOPMENT OF A QUALITY EXTERNAL SUPPORT FRAMEWORK FOR THE FURTHER EDUCATION AND TRAINING (FET) PHASE PHYSICAL SCIENCES TEACHERS IN LEJWELEPUTSWA DISTRICT

By

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South Africa has experienced a number of education reforms such as Curriculum 2005 (C2005), National Curriculum Statement (NCS) and Curriculum and Assessment Policy Statement (CAPS) since 1994. All these curriculum changes were intended to improve the education system of the country. The changes presented challenges to both physical sciences teachers and learners. Some of these challenges addressed the volume of the content and time constraints, the nature and level of the content as well as assessment and progression between grades. All these curriculum changes were new to teachers hence the need to empower them through an appropriate educator development programme that dealt with educational reforms in order to boost their teaching confidence. This was a sequential explanatory mixed methods research. A hundred questionnaires were randomly sent to 60 secondary schools. Forty-six questionnaires were returned. The researcher conducted three focus group interviews, which were comprised of seven (7) physical sciences teachers in each group. She also interviewed one physical sciences subject advisor.

The quantitative research revealed that teachers attended subject-specific workshops, organised during and after hours, they have improved their educational qualifications, and in some instances, teachers have managed to form collaborations with peers, where they planned lessons together. They also seemed very comfortable with the new system of discussion of examination memoranda before marking. However, teachers also felt challenged by a lack of funds to buy science equipment, inadequate supply of science textbooks, low learner interest in science, lack of opportunities for science teachers to share ideas, and inadequate time to teach science. These findings were corroborated by the findings from qualitative research, which indicated ways in which these teachers feel they can be empowered, through involvement of external stakeholders. Interviews revealed that even though teachers attend training sessions, professional support of physical sciences teachers is still inadequate. Teachers still feel they are not receiving the in-school support as they should, and there is a lack of science equipment in schools. Above all, they feel that the content is overloaded. The subject advisor felt disempowered due to a high workload. He could not visit physical sciences teachers in their classrooms to offer support in curriculum delivery. As a result, the performance of teachers did not improve because they felt neglected. The study recommends that the physical sciences' content should be streamlined, so as to allow teachers to be fully trained in new topics. Teachers should be responsible for their own development, in their own settings and if there is an external expert involved in developing physical sciences teachers, the professional development programmes should be regularly evaluated and improved. The results of the study were used to develop a model of external support that will improve performance in physical sciences.

Keywords: Curriculum and Assessment Policy Statement, curriculum change, curriculum implementation theories, curriculum implementation, educator support, external educator support, physical sciences, professional development, professional development evaluation, professional development programmes, science teaching.

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ACRONYMS

Ass - Assessment Standards

C2005 - Curriculum 2005

CAPS - *Curriculum and Assessment Policy Statement*

CASS - Continuous Assessment

CBAM - Concerns-based Adoption Model

CDE - Centre for Development and Enterprise

CPT - Continuous Professional Teacher Development

CTA - Common Tasks for Assessment

DAS - Development Appraisal System

DBE - Department of Basic education

DOE - Department of Education

EER - Educational Effectiveness Research

FET - Further Education and Training

GET: General Education and Training

HODs - Heads of Departments

IEA DPRC -IEA Data Processing and Research Centre

IEA - International Association for the Evaluation of Educational Achievement

INSET - In-service Education and Training

LO - Learning Outcome

LTSM - Learning and teaching support materials

NCS - National Curriculum Statement

NGO - Non-governmental Organisation

NIE - National Institute of Education

NPFTED - National Policy Framework for Teacher Education Development

OBE - Outcomes-based Education

OECD - Organisation for Economic Cooperation and Development

RNCS - Revised National Curriculum Standards

SACE - South African Council of Teachers

SD - Standard Deviation

SGBs - School Governing Bodies

SMT - School Management Team

SPSS - Statistical Package for Social Science

TALIS - Teaching & Learning International Survey

TIMMS - Trends in Mathematics and Science Study

USA - United States of America

WCED - Western Cape Education Department

WEF - World Economic Forum

CHAPTER 1

BACKGROUND TO THE STUDY

1.1 INTRODUCTION

South Africa has seen a number of education reforms, such as Curriculum 2005 (C2005), National Curriculum Statements (NCS) and Curriculum Assessment Policy statements (CAPS), since 1996 that were all intended to improve its education system from policy to classroom teaching and learning. These changes targeted the content, pedagogy and also the subject structures. The structural change introduced the learning areas (now referred to as subjects) which are part of Senior Phase (Grades 8 & 9) and the Further Education and Training (FET) bands (Grades 10, 11 & 12). Learners who go through this system sit for their final examination at the end of Grade 12. This is the level where most of them are not performing to the expectation of the parents, teachers and all other stakeholders.

Studies by Howie (2001), Department of Education (DoE), (2001a), Department of Education (DoE), (2002), Martin, Mullis, Gonzalez and Chrostousski (2004), Naidoo (2004), Makgato and Mji (2006), Gregson and Botha (2017), have shown that South Africa has not been performing well in science as compared to her international counterparts. This poor performance in South Africa has always been as a result of poor infrastructure and quality of teachers, because of the historical settings (Scherman & Gaigher, 2012).

Historically, education in South Africa has always been marginalised, it was always preferential against black schools whereby the white schools were provided with good resources by the government whereas blacks were provided education by the missionaries. White schools were well funded by the government and African schools had limited resources (Wilmont, 2015). This was intensified by the laws such as Bantu Education Act of 1953 (Msibi & Mchunu, 2013). This Act legalized provision of poor quality education to black children. The backlogs and inequalities developed by this Act resulted in problems such as under-qualified teachers and poor resources and this has resulted in perpetual poor state of results in physical sciences in the country (Adu & Ngibe, 2014

1.2 PERSONAL BACKGROUND TO THE STUDY

The researcher has been a physical sciences educator for many years in Lejweleputswa district in the Free State, before CAPS was introduced and implemented, and has undergone the struggles of different curricula implementations such as C2005 and NCS. Throughout the curricula reform, there was minimal consultation between the Department of Education and teachers, instead, teachers were superficially trained either during the school holidays or in selected afternoons. There were no follow-up activities because most officials concentrated on paper-work, with less efforts or support on what was actually taking place in the classroom. This lack of in-school support and follow-up activities called the researcher's attention to investigate the professional development support that physical sciences teachers are being provided with and its impact on their teaching and implementation of the new curriculum, namely CAPS in the South African education system.
The following section will briefly describe the South African education system.

1.3 THE CURRICULUM CHANGES IN SOUTH AFRICA

Developed and developing countries around the world have tried to revise their school and higher education curricular, to increase knowledge and skills in order for their citizens to be competitive in the global community (Makgato & Mji,2006). In South Africa, the introduction of Curriculum 2005 (C2005) in 1998 came with challenges to teachers as well as to learners (Kriek & Basson, 2008). In their study, Kriek and Basson (2008) reported the following challenges and factors:

- the amount of content that had to be covered,
- the time constraints,
- the nature and level of content across different grades,
- assessment strategies and progression between these grades.

Their study revealed that there existed a huge gap between what teachers had been trained for in their respective tertiary institutions, and the requirements of the C2005, hence there was a need for a revised and packaged Curriculum and Assessment Policy Statement for Grades R-12 (Kriek & Basson, 2010). This gap brought a lot of changes in the way teachers used to teach, not only to physical sciences teachers, but the South African teaching fraternity as a whole.

All of these changes were new to South African teachers, hence the need to empower them through an appropriate professional development programme that deals with educational reforms, in order to boost their aptitude, morale, attitude and confidence (Adu & Ngibe, 2014). Performance in science has a strong relationship with economic growth, this is why education systems have to monitor science education and improve its quality (Cho, Scherman, Gaigher, 2012; Baker; Hanushek, Jamison, Jamison & Woessmann, 2008). If the education system of any country is of low standard, performance of learners always suffers. Educational Effectiveness Research (EER) has shown that there are many factors which are likely to influence learner achievement directly or indirectly, and has developed some theories and models which can help schools in making learning and teaching of science effective (Cho, Scherman & Gaigher, 2012). Some of these factors are:

- Time on task
- Opportunities used
- Aptitudes towards science
- Attitudes towards science and
- Social context

The other common factor that was identified as a factor which can affect learner performance is adultification or parentification (Nako, 2015). They may lead to poor performance in school subjects, especially in science.

Cho, Scherman and Gaigher (2012) cited the 2003 TIMMS report, in which it was asserted that South Africa has not been performing well in Mathematics and Science when compared to its international counterparts. This sentiment was also shared by Gregson and Botha (2017). South Africa ranked last amongst the 49 participating countries. This poor performance could be attributed to lack of quality teachers in science and the poor infrastructure which was the result of unequal distribution of resources by the Apartheid system (Cho, Scherman & Gaigher, 2012).

Several reports including those from the Department of Education (DoE, 2008) and the World Economic Forum Report of 2012- revealed that approximately 45% of grade 12 learners who wrote the physical sciences examination in 2008 did not achieve the required pass level. A drastic increase in the failure rate was also noted in the 2009 Grade 12 physical sciences results that were released in January 2010. However, since the inception of CAPS in 2012, there has been some change in the National senior certificate results, even though they seem to fluctuate each year.

The following table show some examination results at the National Senior Certificate level for mathematics and physical sciences from 2013 to 2016.

Table 1.1: National performance in Maths and Physical sciences from 2013-2016

	2013			2014			2015			2016		
	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved
Physical sciences	184383	124206	67.4	167997	103348	61.5	193189	113121	58.6	192618	119427	62.0

Source: *Department of Basic Education National Senior Certificate, Report on National Examinations (2016)*

In 2013, there were 184383 candidates who sat for physical sciences National senior certificate examinations. Out of these, 124206 candidates managed to achieve 30% and above, which showed 67.4% pass. In 2014, 167997 candidates were registered for the senior certificate examinations, but only 103348 managed to achieve at 30% and above, which produced 61.5% pass. There was a 5.9% decrease as compared to the results of 2013. In 2015, there were 193189 candidates registered for physical sciences senior certificate examinations, and only 113121 candidates achieved at 30% level, and this was 58.6% pass. There was also a distinctive decline of 2.9% in comparison with the 2014 results. In 2016, there were 192618 candidates who wrote the physical sciences national senior certificate examinations. Out of these, 119427 candidates managed to get a 30% pass, producing a 62.0%pass rate. There was an increase of 3.4%.

Some studies such as Edwards (2010), noted some of the possible reasons that were put forth by examiners' reports after the analysis of final examinations of physical sciences. Among others, the following were noted:

- That, candidates are unable to explain phenomena by applying principles,
- They lack comprehension in dealing with high-order concepts that need reasoning.

The level of training and support given to physical sciences teachers has not addressed issues that may help learners to improve in physical sciences. For many years, education policies have been imposed on teachers in many parts of the world. Teachers have had little or no voice in the changes which affected them. Overload, burnout, discouragement, poor implementation and a rush for early retirement have been widespread consequences (Bantwini, 2009). With the introduction of CAPS, teachers were hoping that their concerns relating to the previous curricula would be limited (Singh, 2011). The following section briefly describes the South African school setting.

1.4 SOUTH AFRICAN SCHOOL SETTING

In South Africa, learners have to pass through four levels/phases before they are enrolled into tertiary education. These are the Foundation phase (grades R-3), Intermediate phase (grades 4-6), senior phase (grades 7-9) and Further Education and Training (FET) phase (grades 10-12). Physical sciences fall under the subjects that are offered at FET phase. The study is based on the professional support of physical sciences.

At the end of grade 12, learners are required to sit for an external examination which will award them the National Senior certificate - a prerequisite to entry into tertiary institutions. Throughout the primary and secondary education, the Department of Basic Education takes the responsibility of funding the schools with textbooks, laboratory materials and teachers' salaries.

The National Curriculum Statement (NCS) requires all learners in grades 10 to 12 to do seven subjects. Two of these subjects must be South African languages. In addition, all learners must offer either mathematics or mathematical literacy and all learners must offer Life Orientation. This compulsory requirement of mathematics or mathematical literacy aims to ensure that all learners are prepared for life and work in an increasingly technological, numerical and data-driven world. Learners who pursue physical sciences are also required to study mathematics (Du Plessis, & Gerber, 2012).

The National Curriculum Statement requires extensive reading and extended writing in all subjects. It requires that learners think carefully about what they learn; that they have a strong conceptual knowledge and are able to apply this in a variety of situations; that they are critical and curious learners; that they are aware of the social, moral, economic and ethical issues which face South Africans and citizens around the world (DoE, 2009).

The following section tabled the recent educational reforms that led to National Curriculum statement (NCS) and CAPS.

1.4.1 The National Curriculum Statement and CAPS

Since 1994, South Africa has undergone a great deal of educational change, which was necessary because of the situation inherited by the first democratic government (Ono & Ferreira, 2010). Following the 1994 elections, one of the first tasks of the National Education and Training Forum was to begin a process to revise the national syllabi and to have certain subjects rationalised with the aim of laying the foundation for a single national core syllabus (Adu & Ngibe, 2014).

The adoption of an OBE approach that underpinned the introduction of Curriculum 2005 was a very challenging aspect. This was a unique curriculum reform in the history of South Africa and probably the most significant one in the history of South Africa in the last century (Ono & Ferreira, 2010).

Deliberately intended to simultaneously overturn the legacy of apartheid education and propel South Africa into the 21st century, it was an innovation both bold and revolutionary in the magnitude of its conception (Wilmont, 2015). As the first major curriculum statement of a democratic government, it signalled a dramatic break from the past (Department of Education, 2000). Twenty-four years later, however, it is widely recognized that many of these ambitious goals were undermined by a defective implementation process that resulted in curricular outcomes very different from those envisaged by the curriculum planners. In the following section, factors that led to the revision of the C2005 and NCS are discussed.

The report of the Review Committee on C2005 revealed that, while there is still overwhelming support for the principles of Outcomes-Based Education (OBE) and C2005, implementation in the schools has been confounded by a range of factors, namely:

- *A twisted curriculum structure and design*
- *Lack of coalition between curriculum and assessment policy*
- *Insufficient quality and availability of learning support materials*
- *Policy overload and limited transfer of learning into classrooms*
- *Shortages of personnel and resources to implement and support C2005*
- *Inadequate recognition of curriculum as the core business of education Departments*
- *Inadequate orientation, training and development of teachers* (DBE, 2011: 10).

OBE is considered to have its roots in two educational approaches, namely: the competency-based education movement and mastery of learning. Competency-based learning aims to prepare learners for success in fulfilling various life roles. William Spady, who first presented his framework in 1988, led the development of an OBE model that derives from competency-based learning. In order for learning to be mastered, learners can achieve the desired teaching outcomes if favourable learning conditions prevail, such as flexibility in the time provided and alternative ways of learning (Du Plessis & Gerber, 2012).

In March 1997, the then Minister of Education, Professor Sibusiso Bengu, launched C2005 and announced a process whereby the new curriculum would be phased in from 1998 to 2005. Thus the OBE and the development of C2005 was adopted (Du Plessis & Gerber, 2012). In 2010, the curriculum was reconstructed once again and, according to the Minister of Basic Education, Ms Angie Motshekga, the following steps were taken (DBE 2010: 2-7):

- *a reduction in the number of projects for learners;*
- *a discontinuation of the need for portfolio files of learner assessment;*
- *a reduction in the number of teachers' files to a single one; the discontinuation of Common Tasks for Assessment (CTAs) for Grade 9 learners from January 2010;*
- *Tests for Grades 3 and 6 to be set nationally, and the establishment of three committees to implement the new curriculum, namely:*
- *the Curriculum and Assessment Policy Statements Ministerial Project Committee (the Subject Learning Area by Grade guidelines were known as the Curriculum and Assessment Policy Statements (CAPS), to be implemented in a two-year time frame)*
- *the Committee for the Reduction of Learning Areas in the Intermediate Phase in the General Education and Training (GET) band (the NCS with its eight learning areas for the Intermediate Phase would be repackaged into six learning programmes, known as subjects), and*
- *the Learning and Teaching Support Materials Committee (this includes the distribution of learning and teaching support packs for Grade R teachers, as well as lesson plans in Literacy and Numeracy for Grades 1-6).*

These recommendations may have a positive effect on teachers' views about the changes in curriculum. It might also provide valuable information about what needs to be done in order to sustain the change as well as to ensure that the ideals of the new curriculum are realised. Teachers' views might also be considered as necessary because they know what might motivate them.
The following section deals with the in-servicing of teachers by the Free State Department of Basic Education.

1.4.2 In-service Programmes for Teachers

The Department of Basic Education through its curriculum development services and Subject advisors have been organising training for teachers who are already in schools, and this is referred to as In-service Education and Training (INSET). This training is conducted in specific subjects and one of these subjects is physical sciences. Accordingly, the providers of teachers' training and development continue to search for meaningful ways of making INSET transferable into the classroom.

At the beginning of each year, teachers who belong to the same cluster/area meet to discuss issues pertaining to the previous year's examination results, the new teaching requirements for the coming year and the way forward. It is where teachers are trained for the implementation of the curriculum. It is during these trainings, that it becomes clearer that there is a gap that exist between the content knowledge that the subject advisors offer with the knowledge and experiences that teachers bring along to the workshops. Sometimes training of teachers continues even during school holidays, but mostly once per term in one afternoon.

The researcher therefore felt the need to evaluate the support activities that will inform the type of professional development programmes, which may interest teachers, other than the one provided by the Free State Department of Basic Education. The researcher also feels that if physical science teachers can be part of these programmes, this will improve their performance in teaching the subject, hence also be beneficial to the country as a whole.

1.5 PROBLEM STATEMENT

Despite the efforts by the government to support teachers in implementing CAPS, recent research (Bantwini, 2010, Mogashoa, 2013, Bjorklund,2015) indicates that physical sciences teachers in particular, still have an unsatisfactory perception of the support they get from the Department of Basic Education as a whole. This lack of support seems to impact on the implementation of CAPS and classroom practice (Kriek & Basson, 2012). There is a vast amount of change and incorporation of content which was not part of the grades in the previous dispensation, and the fact that the South African teaching fraternity as a whole has not been adequately trained for effective implementation of CAPS. This research will provide a support framework/model that may be applied so that all the physical sciences teachers in the district feel empowered and confident to tackle all the teaching challenges that came with the introduction of CAPS. In the light of the above, the study intended to answer the following research questions:

1.5.1 Research Question 1

What problems are encountered by physical science teachers when implementing CAPS?

In order to determine the type of support that would be suitable for physical sciences teachers in the Lejweleputswa district, the type of problems that these teachers are faced with in their day-to-day duties in their classrooms have to be determined. This would then determine the type of professional development programmes that would cater for their problems.

1.5.2 Research Question 2

What type of support programmes are provided to physical sciences teachers?

The Department of Basic Education through its districts has been providing schools with training sessions which focus on the implementation and interpretation of policy documents. The training sessions also focus on of content knowledge and pedagogical issues. This research question would form the basis and starting point of the study, in identifying and determining the need for further support programmes that could be provided to the physical sciences teachers.

1.5.3 Research Question 3

How best could teachers be supported to improve physical sciences teaching in schools?

The study will determine the types of professional development programmes that can benefit physical sciences teachers to improve their morale, classroom practice and performance in physical sciences.

1.5.4 Research Question 4

What should a framework of quality external support for physical sciences teachers include?

By working closely with physical sciences teachers in the district, the study intends to investigate the different types of professional development programmes and come up with a suitable framework for support that will cater for teachers' needs even in future. This can be the basis for further research in professional development of teachers and most importantly, further exploration of the approaches of in-service education.

1.6 AIM AND OBJECTIVES OF THE STUDY

The main aim of the study is to develop a framework for quality external support for the physical sciences teachers. The research questions can be answered through achieving the objectives of this study, which are as follows:

- establish problems that are encountered by physical science teachers when implementing CAPS.

- evaluate type of support programmes that are provided to physical sciences teachers.
- ascertain how best teachers could be supported to improve physical sciences teaching at secondary schools.
- recommend a framework of quality external support for physical sciences teachers

1.7 SIGNIFICANCE OF THE STUDY

This research focuses on the township secondary schools in the Lejweleputswa district. Most parents have a perception that there is a lack of quality education in these schools (Segalo, 2014). Parents spend a lot of money to transport their children from the townships to former “whites-only” schools situated in towns, because according to them, teachers in those schools offer quality education than the local township schools (Segalo, 2014). The study looked at the contexts of township secondary schools and whether the support that teachers from these schools are receiving, has any impact on classroom practice.

In the light of the forgoing, this study seeks to develop a framework of support for teachers that will help to accommodate them in dealing with the new concepts in the new curriculum, and to suggest relevant preparation programmes to develop necessary skills and competences, and thereby contribute to the body of knowledge on the broader professional development of teachers.

1.8 RESEARCH DESIGN AND METHODOLOGY

The following paragraphs highlight the research design and methodology that are implemented in this study.

1.8.1 Research Design

A research design describes sets of procedures that are used by researchers in order to collect, analyse and report their data in a research (Clark, Vicky & Creswell, 2015).

In order to evaluate the type of professional support provided to physical sciences teachers in the Lejweleputswa district, an empirical research was conducted using two research approaches, namely qualitative and quantitative approaches to collect data. Data was collected concurrently and integrated during interpretation phase. This allowed for confirmation of results, substantiation or cross-validation within a single study (Terrell, 2011). Data was also integrated during analysis.

The researcher's epistemological stance comes from an interpretivism point of view as findings from this research provided the researcher with meaning on why physical sciences teachers are feeling the way they do. The interpretivism paradigm is influenced by phenomenology, an approach that promotes the need to consider the subjective interpretations of human beings and their perceptions of the world (Nieuwenhuis, 2016). People are surrounded by many phenomena, which they are aware of but not fully understand (Rossman & Rallies, 2017; Edmonds & Kennedy, 2017), and *it is assumed that by studying people in their social contexts or natural environment, there is greater opportunity to understand the perceptions they have of their own activities* (Nieuwenhuis, 2016:60).

In this study, the phenomenological research design was implemented to understand the participants' personal feelings on the professional support. Phenomenological study tries to relate to peoples' perceptions, perspectives and understanding of a particular situation as opposed to the event as it exists external to a person (Leedy & Ormrod, 2015; Steyn, 2009 & Maree, 2016). Steyn (2009) asserted that phenomenologists tend to put aside their pre-conceived ideas before they collect data so that they can have a broad description of the meaning or essence of the phenomenon in question. This was mainly why the researcher, despite being an ex-physical sciences teacher, had to use questionnaires and conducted interviews in order to gain insight into the experiences of physical sciences teachers.

This study is phenomenological in the sense that there seem to exist a gap between what the physical sciences teachers have been trained on, to the way they are expected to implement CAPS policy when teaching physical sciences. There are new topics that they have to deal with, there is a lot of practical work that learners have to engage in, and the time to do all these is limited. This type of research will not necessarily provide absolute explanations, but it does raise awareness and increases insight on the investigated phenomenon.

1.8.2 Population and Sample

Creswell (2012:142) regards population as "*a group of individuals who have the same characteristics".* So population can be a precise group of people or objects that possesses the characteristics that is questioned in a study. In this study, the population was the grades 10 to 12 (FET) physical sciences teachers in the Lejweleputswa district.

McMillan (2012) and Creswell, Ebersohn, Eloff, Ferreira, Ivankova, Jansen, Nieuwenuis, Pietersen, Plano Clark (2016) state that a group of participants who will represent a larger group of individuals and provide targeted responses represent a sample of the study. For the purpose of this study, the researcher collected data from teachers who teach physical sciences, in Lejweleputswa district, and not in the whole of the Free State province. The type of a sampling technique used in this study was purposive sampling. Purposeful sampling was utilized to select participants who provided both quantitative and qualitative data, to represent the teachers who teach physical sciences in the semi-urban and townships around Lejweleputswa district. Purposive sampling as Creswell *et al., (*2016) state, is precisely what the name suggests.

Members of a sample are chosen with the purpose of providing rich information because they have specific characteristics. These may not necessarily be representative of the larger population if the rest of the population do not exhibit the same characteristics that a researcher is looking for.

The rationale for employing purposive sampling was to sample teachers residing under one district and who therefore receive the same training offered by the same departmental officials. One Physical sciences subject advisor out of two was purposefully interviewed to gather information on the type and nature of training the Free State Department of Basic Education has been providing to the teachers. Focus groups interviews were conducted with twenty-one teachers from three of the five clusters in the Lejweleputswa district. Each focus group comprised of between five and eight teachers. The researcher wanted to investigate the problems these teachers encounter in their everyday classroom practices as well as in their respective school contexts regarding the implementation of CAPS. Teachers also provided information on the type of professional development programmes they are provided by the Department of Basic Education, through their district. Twenty-one physical sciences teachers were interviewed in groups seven (focus groups). They provided information on the type of professional development programmes that they were provided with from when CAPS was implemented, the type of support they were receiving from the Free State Department of Education as well as information on how they feel they ought to be supported.

Simple random sampling was used to select the teachers who responded to the questionnaire. One hundred questionnaires were distributed to fifty secondary schools in Lejweleputswa district, which offered grades 10 to 12 physical sciences. This sample included teachers who would have received or who would not have received training in the implementation of CAPS.

1.8.3 Data Collection Instruments

Data collection instruments that were used to collect data were interviews, questionnaires.

1.8.3.1 Interviews

According to Okeke and Van Wyk (2015: 297), an interview is "*an interpersonal face-to-face conversational engagement between two people where questions are asked by the interviewer in order to elicit responses that can be analysed within qualitative research situations*". Interviewing, when considered as a method for conducting qualitative research, is a technique used to understand the experiences of others (Ravitch & Carl, 2016; Creswell *et.al.,* (2016). It seeks to describe the meanings of central themes in the life world of the subjects. It has to be a planned exercise that follows an ordered and rational pattern.

The aim of employing interviews as part of the data collection methods was to get an individual's or a group's perspective about their experiences in the implementation of the CAPS when teaching physical sciences and the support they received from the Department of Basic Education.

In this study, semi-structured interviews were conducted. Semi-structured interviews as Nieuwenhuis, (2016) indicates, allow for probing of views and opinions where it is desirable for the participants to expand on their answers. Teachers were asked questions which allowed them to elaborate their views on the type of training and support they received from the Free State Department of Basic Education. This was done to gather information on the type of in-service training services that teachers have been provided with and their views on their training.

There are two subject advisors for physical sciences in the Lejweleputswa district, but only one of them was interviewed because of his vast experience of being part of all the different curricular changes that took place from 2001 to date. The aim was to gather information on the type of training they have been providing as departmental officials, which schools attended the training and how often do they offer training to teachers.

The other aim was to get clarity on the follow-up activities, the absence of which will need extra support in the future. The other research instrument that was employed was the questionnaire.

1.8.3.2 Questionnaires

A questionnaire is a self-report data collection instrument that each research participant fills out of a research study (Kumar, 2014, Creswell, 2012, & Maree and Pietersen, 2016). Questionnaires are used by researchers to obtain information about the thoughts, feelings, attitudes, beliefs, values, personality and behavioural intentions of research participants. Questionnaires are relatively economical, have standard questions, ensures anonymity, questions can be written for specific purposes and can be delivered and collected by hand (Kumar, 2014 & Maree and Pietersen, 2016).

For purposes of this study, the researcher formulated a set of questions and statements, appropriate to the research problem with the aim of finding justification for the existence of such in-service training and its possible extent. The questionnaire mostly was comprised of closed-ended questions, as open-ended questions sometimes tend to provide data that is difficult to code and analyse. In close-ended questions, respondents must select from the predetermined responses provided by the researcher.

Questionnaires were delivered by hand to all the secondary schools in the Lejweleputswa district, which offer physical sciences. The following table is a summary of the research instruments that were used in the study.

Table 1.2: Research instruments

Research tool	Focus	Purpose	Sample	Research questions
Semi-structured interviews	Departmental officials (subject advisors)	To determine how subject advisors, support physical sciences teachers	One physical sciences subject advisor	*How best could teachers be supported to improve physical sciences teaching in schools?*

	Physical sciences teachers	To evaluate type of support programmes that were provided to physical sciences teachers and to ascertain the type of professional development programmes that they envisage so as to improve their teaching practice	Focus groups interviews were done with twenty-one teachers. Each focus group comprised of between five and eight teachers.	*What problems are encountered by physical science teachers when implementing CAPS?*
Questionnaires	Physical sciences teachers	evaluate type of support programmes that were provided to physical sciences teachers, and the impact of those programmes in their teaching practice	A maximum of three questionnaires were distributed (in most schools there is only one teacher who teaches physical sciences, whereas in other schools, there would be more than three educators).	*What type of support programme are provided to physical sciences teachers?*

1.8.4 Data Analysis

The data on the survey questionnaires was analysed using the Statistical Package for Social Science (SPSS). This is important to reveal any possible errors in the data that might have skipped the researcher's eye. The other important reason for using SPSS in analysis is that it performs reliability and validity of the tool that was used.

The data for the interviews was analysed verbatim, that is, transcribed from the original hard-copy transcripts. Analysis was done by re-organising respondents' responses provided during interviews and the information was then compared with information from questionnaires, to compare the compatibility of the two instruments. Data was also integrated to check for the same responses from both instruments. During analysis of the questionnaires, any data that displayed some contrasting information was corroborated during the interviews.

1.9 ETHICAL CONSIDERATION

The following ethical considerations were taken into account while conducting the research:

- Permission letter from the Free State Department of Education was sought to conduct this research in Lejweleputswa district.
- Participants were assured of their privacy, anonymity and confidentiality regarding information gathered during the study, and they were presented with some consent letters.
- Prior to data collection, teachers were informed about the aim, purpose of the study, analyses methods and how reporting of data was to be done on an ethical level.
- The research methods and techniques were revealed to teachers and the subject advisor during the progress of the study.
- All sources consulted were acknowledged and resulting recommendations, including the in-service framework that arose from the study will be utilised to improve the support structures of physical sciences teachers and their classroom performance.

1.10 DELIMITATION AND LIMITATIONS OF THE STUDY

Leedy and Ormrod (2015) refer to the delimitation of the study as the relevance of the study being generalised and the parameters that the study is going to cover. Limitations of the study are *the weaknesses that may cast doubts on the results and interpretations* (Leedy & Ormrod, 2015: 353). This includes all things that may prevent the researcher to perform the research in the wider scale.

1.10.1 Delimitation of the study

The study is conducted in the field of curriculum development of education in order to:

- contribute to the existing body of knowledge in the field of professional development of teachers
- establish the significance of support in order to have quality education in township schools
- strive to provide suggestions and recommendations on how to develop, sustain and maintain quality support for physical sciences teachers in township secondary schools.

1.10.2 Limitations of the study

Limitations to the study are *the weaknesses that may cast doubts on the results and interpretations* (Leedy & Ormrod, 2015: 353). One of the most common limitations is related to the nature of the methodology that was used (McMillan, 2012). The study employed a phenomenology stance, whereby perceptions of individuals were quoted verbatim, which implies therefore that, conclusions from such could not be reached as representing the whole population of physical sciences in the country. The main limitation of the study was that the findings could not be generalised to all the secondary schools in the Lejweleputswa district due to the fact that other schools seem to be improving learner performance in grade 12 physical sciences, whereas others are still on the same page as before, as well as the quality of physical sciences results that are published yearly. Consequently, the results could not be inferred to primary schools and former “whites-only” schools.

Data was collected during the early years of implementation of CAPS, so the gap that existed in terms of support programmes, may have improved and so the perception of teachers might also have changed.

1.11 VALIDITY AND RELIABILITY OF RESEARCH METHODS

Both qualitative and quantitative methods conceptualize the validity and reliability of the research differently.

The following is an outline of the different approaches, specifically regarding how the validity and reliability of research is conceptualised by scientists in the human sciences.

1.11.1 Validity and Reliability of Quantitative Research

The validity of the research refers to the extent to which the instrument used to collect data measures what it purports to measure (Bless, Higson-Smith & Sithole, 2013). McMillan (2012: 131) describes validity as *an overall evaluation of the extent to which theory and empirical evidence support interpretations that are implied in given uses of the scores.*

In the context of this research, a questionnaire was designed to elicit information on professional development activities provided for physical sciences teachers. Amongst others, the questionnaire contained some questions that were adapted from the *International Association for the Evaluation of Educational Achievement (IEA), The Netherlands…IEA Data Processing and Research Centre (IEA DPC), Germany Statistics Canada, Canada.*

Leedy and Ormrod (2015:117) refer to reliability in quantitative research as the *consistency with which measurement instrument yields a certain, consistent result when the entity being measured has not changed.* In addition to that definition, *McMillan (2012: 137)* refers to reliability *as the extent to which participant and/or rater scores are free from error.*

Reliability of a study refers to the accuracy of the researcher's study methods and techniques, and to what degree it can be maximised. It also refers to the consistency of scores or measures from one administration of an instrument to another and from one set of items to another (Fraenkel, Wallen & Hyun, 2015). If there is consistency with which the research tools produce the same results, then reliability will have been measured (Leedy & Ormrod, 2010; Leedy & Ormrod, 2015; Gay, Mills & Airasian, 2011; McMillan, 2012).

Analysis using SPSS showed some amount of error in some questions that were left unanswered. This might be due to the attitudes of the respondents at the time, or the type of questions. The questionnaire was expected to produce the same general results in the various contexts that it was used. Furthermore, the research study used internal consistency to ascertain that items on the questionnaire were measuring the same thing by ensuring that items of question statements are consistent with the literature received on the research questions.

1.11.2 Validity of Qualitative Research

Validity of qualitative research refers to the "trustworthiness" of the research, and its ability to be defended when challenged. Validity is often related to the operationalization of concepts (Gay, Mills & Airasian, 2011). This means that the researcher needs to be able to demonstrate that concepts can be identified, observed or measured in the way it has been planned. Johnson and Christensen (2012) argue that experimental validity that includes both internal and external validity for interpreting the results for generalisation should be followed. For the result to be valid, the instrument must measure what it is supposed to measure in order for the findings of a research study to present a true and accurate picture of what is claimed to be described. The researcher had to identify the measures of validity and the interpretation of answers from the respondents.

In qualitative research, trustworthiness is referred to the degree of consistency which is assigned to the same category by different observers or by the same observers at different occasions, whether the instrument will measure data in a consistent way when used in a different setting.

Trustworthiness of qualitative investigation establishes the credibility and confirmability of the research results (Newton, 2009; Creswell, 2013). Through the employment of triangulation, whereby data was collected and analysed simultaneously, the researcher could decide whether the results were credible or not. Even though the study was undertaken in Lejweleputswa, it is believed that the same type of data could also come out in the same way, even in other education districts, because the issue of support is the whole country's plea, thus showing dependability of the instrument.

Confirmability is the degree of neutrality in the research study's findings (Nieuwenhuis, 2016). The use of a tape recorder was to ensure that the researcher would transcribe the interviews verbatim, and not skew the interpretations in any way.

1.12 RESEARCH PLAN

Chapter **one** provides the background to the South African education system and the indication of the necessity to give support to physical sciences teachers.

Chapter **Two** presents the literature review on curriculum change and professional development programmes of teachers through in-service as depicted internationally and in South Africa.

Chapter **Three** discusses the theoretical framework that was used as a lens through which the study had to be based upon.

In Chapter **Four** highlights research design and methodology. It also provides research processes that were followed during the gathering of quantitative and qualitative data.

Chapter **Five** provides data presentation and analysis.

Chapter **Six** discusses the findings, recommendation and conclusions of this research. It also provides a quality external support framework for the Further Education and Training (FET) Phase physical sciences teachers.

1.13 SUMMARY

The purpose of this introductory chapter was to provide an overview of the study. This included the brief discussion of professional development and support of teachers in the FET phase. The problem statement was stated, the aim of the study was rendered, the research questions were formulated and stated, and methodological procedures were described. This plan that was included in this chapter will provide a framework of what will happen throughout the study. The following chapter provides literature review on curriculum change and professional development.

CHAPTER 2

CURRICULUM CHANGE AND PROFESSIONAL DEVELOPMENT OF TEACHERS

2.1 INTRODUCTION

In this chapter, the literature will be sourced on the curriculum changes in South African education system to shed light on what brought about the changes, and how these changes have affected teachers' practices. The chapter will further clarify the introduction of curriculum and assessment policy statement (CAPS) in schools and how this affected physical sciences teachers in terms of their training and support. Some literature on external support in the implementation of curriculum will also be sourced to shed some clarity on what should have been done. The concept of professional development of teachers will also be discussed as a way of support mechanism for teachers who are responsible for implementation of a new curriculum, and how teachers' beliefs, attitudes and behaviours affect the way in which they react to a new curriculum. Lastly, Guskey's levels of evaluation of a new curriculum will be discussed as a theoretical lens through which a new curriculum can be assessed in order to support teachers.

2.2 CURRICULUM CHANGES IN SOUTH AFRICA BEFORE 1994

For many years, education policies have been imposed on teachers in many parts of the world. Teachers have had little or no voice in the changes which affected them. Overload, burnout, demoralization, poor implementation and a rush for early retirement have been well-known cost (Bantwini, 2009 & Gudyanga, 2017).

In South Africa specifically, schools have been confronted with educational reform since the mid-nineties and this process is still continuing. These changes in curricula put a very high demand on physical sciences teachers and also have had a strong impact on their behaviour (Bantwini, 2009). The goals of physical sciences teaching demand the implementation of good professional development programmes. These programmes are designed in different ways by different countries, but the main issue here being the development of science teachers to improve their teaching of physical sciences in the classroom. Below are the different curricula reforms that have been taking place in South Africa since 1994.

2.2.1 Pre-1994 Curriculum in South Africa

Before 1994, South Africa had a teacher-centred form of curriculum, known as NATED 550. It was authority-driven, content-based, elitist, examination-based and Eurocentric. This was a practice of maintaining the status quo of preserving the master-servant relationship between the Africans and the whites. Under this curriculum, learners were subjected to rote learning and teachers used to follow the syllabus, preparing the learners for examinations. White learners that were recipients of this curriculum were privileged with a more content-centred and academically oriented Christian National Education, while the Africans received a more watered-down and culturally inclined Bantu Education (Carrim, 2001 in Msibi & Mchunu, 2013). The democratically elected government which came into power in 1994 had to undergo thorough reforms to eradicate apartheid, and one of the important reforms that took place was in education (Adu & Ngibe, 2014).

Before 1994, there were 19 departments of education catering for different provinces, homelands and population groups, and the important task of curriculum reformers was to unify these different departments to form one department. The other task was to develop a new curriculum policy that would replace the racially offensive, sexist and outdated apartheid curriculum, as well as overcoming the inequalities of the past and to prepare citizens for full involvement in a democracy (Rogan & Grayson, 2010). The vision for education that emerged was to integrate education and training into a system of lifelong- learning which was considered to be sustainable. South Africa embarked on drastic education reform, and this has been justified by the continuous change in curriculum policy systems since 1997, when the first change was introduced (Valero & Skovsmose, 2002). In 1998, the new curriculum called Curriculum 2005 (C2005) was designed and developed, and it is believed to be the largest and most important in the history of curriculum studies (Adu & Ngibe, 2014). The emergence of C2005 is briefly discussed below.

2.2.2 Curriculum 2005

When C2005 was implemented, it was based on the principles of outcomes-based education (Jansen & Taylor, 2003). Outcomes-based education (OBE) was adopted therefore as an approach that would enable expression between education and training, through recognition of prior learning and to increase mobility for learners (Adu & Ngibe, 2014). It's implementation in schools demanded new approaches to teaching, learning, assessment and management within the classroom and school, and it focused on a decentralized curriculum (Hartell, Steyn & Chetty,2015).The introduction of this system of education was not done merely to change the South African education system, but also for the purpose of transforming the mental capacity of the society as a whole, that one of having parents and learners' guardians who were supposed to own their children's education and have a say and contribute as much as possible.

This curriculum advocated for an educator to be more of a facilitator because of its learner-centeredness form. One of the highlights of this curriculum was to let learners work at their own pace and the teacher's input was no longer central, (DoE, 2002). The C2005 was thought out to be much better than the pre-1994 education system as it also advocated for learning outcomes that learners should be able to demonstrate after a period of instruction. It required continuous, formative assessment rather than the once-off high stakes examinations that were the features of the pre-1994 education system.

Teachers were not well trained for this type of curriculum and their professional training was not aligned with the OBE approach. This non-alignment of professional training generated gaps in grave activities such as lesson preparation, methods of lesson facilitation and assessment strategies. This led to poor implementation of the curriculum in schools (Hartell, Steyn & Chetty, 2015). The Department of Education (DoE) used a cascade method where selected teachers were supposedly trained to train other teachers.

This method was not as ideal as it appeared that even the trainers themselves were not so sure of what they were doing (Koopman, Le Grange & De Mink, 2016). This sentiment is also shared by Bjorklund (2015) who noted that the trainers were not properly trained for the task at hand.

Even though they could explain the design and structure of the curriculum, they were not adequately skilled to effectively help teachers with the implementation. There were little or no follow-up support structures for teachers who had to deal with the long-term implementation of the new reforms (Dichaba & Mokhele, 2012). Other issues that hampered the implementation of the curriculum were the classrooms contexts, which were and are still complex and diverse in terms of resources, large amount of paperwork required, which was more evident in schools with limited resources, the educational and cultural backgrounds of teachers and learners, as well as the school culture and class size.

According to Jansen and Taylor (2003:37), C2005 had some flaws and it was criticized due to the following reasons:

- *Teachers were not directly trained in the GET phase of schooling*
- *It used a highly inaccessible and complex language*
- *The large-scale discrepancies in resources and capacity between the few privileged schools and the large mass of disadvantaged schools with respect to implementation*
- *The power of existing curricula, teachers' socialization and the all-pervasive system of examinations and control*
- *The lack of confident and competent teachers to manage the curriculum and*
- *The critical lack of a solid learning materials base, supports the pedagogy and philosophy of this progressive curriculum.*

The curriculum also ignored the content and the specification of what was to be learned in favour of the process and it strongly advised for integration of various curriculum parts, but it was not so clear about the content demands for progression that would enable learners to move from one grade to the next. That means, for physical sciences teachers to progress, they either followed the NATED 550 curriculum in terms of the syllabus or used their discretion on the amount of content they had to cover in a grade. This was more evident in learners from disadvantaged schools which lacked essential facilities and other technologies of teaching needed to implement C2005 effectively (DoE, 2000 & Christholm & Leyendecker, 2008). Due to the deficiencies of C2005, a new revised curriculum was established, namely, Revised National Curriculum Statement (RNCS). This will be briefly outlined below.

2.2.3 Revised National Curriculum Statements

A more streamlined curriculum called the Revised National Curriculum Statements (RNCS) was introduced in 2002 (DoE, 2002a). This policy was aimed at transforming teaching and learning. This curriculum somehow managed to remove some of the heavy language barriers established by C2005. According to the RNCS (DoE, 2002a), teachers in Early Childhood Education had to dedicate at least 40% of teaching time to literacy. The curriculum emphasized communicative language and literacy development in the Foundation phase, without clear directives being given to teachers on how to teach and facilitate this language acquisition (Hartell, Steyn & Chetty, 2015). Even though it came at the right time when teachers were not sure of what to do with Grade 10 learners, it lacked guidance in terms of teacher pedagogical skills and it did not address the classroom contexts of teachers (Mudzielwana, 2012). Physical sciences teachers struggled to incorporate the new content into their teaching because there were not clear directives on how to deal with such, therefore most of them resorted to the old system of teacher-centred teaching which promoted rote learning.

They were still faced with problems of large classes and inadequate materials and as result, even the amount of practical work that was supposed to be covered was very limited. (Koopman *et al.,* 2016). Following negative public perceptions about Outcomes-Based-Education (OBE) in South Africa, the Minister of Basic Education established a Ministerial Committee in 2009 to undertake a review of the curriculum. This led to the introduction of the National Curriculum Statement (NCS) as the third initiative, aimed at improving teaching and learning.

2.2.4 The National Curriculum Statement for Grades R-12

A new National Curriculum Statement (NCS) for Grades R-12 was introduced in 2006 (DoE, 2006). This curriculum came with improved pedagogical skills, (Hartell, Steyn & Chetty, 2015). There were clear yearlong schedules, a learning programme, lesson plans and clear assessment guidelines. Its outcomes emphasized skills, knowledge and values that leaners should acquire and demonstrate during the learning process. The main aim of NCS was to produce a learner who could think logically, analytically, holistically and factually (DoE, 2006, & DoE, 2008). According to this curriculum, teachers were expected to be designers of learning programmes and materials, researchers and subject specialists (DoE, 2003). In this curriculum, as opposed to C2005, each Learning Outcome (LO) was accompanied by Assessment Standards (ASs) which described ways in which learners should attain these outcomes. The following table shows the ASs and the respective LO for physical sciences.

Table 2.1: Assessment Standards for NCS physical sciences for the respective Learning Outcomes in the FET phase

	Learning Outcome 1: Practical Scientific Inquiry and Problem-solving Skills (LO 1)	**Learning Outcome 2:** Construction and Application of Scientific Knowledge (LO 2)	**Learning Outcome 3:** The Nature of Science and its Relationship to Technology, Society and the Environment (LO 3)
Assessment Standards (AS)	Planning and conducting an investigation	Recalling and stating concepts	Integrating science with technology and Mathematics
	Accurate and reliable collection of data	Explaining interrelationships between facts and concepts	Impact of science on ethical and moral arguments

	Interpreting data and seeking patterns and trends	Applying scientific knowledge	Impact of science on the environment and social development

Constructed from Department of Education Policy Document (2003:13-14, 17)

According to the NCS policy document (DoE, 2003), ASs are vehicles of knowledge, skills and values through which the learning outcomes are addressed. The LOs for Grades 10 to 12 are the same but the ASs differ across the grades, serving to indicate the level at which the LOs must be achieved in each grade. The NCS in the FET phase is also based on the three LOs, namely, skill, knowledge and application. Each outcome has three assessment standards, except for LO1**,** which has four. In order to implement these, teachers are supposed to be innovative in their teaching strategies to expand their knowledge and perceptions about how they think learners should learn.

The National Curriculum Statement Grades R-12 (NCS) stipulates policy on curriculum and assessment in the schooling sector (DBE, 2011a). Since its introduction, physical sciences teachers experienced many challenges with regard to its implementation. It introduced many changes and new content knowledge areas such as Mechanics (*two-dimensional motion and two-dimensional momentum), Lasers, the Doppler Effect, two-dimensional and three-dimensional waves, Electrodynamics, Electronics, Mechanical properties of light and Electromagnetic radiation* (Koopman *et al.,* 2016), and core concepts, such as learning outcomes (LOs), assessment standards (ASs) and the inclusion of practical investigations as well as research projects (DBE, 2011a).

In their study, Mchunu and Imenda (2015) chose mechanics as one of the most challenging sections of the physical sciences curriculum. Due to the nature of NCS, the content was not dealt with during the workshops, and this continued to be a problem as there was no clear indication on how far an educator has to deal with the section. To address these challenges, new amendments to the curriculum came about in the form of Curriculum and Assessment Policy Statements (CAPS), to make it more inclusive and concise for it to be easily followed by teachers. CAPS is briefly discussed below.

2.2.5 Repackaged Curriculum and Assessment Policy Statement

In response to the recommendation of the Ministerial Committee to streamline and clarify the curriculum policy, national Curriculum and Assessment Policy Statements (CAPS) have been developed for each subject, replacing Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines listed in the National Curriculum Statement (NCS) for Grades R to 12 (DBE, 2012b). CAPS is an adjustment to what teachers teach (curriculum) and not their teaching methods (Pinnock, 2011, Du Plessis & Gerber, 2012). The Minister of Basic Education, Ms Angie Motshega stressed in a Government Gazette that the CAPS: *"must not be seen as a new curriculum but only as a refined and repackaged NCS"* (DBE, 2010: 7). Under this "refined" NCS, teachers are expected to have an adequate understanding of all the attendant changes, as well as applied competences to successfully implement the curriculum. This means teachers have to be conversant with the requirements of the different LOs and ASs. In the past C2005 and RNCS, subjects in the General Education and Training (GET) band were called learning areas. Under CAPS, they are traditionally referred to as subjects, and they are reduced from eight to six. Subjects such as Natural Science and Technology have been combined to form one subject. As every subject has a single inclusive and concise policy document, teachers need to have skills to plan and assess practical investigations and research projects, as well as skills in developing the attendant assessment rubrics.

CAPS has brought about significant changes in the methods of assessments, time that learners have to spend in the classroom from grades R-12, as well as new teaching approaches (Maharajh, Nkosi & Mkhize, 2016). The Department acknowledges that CAPS is not a solution to implementation challenges. It asserts though, that the simplification of the curriculum will go a long way in assisting with other barriers to quality education (DBE, 2012b). The following is an example of how a physical sciences teacher has to apply the pedagogical skills when dealing with a problem in physics:

As learners progress through the FET phase, their knowledge of scientific concepts is strengthened. When teaching Boyle's law in physics, a physical sciences educator must not merely guide learners to collect data to verify textbook information as in the former apartheid curriculum, instead, "*the educator now has to develop the learner's insight into the objectives and rationale behind these experiments by guiding them to understand what led Boyle to arrive at these laws. It follows that the educator needs to familiarize himself with the work of Torricelli, his experimental evidence for atmospheric pressure, and his design of the barometer from which Boyle derived his theories, furthermore, it is expected of teachers to encourage their learners to develop practical skills in the science classroom, by allowing them to design their own experiments and collect similar data that will confirm the inverse proportionality relationship between volume and pressure if the temperature remains constant. Learners are then expected to link Boyle's law to real life applications such as in the tyre industry where tyres with stronger casings reduce road accidents. Teachers must also promote higher order cognitive skills in the learners in order for them to understand that an increase in temperature results in an increase in pressure, therefore, a stronger tyre casing would reduce the number of road accidents caused by tyre bursts*" (Koopman *et al.,* 2016 :13 & DBE, 2011).

The repackaged curriculum (CAPS), also has already been scrutinized by different scholars. A study by Nakedi, Taylor, Mundalamo, Rollnick and Mokeleche (2012), pointed out that the physical sciences curriculum continues to be loaded with too much content, especially for the Grade 12 year, and this results in sections being dealt with at a superficial level, which result in rote learning, loss of precision and failure to produce the critical, creative and analytical thinkers. This in itself becomes a problem when learners leave school to get into universities, because of lack of preparedness, therefore it does not seem that schooling is adequate grounding for university competence.

According to Basson and Kriek (2012), physical sciences teachers are not adequately equipped to teach physical sciences or to improve the teaching and learning of physics at the secondary level from the levels of the past. Their conclusion was in accordance with reports by the Centre for Development and Enterprise (CDE) on "*maths and* *science challenge in South Africa's schools* (CDE, 2007:452). The report specified insufficient supply of teachers with high levels of subject content knowledge as one factor that accounts for the low performance in secondary schools.

The content seems to have changed significantly, with various topics having been removed, between grades or even considerably reworked and as a result of the changed content and shifting of topics, the current textbooks have been rendered outdated (Nakedi, Taylor, Mundalamo, Rollnick & Mokeleche, 2012). These researchers however asserted that, even though the physical sciences syllabus was still unmanageably long, the content itself seemed to have been set out more clearly and logically than before. In contrast to this, many researchers (Mogashoa, 2013; Adu & Ngibe, 2014; Masekoameng, 2014; Bjorklund, 2015; Koopman, *et al.,* 2016) seem not to be satisfied with the type of training that teachers had, considering the fact that the content is compressed. They therefore suggest that more training is required for the smooth implementation of CAPS.

Having discussed the continued curriculum changes in South African education system, and seen how these changes have not been successful, it is imperative to discuss curriculum change as a process and maybe get a clearer picture of how these initiatives failed.

2.3 CURRICULUM CHANGE AND IMPLEMENTATION

Curriculum changes are done globally, motivated by prioritizing curricula that focus on skills, application and problem-solving (Maharajh, Nkosi & Mkhize 2016). According to Adam (2009), these global changes shape what is happening in the 'new South Africa'. Studies by Kirkgoz (2008) and Bybeee and Mclerney (1995) show that curriculum changes have been happening in other countries such as the United States of America and Turkey, with a lot of success in the field of science. The curriculum changes that were projected in South Africa in the post-1994 were projected to rectify past racial inequalities and reduce skill shortages in areas such as mathematics, science and technology, even though some researchers such as Jansen and Taylor (2003) asserted that curriculum changes have not vastly improved the quality of education.

According to Adu and Ngibe (2014), curriculum change affects the lives, relationships and working patterns of teachers as they have to change their way of doing things, and adapt to the requirements of the new curriculum. Curriculum changes frustrate teachers if there is lack of technical expertise to carry out teaching responsibilities and when they lack the theoretical knowledge and familiarity with principles informing the implementation of such changes (Mdunshane, 2007 in Mestry, 2016). It also affects the educational experiences of learners. It affects parents by modifying the education which their children get, and thereby challenging their own expectations of what schools should be like. Curriculum implementation is not an easy process as it does not occur in a vacuum; instead, it has to include various factors such as the diversity of schools and factors related to the teachers and learners (Rogan & Grayson, 2003).

Kandiko and Blackmore (2012:1) maintain that "*there are many broad influences that shape a curriculum, set its scope, and that provide a sense of coherence throughout the educational experience*". This implies that if the schools that the curriculum is going to be implemented onto are not functional, in terms of the type of learners and teachers, then such exercise is set to fail.

Bantwini (2010) in Koopman, *et al.,* (2016) argues that, at the heart of a successful curriculum implementation, is continuous professional development. Teachers should feel the need to obtain new skills and pedagogies to improve their classroom practice and learner performance. Teachers should also identify their needs so that the new curriculum innovation can take them into consideration. Schools should also be open for a new change, by acquiring material and resources that will enable the new curriculum innovation to run smoothly. In case of physical sciences, schools should obtain funding for science equipment, and textbooks should be ready in time before the implementation. Physical sciences teachers should be provided with support that will lead to an effective implementation of CAPS in their classrooms.

It is however important to note that curriculum change could also be driven by economic, political and social factors (Smith, 2001 in Maharajh, Nkosi & Mkhize, 2016). Politically, a new government may bring a new ideology and as a result, policy-makers often tend to make a mistake of focusing on the 'what' of desired educational change and always neglect the 'how'. Adding to this effect, Rogan and Grayson (2003) asserted that curriculum developers do not usually follow up the process of implementation, and this is the reason why curriculum change fail. It therefore implies that before any curriculum is implemented, the government should identify areas of concern, whether there will be suitable personnel that will train teachers, and whether our schools are ready in terms of infrastructure and surroundings, and lastly, whether there are adequately trained teachers to implement the curriculum. If teachers are not adequately trained to implement a new curriculum, they should be supported to effectively implement it in the classroom. The following is a brief discussion on factors that compromise curriculum implementation.

2.3.1 DIVERSITY IN SCHOOLS

Rogan and Grayson (2003) argue that for any theory of implementation to be successful, diversity of schools should be taken into account. This diversity includes educational facilities, teachers, learners and school managers, cultural resources and material resources (Usman, 2016). The problem with inadequate facilities such as classrooms, laboratories, libraries and playing grounds can adversely affect the implementation of the curriculum. These have been a major hindrance in South Africa in science and mathematics classrooms such that it impacted negatively on the untrained teachers.

The problem of untrained teachers has been far the greatest as they are supposed to implement the curriculum. Teachers need to be trained in how to develop their own resource materials so that they can implement the curriculum smoothly. Even during the period of the implementation of C2005, this has been a challenge for many South African teachers who did not have adequate knowledge, skills and competences to apply it in their classrooms (Jansen,1998).

South Africa has a wide range in the quality of schools and an enormous range in the knowledge and skills of teachers. However, during the continuous curriculum changes, around 50% of mathematics teachers and 60% of science teachers had no formal training in these subjects (Rogan & Grayson, 2003). It follows therefore that, before any curriculum implementation can take place, proper professional development of teachers should occur, as De Feiter *et.al*. (1995: 88) in Rogan and Grayson (2003) suggest that *"if teachers lack a proper background and confidence in their subject, in-service education should start concentrating on this".* This implies that teachers should be provided with a relevant training that is appropriate to their needs (Verspoor, 1989 in Rogan & Grayson, 2003). Changes have to be introduced gradually, introducing small changes at a time to allow teachers to vary their practice (Johnson, Hodges & Monk, 2000). A study undertaken by Ono and Ferreira (2010) showed that in order to prepare teachers to implement a new curriculum, extensive professional development would be necessary.

Research has shown that the leadership of a principal is very important (Berman & McLaughlin, 1977; Hall & Hord, 1987; Fullan, 1991 in Rogan & Grayson, 2003). School principals and school management teams should also play their part in implementing the curriculum by setting up school calendars that will allow teachers to attend training for the purposes of implementation of the curriculum. This implies that they have to make sure that the change is realistically planned and monitored, and for them to delegate support in a variety of ways so that collaboration between participants can take place.

Furthermore, curriculum implementation has to take into account the contexts of the schools and not apply a 'one size-fits-all' system because schools do not operate on the same level. Some schools have better resources, both human and physical, than other schools hence they are better placed to take advantage of the benefits of the new curriculum. The process of change is context -specific and will play out differently in each and every school as it is influenced by their financial resources.

2.3.2 Financial resources

The other factor that hampers the curriculum implementation is the financial constraints. In South Africa, not all learners pay school fees. The issue of school fees is a very important one as the funds are needed in schools to purchase learning and teaching support materials (LTSM) (Badugela, 2012 in Maharajh, Nkosi & Mkhize, 2016). This issue however has been somehow alleviated in South Africa through some economic support systems for schools that exist. These support systems are subsidized by the government and they are classified as Section 20 schools and Section 21 schools respectively. The former are those schools that do not receive the full budget amount from the Department of Basic Education, and the latter are those schools that receive the full budget amount from the Department of Basic education for stationery and textbooks. School governing bodies (SGBs) of the latter are required to apply for additional functions to the provincial Head of Department, in terms of section 21 of the schools' Act (Mestry, 2016). These functions include:

- *Maintaining and improving the school's property, buildings, grounds and hostel;*
- *Determining the extra-mural curriculum and the choice of subject option in terms of provincial curriculum policy;*
- *Purchasing textbooks, educational materials or equipment for the school; and*
- *Paying for municipal services provided to the school* (Mestry,2016:2)

The capacity of the SGBs and the timely submission of financial statements at the end of each year is determined by the DoE. This is done so that schools can be allocated additional funds in the following year.

At the beginning of each academic year, the provincial DoE deposits some money into the "section 21" school's banking account so that schools can take care of physical resources as well as buying learning and teaching support materials (Van Rooyen, 2012). Governing bodies are also given some form of financial freedom on these funds, even though they are required to spend the allocated resources according to the prescriptions of the Provincial Head of Department. They can select their own suppliers and have the opportunity of negotiating better prices and discounts. If funds are not fully utilized, they may be utilized in the following year (Mestry & Bisschoff, 2009; Van Rooyen, 2011). Most of these schools perform much better financially as they recruit governors with good communication and financial skills like preparing and managing school budgets (OECD, 2008).

However, if the SGBs are not selected appropriately, this can lead to mismanagement of funds, corruption and fraud, and these can hamper the implementation of any site-based curriculum (Theodorou & Pashiardis, 2015). Media reports are always reporting on principals and SGBs who have been entangled in financial mismanagement of funds, fraud, theft, poor record keeping and improper financial controls and these factors can negatively impact on the implementation of any reforms at schools (Mtshali, 2012; Phaladi, 2015). As parents are exempted from paying fees at Section 21 schools, it is important to discuss how parental involvement may affect curriculum implementation.

2.3.3 Parental involvement

Parental involvement is another factor that affects the curriculum implementation as it can affect academic achievement of learners positively or negatively. De Castro-Ambrosetti and Cho (2005) claim that sometimes some teachers do not attract adequate support from parents as parents believe that it is not their role to assist their children with their school work. Parents who are ill-informed regarding curriculum implementation do not help their children with homework. Some of their reasons are that these parents have their own problems and they lack knowledge to become involved due to the nature of the subjects that their children are doing (Fullan, 2007 in Maharajh, Nkosi & Mkhize 2016).

A study by Nel, Tlale, Engelbrecht and Nel (2016) on implementation of inclusive education in South Africa, also revealed that teachers are not supported by the parents. Teachers who participated in that study felt frustrated because they deal with learners with barriers to learning and it seems their parents are not interested in their children's education, and also because parents are functionally illiterate. All these factors may have a negative or positive effect on how a country's curriculum is implemented. It is therefore important to check or suggest ways in which a curriculum can be effectively implemented so that the education system can merge with what is happening elsewhere around the globe.

2.4 WHAT NEEDS TO BE DONE

It seems like in South Africa, the government was mainly concerned with changing the science and other subjects' curriculum, but neglected to support teachers on how to implement curriculum changes in the classroom. For instance, the use of a cascade model consisting of one-shot courses was instituted in most areas around the country, and this 'one size fits' all approach has proven to be inadequate in the implementation of the new curriculum (Rogan & Grayson, 2003). In their study, Dichaba and Mokhele (2012:250) and Dichaba & Makgopa (2013:267) found out that this model of disseminating information resulted in *"watering down and misinterpretation of crucial information" and as a result, it failed to significantly improve the performance of teachers.*

The provincial education departments should also provide further relevant training to the already experienced presenters (Taole, 2013). According to the study by Phasha, Bipath and Beckmann (2016), during the implementation of NCS, it seemed most of the subject advisors had inadequate knowledge of policy issues, and this could have a negative impact on the way they carry out the support to teachers. Teachers should also be involved during decision-making process of the planned change in the curriculum (Maharajh, Nkosi & Mkhize, 2016; Adu & Ngibe, 2014 and Bantwini, 2009).

Curriculum implementation in South African context still has to go along way, in order to make any impact in schools and provide the next generations with a better education. For any curriculum implementation to succeed, continuous professional development should be continuously practiced (Bantwini, 2010). Through the attendance of workshops, seminars and conferences to improve knowledge and skills by teachers, the standard of education system may be improved (Phasha, Bipath & Beckmann, 2016). Mestry, Hendricks and Bisschoff (2009) asserted that by improving the quality of the performance of teachers through professional development programmes tend to improve the education system of a country. This should be done in all developing countries in order to guide school-based practitioners, change-agents and curriculum policy-makers (Kriek & Basson, 2008).

Additional implementation challenges are human factor- absenteeism of learners and teachers, lack of discipline and learner attention problems, as well as shortage of contact time in lessons, owing to a multitude of extra-curricular activities. The other factor is shortage of classroom space (Verspoor, 2008). In order to combat these challenges, a reference on some theories and models of curriculum change may be visited. The following is a short discussion of some curriculum implementation theories.

2.4.1 Curriculum Implementation Theories

The policy-makers may learn from different models and theories of curriculum implementation. Such models have already been designed and modified by researchers such as Rogan and Grayson in 2003. Kriek and Basson (2008) evaluated a theory of curriculum implementation as developed and modified by Rogan and Grayson (2003). The theory was developed with some incorporations from Beeby (1966) and De Feiter, *et al*., (1995). All these theories were relevant to the implementation of C2005 with particular reference to the teaching and learning of physical sciences.

The main aim of these curriculum theorists was to develop indicators to determine the extent to which the implementation of a curriculum process is successful. Rogan and Grayson theory of curriculum implementation is based on three constructs, namely, *profile of implementation; capacity to support innovation*; and *support from outside agencies*. The school's *Profile of implementation* construct, with its four sub-constructs of '*Classroom interaction'*, '*Science practical work'*, *Science in society'* and *Assessment'* describe the type of activities happening during science lessons (Rogan & Crayson, 2003). Matshikiza (2014:16) also stated that this construct *"deals with coverage of learning areas, the nature of classroom interaction, examinations and practical/models made by learners (curriculum issues)"*. It also refers to the way learners and teachers interact with one another and their use of teaching strategies as well as the learning materials used to produce the desired learning outcomes. The quality of the product depends on the quality of the teachers, materials and learner factors.

Msengimana, Ozawa and Chikamori (2014) stated that this framework was used by researchers such as Rogan & Aldous (2005), looking at the implementation of C2005 at the school level, targeting 10 schools in South Africa. Their findings indicated that 'the capacity may not be the problem' and 'the implementation' sub-constructs were slow, which suggested that schools might not be reaching their potential based on the assumption that implementation and capacity are positively related (Rogan & Aldous, 2005:15 in Msengimana, Ozawa & Chikamori, 2014).

A school's '*Capacity to innovate* with its four sub-constructs of '*Teacher factors'*, '*Learner factors'*, '*Physical resources'* and '*School ethos and management'* describes the opportunities the school has to support or achieve implementation of the new curriculum (Nsengimana, Ozawa & Chikamori, 2014). Capacity factors include educator capacity, which refers to the teachers' qualifications, specialization, the physical resources, that is, school infra-structure such as classrooms, libraries, furniture and other learning materials used by learners which are procured by parents and responsible authorities.

It is necessary for schools to have adequate classrooms/laboratories and materials for use by learners in physical sciences. Learner factors focus on attitude and class size, willingness to learn, background, the kind of strengths and constraints that learners might bring to the learning situation (Matshikiza, 2014). Another factor that can deter or improve curriculum implementation is the general ecology and management of the school. *"The school ethos and management are not the same, yet they are considered together as they are closely intertwined, particularly in schools in developing countries"* (Matshikiza, 2014:17). If the school is dysfunctional, innovation cannot, or will not, be implemented. This could be determined by the qualification and experience of the school heads of departments. Research has also shown that the leadership role of the school head is critical in reform implementation (Matshikiza, 2014).

The last curriculum implementation construct of '*Outside influence'* is concerned with factors such as policy mandates and the external support the school may be able to draw on (Kriek & Basson, 2008). It focuses on the monitoring system, professional development provided by subject advisors and the provision of resources from the district, parents and other stakeholders. The support from outside agencies describes the kinds of actions undertaken by outside organizations, such as the DBE and district subject advisors, to influence practices (Matshikiza, 2014). The role of the subject advisor is to see that standards are maintained. They act as quality assurance officers, to provide schools with expertise and professional development courses.

In their study, Kriek and Basson (2008) asserted that these constructs are symbiotic and each needs to inform the others. The beginning levels encompass the period of becoming aware of and preparing to implement the new curriculum, and the final levels are when the educator begins to take ownership of the curriculum and may enrich it by modifying it.

These researchers referred to comprehensive models that attempted to categorize schools and educational systems. These were models provided by Beeby (1966) and De Feiter *et al.,* (1995).

These models were very relevant during the implementation of C2005 as they both used classification of schools that were relevant to C2005 contexts as well as the different stages that were relevant to the principles of C2005. Beeby's model classified primary schools as being in one of the four stages, and that progress consisted of moving form 'lower' to 'higher' stages. The four stages are Dame school, Formalism, Transition and Meaning. However, the model was criticized by researchers such as (Guthrie, 1980), for focusing only on the educator and not mentioning any other aspect of the school context. The following is a brief explanation of these stages.

Dame school

Guthrie (2011) describes the type of teachers that fall under the Dame school system. These are ill-trained and unorganized teachers, with a very low and narrow subject content. This means that they have a very low level of teaching subject -matter knowledge and they place a great emphasis on memorizing facts (O'Donoghue, 2016).

Formalism teachers

Teachers under this stage are highly organized and have received training, even though they are ill-educated. This type of teachers tends to stick to the rigid syllabus and the use of one textbook, and they also subscribe to the “one best way” of teaching (O’Donoghue, 2016). They instil very tight discipline on their learners, as a result they ignore their emotional well-being. Examinations and inspection are also stressed (Guthrie, 2011).

Transition

According to Guthrie (2011), teachers that fall under this stage are better educated and better trained than in the Dame and Formalism stage. Even though the use of textbooks and a rigid syllabus is less restrictive, teachers under this stage hesitate to use greater freedom. They still have to deal with final school- leaving examination, which often restrict experimentation (O’ Donoghue, 2016).

Meaning

Teachers who fall under this stage are well educated and well trained. They emphasize meaning and understanding of their teaching. They are more open to a wider curriculum and a variety of content and teaching methods, such as problem solving skills and creativity. They are more relaxed and exercise positive discipline, emotional and aesthetic life as well as intellectual closer relations with community (O’Donoghue, 2016 & Guthrie, 2011). Beeby suggest that progress through the stages was inevitable, sequential and evolutionary.

Then another curriculum model was adapted due to the fact that unlike Beeby’s model, this one included factors to teachers, the curriculum and the school guidelines for improvement (De Feiter *et.al.* 1995). De Feiter’s model included different stages when teachers behave:

- *in an ‘unskilled fashion’,*
- *in a ‘Mechanical fashion’,*
- *in a ‘Routine way’ and*

- *as 'Professionals'*. (Johnson, Hodges & Monk, 2000:183)

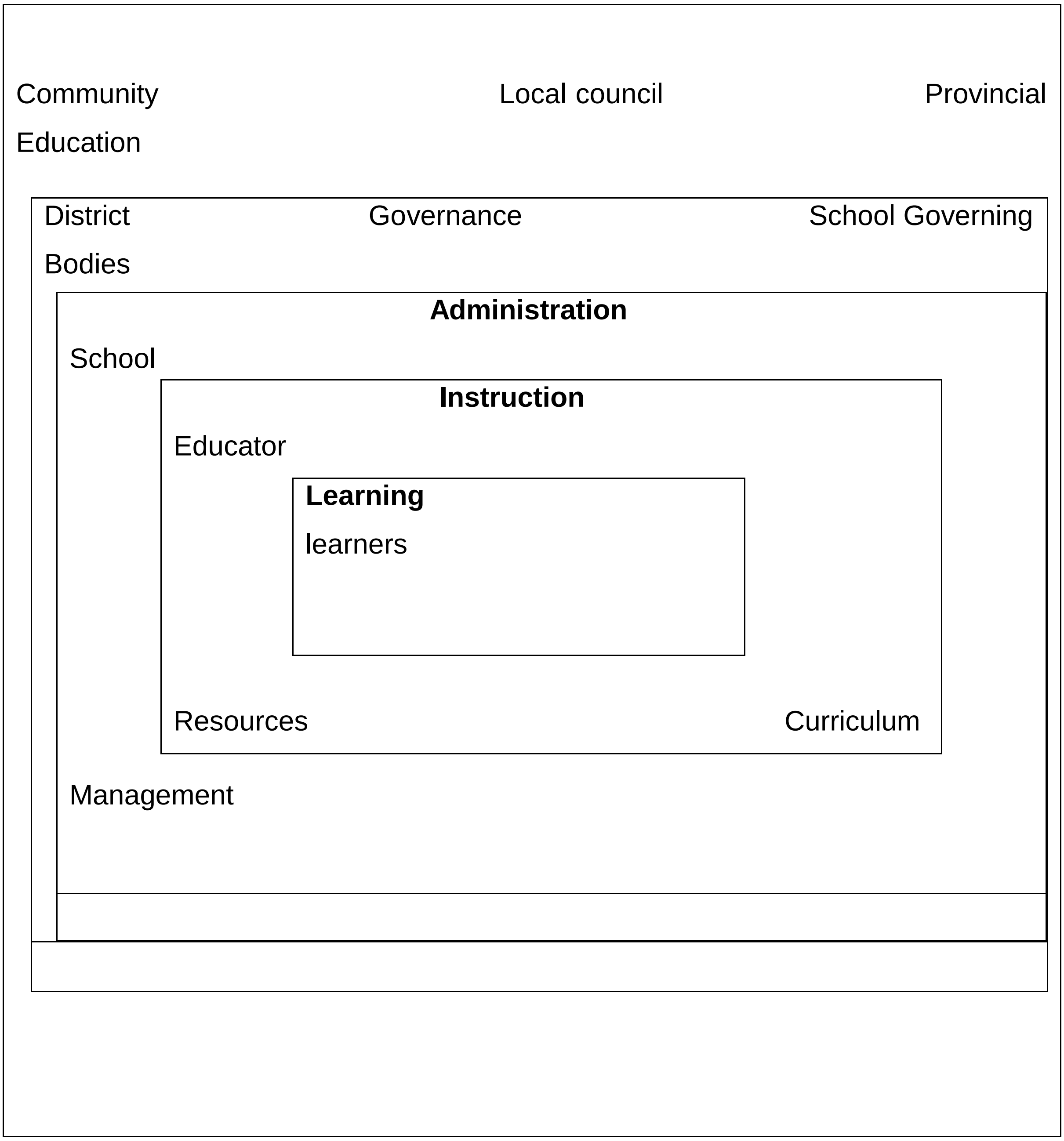
At the unskilled stage, teachers' mastery of subject content is weak and teachers are poorly motivated, unguided and confused, they rely on recitation, rote learning and memorization. In the mechanical stage, teachers have attained only moderate subject mastery through limited professional training. Teachers in this stage still emphasize memorization for learners and have no alternative pedagogic strategies at hand. Improvements that Beeby consider appropriate for teachers at this stage were to broaden the curriculum with diverse teachers' guides and textbooks, together with examination reform. Beeby's model was seen as useful, not only because it identified distinct stages, but because of the components that describe these stages (Rogan & Grayson, 2003). Both models were relevant in implementing C2005 as the practices described were in both models' highest stages.

As C2005 was implemented in a system which comprised diverse schools, the implication of using such models might have caused problems as planning and monitoring of the whole process was evident, and such monitoring was not going to be possible due to the diverse school contexts in South Africa.

Curriculum change can also be influenced by systems design (Rogan & Crayson, 2003). Banathy (1991) as cited in Rogan and Grayson (2003:1179) notes that there are four levels at which education is organized, namely, *the institutional or governance level:* where the school community interacts with the school, *the administrative level:* where decisions and resources are managed, *the instructional level:* which is concerned with educating learners and the *learning-experience level:* which focuses on learners. Banathy (1991) as cited in Rogan and Grayson (2003) suggests that any of these levels can be selected as the primary level where the whole educational initiative can be designed and built. As a result, the choice can lead to different organizational models of education.

The following diagram/figure shows Banathy's four levels of educational organization which have been contextualized for the South African education system.

Figure 2.1. The various levels according to which education is organized in South Africa



Adapted from Rogan and Grayson (2003: 1180)

The above figure shows that, at the governance level, the purpose is to '*enculturate, train learners'*; at the administrative level, the purpose is to '*establish regulations by which to implement input and account for resources*'; at the instructional level the purpose is '*to provide instruction as defined by the administration'*; and at the learning-experience level it is '*to respond to instruction*' (Rogan & Grayson, 2003:1179).

According to Banathy's systems design model, this explains what happened during the implementation of C2005, that availability of resources in support of the learning-experience level was mainly run through the *governance level*, and the *administrative level* was mainly concerned with formalizing information regarding the requirements for those resources. At the *instructional level*, that is where the learning resources were provided to facilitate learning. The *learning-experience level* was mainly concerned with mastering of learning tasks by the teachers so that they could become competent. This shift in the primary level required curriculum policy-makers to be conversant with how schools were managed as well as the school context and the roles of teachers in implementing the curriculum.

In contrast to Banathy's model, Rogan and Grayson (2003) developed a theory of curriculum implementation that was based on three major constructs, which are *Profile of Implementation*, *Capacity to Support Innovation and Support from Outside Agencies*. Furthermore, Rogan and Grayson (2003:1180) maintains that these constructs share three important characteristics, namely;

- *They can be measured by means of indicators*
- *They are broad enough to encompass a number of related factors and*
- *They are narrow enough to include one main idea.*

The dimensions of the three constructs of curriculum implementation developed by Rogan and Grayson as depicted in Kriek and Basson (2008) are shown in the following table.

Table 2.2: **Dimensions of the three constructs of curriculum implementation**

Construct	**Dimensions**
Profile of implementation	1. Classroom interaction 2. Science in practical work 3. Science in society 4. Assessment
Capacity to support innovation	1. Physical resources 2. Teacher factors 3. Learner factors 4. School ecology and management
Support from outside agencies	1. Types of encouragement and support • Physical resources • Design of professional development • Direct support to learners 2. Dominant change force evoked by agency 3. Monitoring mechanisms and accountability

Adapted from Kriek and Basson (2008: 65)

2.4.2 Constructs of curriculum change: Profile of implementation

The construct Profile of Implementation is the recognition of a new curriculum. It is an attempt to comprehend and express the extent to which the ideals of a set of curriculum proposals are being put into practice. It is designed to offer a 'map' of the learning area and to offer a number of possible ways to implement the curriculum. Through this process, curriculum planners at the school level can determine their position in terms of identifying their strengths and weaknesses, by looking into their contexts and capacity of the school (Rogan & Grayson, 2003 in Kriek & Basson, 2008). Therefore, this implies that profile of implementation has to be a long-term, ongoing process which includes services of teachers and anybody who is connected to the school. This approach can also be applicable to the concept of "development planning" as depicted by Hargreaves and Hopkins (1991) and recommended by Rogan and Grayson (2003). Having discussed how the implementation is going to be carried out, it would be wise to discuss further factors that may hinder or support the implementation.

2.4.3 Capacity to support innovation

Capacity to support innovation attempts to comprehend factors that can support or hinder the implementation of new curricula. Each of the four groups can support or hinder the implementation differently. For instance, if resources are not adequate, then teachers may not confidently conduct instruction and as a result, this may affect performance of learners. In the same way, the ecology of the school can also affect the innovation both ways, if a school is dysfunctional, it is because systems in that school are not in place (Maharajh, Nkosi & Mkhize, 2016; Badugela, 2012). Besides resources and the ecology of the school, there is a need to seek support from outside agencies.

2.4.4 Support from the outside agencies

It has always been a trend for developing countries to receive financial aid form developed countries in order to implement new policies. Rogan and Greyson (1999) and Rogan and Grayson (2003) state that the use of such external agencies has always been attributed to the vast variety of educational Non-Governmental Organisations (NGO) sector, which during the 1970s, have always expressed interest in helping black schools. The help has always been in a form of professional development programmes. The Profile of outside Support describes the kinds of actions undertaken by these outside organizations as well as ways in which they manifest their intentions. This may be incorporated by policy makers in South Africa because of the way in which the implementation of CAPS has been. Table 2.4 below shows the types and level of support and pressure that various organizations might bring into a school in order to effect change.

Table 2.3: Profile of outside support

	Types of encouragement and support				
Level	*Physical Resources. Categories of resources: buildings, apparatus, curriculum materials (print & electronic), computers etc*	*Design of professional development*	*Direct support to learners*	*Dominant change force evoked by agency*	*Monitoring mechanisms and accountability*
1	Provision supplements what exists, but not enough to support the intended changes. Provision is in one category only	Information on policy and expected changes are presented to school based personnel. Typical mode is short, one short workshop.	Provision of basic needs, such as lunches and places to study.	Bureaucratic. Change is brought about by top-down directives to bring about change	Inspections by authorities are undertaken.
2	Provision completely covers what is required to affect the intended change in one category, or partly sufficient in two categories.	Examples of 'new' practices as suggested by the policies are presented to school-based personnel, who are given an opportunity to engage in these practices in a simulated situation. Typical mode	Basic academic needs are catered for in the form of extra lessons.	Charismatic. Change is brought about by top-down inspiration and encouragement.	Inspections are undertaken in collaboration with school-based personnel

		in a series of short workshops lasting for one year.			
3	Provision completely covers what is required to effect the intended change in two categories, or partly sufficient in three categories.	Professional development is designed by school-based personnel depending on which new practices they wish to implement using both inside and outside support. Typical mode consists of both external and school-based INSET for two to three years	Enriched academic needs are catered for in the form of field trips and other enrichment type activities	Professional. Change is brought about by encouraging role players to embrace codes of conduct and standards of teaching and learning.	School-based personnel monitor own progress, but report to authorities.
4	Provision completely covers what is required to effect the intended change in three categories, or covers two categories and is partly sufficient in all four categories	Communication of practice take full responsibility for their own continued professional growth, and for school governance and curriculum implementation, calling on outside support as appropriate. Typical mode consists of ongoing	Complete academic and personal support is provided, usually in the form of bursaries	Learning Community. Change is brought about by developing communities that develop shared values and goals regarding educational practice and a commitment to put these into practice.	All monitoring is undertaken by school-based personnel.

		school-based and directed professional INSET			

Adapted from Rogan and Grayson (2003:1193-1194)

2.4.5 Perceptions of Physical Sciences Teachers on Implementation of Curriculum

Factors that influence teachers' perceptions about the implementation of curriculum were studied by Aldous (2004) in Koopman*, et al.,* (2016), but did not explore deep enough into their mind-sets, to explain their thinking or the rationalization undergoing their perceptions when confronted with curriculum change.

In South Africa, there is a discrepancy between the training by university staff and the Department of Basic Education (Kriek & Basson, 2008). In their study, which comprised of teachers from the Tshwane North District and the North West Province, these teachers emphasized that experts should perform the training. Teachers were unanimous in their views that they have received basic information with the implementation, especially on the new content and practical work in CAPS (Kriek & Basson, 2008), however they were concerned by the limited follow-up training and observations by the Department of Basic Education to check whether what teachers were given was really being implemented as it was supposed to be.

Monitoring and support is regarded as very important to ensure that a new curriculum is successfully implemented, and it becomes the duty of Senior Management Teams and the subject advisors to provide that (Taole, 2013). Monitoring and support in the context of class visits give the SMT an opportunity to observe teachers' work, provide motivation and exercise influence. If monitoring is done effectively, it determines the successes, deficiencies and challenges that teachers encounter (Phasha, Bipath & Beckmann, 2016).

The lack of support in policy implementation can be attributed to mainly the continuous curriculum review and adjustment of the school curriculum (Lessing & De Witt, 2007).

Green (2008: 2) warns that "*continuing professional development programmes should not become slaves to political demand, but should reflect the pedagogical and professional needs of teachers and the changing learning needs of learners".* This implies that policy-makers and curriculum developers should not just take policy reviews as a political matter, something that a country have to do, but should consider the professional needs of teachers and the needs of learners before any curriculum implementation can take place, otherwise it would not be possible for teachers to implement the curriculum without proper support from responsible bodies such as the Department of Education (Kriek & Basson, 2008).

Although efforts are made to supply schools with equipment, physical sciences teachers are still not confident in their ability to use and manage it (Kriek & Basson, 2012). In their research Kriek and Basson (2012) discovered from the teachers that the physical sciences curriculum was congested and the subject seemed to have been allocated limited time on the school time tables. The research also found that learners always complained about the amount of work they were required to comprehend. Teachers themselves were still concerned about their content knowledge in some of the new topics such as electronics and semiconductors. This implies a need for appropriate training once more.

University departments involved in training of our future teachers and in-service physical sciences teachers should urgently align their training with the desired objectives and outcomes of CAPS (Shay, Wolff & Clarence-Fincham, 2016). A major concern here is with the FET content, the level and nature of the content and the applications in terms of practical work and projects. These however would depend on whether teachers are prepared to embrace the changes that came with the introduction of CAPS. Teachers are calling for more practical and school-based forms of professional development and a slower rate of curriculum change (Habler, Hennessy, Cross, Chileshe & Machiko, 2015).

2.5 EFFECTS OF CURRICULUM CHANGE ON TEACHING AND LEARNING OF PHYSICAL SCIENCES

Curriculum reform has been undertaken by almost every country in the world over the past two decades, yet there are often insufficient supports provided for teachers to adjust and develop new practices to their own contexts (Camburn & Won Han, 2015). The process of change can arouse emotions and despair but at the same time if taken positively it can raise hope, growth and progress. Teachers always show signs of confusion and struggle to apply change in their classrooms even though they might be exposed to training that is meant to prepare them for changes in the curriculum (Nieuwoudt & Nieeuwoudt, 2016). The way teachers perceive curriculum change might be the reason curriculum change impacts negatively or positively on teaching and learning (Tshiredo, 2013).

Teachers seem to be confused and lack understanding of what curriculum change in physical sciences is. This can be inculcated by providing them with an effective professional development program, which will strengthen their science content knowledge (Kriek & Grayson, 2009). Kriek and Basson (2008) point out that teachers lack motivation due to the fact that they are still not clear of innovation skills and knowledge, as well as the unavailability of required instructional materials. This was also revealed by Bantwini and Diko (2011), who stated that most schools cannot afford to purchase science equipment to support effective teaching and learning of science in schools. They also felt that without the equipment, practical demonstrations for teachers lacking understanding in the field cannot be done effectively, and the blame for not providing schools with adequate support material like science equipment is on the Department of Basic Education. This might be the cause of teachers' resistance to change in curriculum innovation.

Studies done by Kriek and Basson (2012) and Cobbinah and Bayaga (2017) state the confusion which is still being experienced by physical sciences teachers. Both studies raised the problem of the use of old pedagogical practices and lack of subject content knowledge by physical sciences teachers. If teachers are provided with relevant professional development, they can develop their pedagogic content knowledge, which could be outside their subject specialization (Phasha, Bipath & Beckmann, 2016).

For instance, Cobbinah and Bayaga (2017) found out from their study that physical sciences teachers are still teaching in the same way as they used to in NATED 550. This is due to various reforms via content, policy, theory and pedagogical practices amendments. Physical sciences teachers feel they do not have necessary skills to deal with the content such as electronics, semiconductors and mechanics, as these topics have been reshuffled and mainly because some of them did not have prior training on these topics in their training as teachers. They also express their need for proper and appropriate training by professionals and experts to deal with the content and methods of teaching (Kriek & Basson, 2012).

On the issue of pedagogical practices, the CAPS policy (DBE, 2011:143) *insists on marking some of the informal tasks to provide feedback and interventions to learners in the form of continuous assessment (CASS),* but most teachers are actually letting learners to mark their own work, or even worse, ignore informal assessment. The reintroduction of content per subject and greater emphasis on textbook usage in CAPS physical sciences by the Department of Basic Education, appears to make teachers associate CAPS to be similar to NATED 550 in terms of content structure and how teaching and learning must enfold (DBE,2012; DBE,2011). So it would seem that confusion in theory and practice still exist in CAPS due to various reforms. Cobbinah and Bayaga (2017:1649) conclude that "*the old/traditional practices which were often criticized in previous studies by by* Chrisholm, Volmink, Ndhlovu, Potenza, Mahomed, Muller, Lubisi, Vinjevold, Ngozi, Malan,and Mphahlele (2005*), and* Jansen (1998) *and behaviorists' theory principles are still prevalent instead of constructivist underpinnings where adequate learning opportunities to discover knowledge in problem-solving contexts are mandatory".*

Many teachers consider themselves to be inadequately trained to work with OBE and having to deal with another change in curriculum could be frustrating. This is evident from studies around South Africa on physical sciences teachers (Bantwini, 2011; Hartell, Steyn & Chetty, 2015; Kriek & Basson, 2012; Msimanga & Lelliot, 2012). Bantwini (2011) states that the reality of teachers' resistance to change, has led to significant amount of professional literature dealing with understanding of the curriculum change environment and the development of the effective strategies to achieve curriculum change. Experienced teachers do not wish to change the way they have been doing things. They claim that "they have already learned "and have been teaching more or less competently (Tshiredo, 2013).

However, not all teachers feel this way, as Witz and Lee (2009) claim, that life sciences and environmental sciences teachers are more aware that science is not stagnant, and that it is not separated from all societal involvements. This is more than what can be said by physical sciences teachers, who have to deal with newly incorporated concepts like mechanics (Bantwini, 2011). There is therefore a need to understand teachers' attitudes and reaction more fully so that researchers may be able to examine the motives for involving learners' actions.

Teachers have to deal with many changes, and for them not to comprehend what is expected of them, might be the cause of their resistance and negative attitudes towards the curriculum change endeavour. Bantwini (2011) also states that acceptance predicament happens when teachers have to deal with curriculum constraints such as texts, tests, and staffing as well as systemic limitations such as curriculum plans calling for particular methods of instructions or assessment. Therefore, there could be a considerable divergence between "what is said and what is done" in schools.

Furthermore, teachers still need to face challenges of adapting with the local environment and some constraints that hinder their progress to implement the changing curriculum needs. While South African teachers are still adapting with the changing curriculum, they were undergoing challenges of dealing with larger classes, unruly learners and uncooperative parents and high profile accountability from the department. This led to local adaptation that resulted in less reform type classroom instruction (Tshiredo, 2013). This might have caused teachers' frustration and hence the negative attitudes towards curriculum change.

Teachers are struggling with the sudden changes of policies and approaches in the curriculum, and are still facing challenges on whether to adopt or resist the new changes while facing those challenges. Bantwini (2011) argues that when teachers are exposed to training of new knowledge and skills, they often reject them. They sometimes select what they want and delay acceptance of new reforms until other innovations surpass them. Teachers do not respond in the same way to change, due to personal orientation to change, as well as gender, age, and stage of their career (Tshiredo, 2013). It is evident that teachers who might be on the realm of retirement will not be so keen to accept change.

Geldenhys and Oosthuizen (2015) state that teachers who are close to retirement do not see the need to develop themselves further as they believe they have been teaching for a long time and succeeding with their methods. These teachers do not want to risk their own practice which is rooted in practical knowledge that spans the course of their careers, and it becomes especially difficult if this knowledge has proven workable in what they perceive as satisfying ways (Bantwini, 2011). Habit is a related barrier to these teachers changing their practice, because they think it is easier to continue with the old ways of doing things than learning or developing new skills (Bantwini, 2011). The next section explores the effects of curriculum change in teaching and learning that may have an effect on the development of teachers and training.

2.5.1 The Effect of Curriculum Changes on Development of Teachers and Training

The shift in approaches in science teaching has influenced the impact of curriculum change on development of teachers and training. Schwartz and Saddler (2007) argue that in the face of any end result, what learners can accomplish is influenced by their growth developmentally and the degree of environmental support they receive. As a result, when teachers and learners are differentially empowered, it always impacts on their teaching and learning. The type of skills and knowledge that teachers were taught in their respective training institutions, was not the one they are required to be using during curriculum innovations. This may be one factor that makes teachers to be unable to implement changes in the curriculum.

Rogoff (1990) and Vygotsky (1998) in Schwartz and Sadler (2007) emphasize that teaching and learning require support and scaffolding to ensure that teachers and learners operate at their optimal levels. It therefore implies that teachers' different learning styles and needs must be given serious attention (Tshiredo, 2013). If this gets the right attention, teachers will be able to adopt the use of various approaches and pedagogical knowledge in their teaching practice. Bantwini (2009,) stresses that good learning opportunities for teaching builds on their current physical sciences knowledge, attitudes and skills. Teachers' training and lack of pedagogical content knowledge has been pointed out by Bantwini (2009), Lekgoathi (2010) and Rogan and Grayson (2003) as one of the reasons why these problems still persist in schools.

All of the above-mentioned problems point to a very important factor, that of involving teachers in designing of curriculum. If teachers are not part of policy-making and decision making in the curriculum that they have to implement, that curriculum will have high chances of failing (Adu & Ngibe, 2014). Ngibe (2013) states that teachers feel that continuous change in the curriculum contributes to poor implementation of the curriculum. Teachers are constantly required to shift from what they have practiced, in terms of their training, and focus on the new policy statement brought to them (Adu & Ngibe, 2014).

Mogashoa (2013) points out that in order for the training to be relevant for teachers, their needs should be identified and taken into account when designing professional development programmes. Throughout the changing curriculum, teachers are just subjected to the short-courses training offered by the Department of Basic Education, and little is offered in terms of what they encounter in their classrooms (Koopman, *et al.,* 2016).

Koopman, *et al.,* (2016) conducted research in which physical sciences teachers participated in the Western Cape. The research found that the workshops rendered by the Western Cape Department of Education were too short and confusing, that the times that the workshops were undertaken, was not so ideal as most of them were carried out after school or during weekends when teachers were tired and have other commitments to attend to. Some teachers felt that the quality of the workshops varied, that most of the workshops seemed to be irrelevant to their classroom practices.

Mogashoa (2013) also found out that the follow-up after the workshops was inadequate and this in itself was adding to the confusion teachers felt about CAPS. In her study, Bjorklund (2015) suggests that further training is necessary because a workshop for a few days cannot be sufficient to understand how to implement the policies successfully. It is therefore imperative to discuss the professional development of teachers and how physical sciences teachers can benefit from it.

2.6 PROFESSIONAL DEVELOPMENT PROGRAMMES OF TEACHERS

The following is a brief literature review on professional development and programmes that serve as support for science teachers as seen by different researchers.

2.6.1 Professional Development of Teachers

Professional development is defined as activities that develop an individual's skills, knowledge, expertise and other characteristics as an educator (OECD, 2009). It is also defined as teachers' learning, how they learn to learn and how they apply their knowledge in practice to support learners (Postholm, 2012). Professional development of teachers is described as structured professional learning that results in changes to educator practices and improvements in learning outcomes of learners

(Darling-Hammond, Hyler & Gardner, 2017). Seven widely shared features of effective professional development have been identified as:

- It is content-focused
- It incorporates active learning utilizing adult learning theory
- It supports collaboration, typically in job-embedded contexts
- It uses models and modelling of effective practice
- It provides coaching and expert support
- It offers opportunities for feedback and reflection and
- It is of sustained duration (Luneta, 2012; Darling-Hammond, Hyler & Gardner, 2017:2-3).

These features are somehow similar to the ones that were brought forward by Baker, Chaseling, Boyd & Shipway (2017:4), who suggested that professional development takes on a sevenfold character, that

- *it is based on a constructivist approach to knowledge generation,*
- *it is long-term*,
- *it is context-particular,*
- *it is intimately linked to school reform,*
- *it is encouraging of reflexivity in teachers,*
- *it is collaborative in nature and*
- *it is different in form dependent on the situation* (Baker *et al.,* 2017:4).

However, more recently, this complex characterisation has been strengthened by Reid and Kleinhenz (2015), who draws specific attention to both the global nature of professional development of teachers and the relevance of local particularism and context in implementing relevant practices and policies.

It is a deliberate ongoing process, guided by a clear vision of purposes and planned goals which addresses the needs of teachers in specific context (Samuel, 2008; Maistry, 2008 & Dichaba, 2013). These contexts may be influenced by global developments, national priorities, local challenges and the personal needs of teachers (Singh, 2011). Once these needs have been identified, activities need to be properly planned to support teachers in applying the knowledge and teaching creatively and confidently (Luneta, 2012). This suggests that, there should be a need analysis for physical sciences teachers to address those specific needs. Once the needs have been identified, programmes need to be properly planned to support teachers in applying the knowledge. These programmes can benefit the physical sciences teachers who are already complaining about the curriculum that has been congested by CAPS, that has to be covered in a limited time (Kriek & Basson, 2012).

Professional development of South African teachers has been irregular because of lack of proper training for curriculum implementation (Singh, 2011). According to Nakedi, *et al*., (2013), curriculum policies have also been inconsistent in South Africa. Therefore, there is a need for a suitable professional development for South African teachers (Lessing & De Witt, 2007).

In order for a professional development to be effective, the following characteristics are identified:

- *Alignment with goals of the Department of Basic Education, the Curriculum Assessment Policy Statement (CAPS in South Africa) and professional development needs of teachers*
- *Focus on the knowledge bases and the effective instructional approaches appropriate for high learning outcomes*
- *Inclusion of learning opportunities for acquiring new instructional strategies*
- *Provision of opportunities for reflection and collaboration among teachers and*
- *Inclusion of built-in follow-up and continuous feedback* (Blank & De La Alas, 2009; Croft, Coggshall, Dolan, Powers & Killion,2010; DeMonte,2013; Darling-Hammond, Andree, Richardson & Orphanos,2009; Desimone, Porter, Garet, Yoon & Birman, 2002; Kucan, 2007; Luneta,2012).

According to Luneta (2012), even if professional development is in the form of workshops or through communities of practice, it must be relevant to teachers' situations and constructed in a way that they can gain from the experience. They should also be active and have a chance to relate the theories to their own practice. Effective training needs to be continuous so that knowledge gained can be tried in the classrooms and then taken back to the training to be developed further. This therefore implies that there is a need to implement a suitable professional development of teachers in South Africa's teaching fraternity, due to the constantly changing curriculum.

The constant change in curriculum, forces the Department of Basic Education not to rely on short courses, but a thorough follow-up training in the classrooms is what teachers need, and to incorporate experts into these programmes, who will help these teachers to develop practical skills, that will in turn help improve learning in their classrooms. Professional development that focuses on teaching strategies associated with specific curriculum content support of educator learning within their classroom contexts (Darling-Hammond, Hyler & Gardner, 2017).

Professional development is a career-long process in which teachers fine-tune their teaching to meet learner needs (Diaz-Maggioli, 2010). It is therefore a process which is based in faith in teachers, the schools they work for, and the power of the broader community of teachers around the country. Effective professional development should be understood as a job-embedded commitment that teachers make in order to further the purposes of the profession while addressing their own particular needs (Croft, *et al.,* 2010).

South African government has to recognize its teachers as professionals, and who can design their own curricula, depending on their contextual needs, rather than relying on 'experts' to design a curriculum, but yet they are expected to implement it (Msibi & Mchunu, 2013). This therefore implies that teachers should be involved in formulating or drafting any policy that will affect the curriculum since they are the custodians and implementers of the curriculum (Adu & Ngibe, 2014). These may be teachers from different school categories, from rural and urban schools, as well as parents, for the smooth implementation of the curriculum (Adu & Ngibe, 2014).

Internationally, professional development for teachers is seen to be evolving, responding to a recognized need for change (Baker, *et al.,* 2017). Over a decade ago, researchers such as Villegas-Reimers (2003) in Baker *et.al* (2017) have noted that in relation to widespread educational reforms, the nature and role of professional development of teachers was likewise changing.

Professional development often involves the introduction of new and unfamiliar information to teachers, who may not have prior background knowledge. For instance, the background knowledge of the work of Toricelli in trying to develop the understanding of Boyle' law in Physics (Koopman, *et al.,* 2016). This is also expressed in CAPS document which states that physical sciences is a subject that "*promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships"* (Department of Basic Education, 2011: 8). This implies that learners should be involved in activities that are inquiry-based which is an unfamiliar pedagogy in most classrooms. Application of inquiry-based lessons is likely to develop high quality education in the learners. A high quality science education is regarded as an indicator of economic success around the world, it is imperative for education systems to monitor science education and improve its quality, by providing quality system to both teachers and learners (Villegas-Reimers, 2003 in Baker *et al.,* 2017)

Professional development of teachers for social justice should thus invariably focus both on "*equity and a deeper understanding of the interconnections of power, privilege, difference, oppression and justice, domestically and internationally"* (Bose, 2005:78). This implies that when change is brought about, it should cater for all the custodians of a specific country, not only for the advantaged, but for the disadvantaged as well. Teachers and learners in rural schools must also be given support and materials to allow smooth sailing into the changed curriculum.

In order for professional development of teachers to produce best results, it should be planned systematically and formally so that it can be presented with the focus on enhancing personal and professional growth of teachers (Lessing & De Witt, 2007). Teachers have different training backgrounds and needs, so good professional development programmes should be able to support teachers, wherever they teach or whatever their professional background is and to provide the best possible instruction, so that they become excellent by gaining competence, confidence, commitment and a sense of the joy of teaching (Lessing & De Witt, 2007).

Physical sciences teachers are exposed to short-courses workshops and trainings and these seem not to be meeting all the requirements of CAPS (Koopman Le Grange & De Mink, 2016). Physical sciences teachers may form collaborations, either within the same district or clusters, to share developmental problems in CAPS. Professional development workshops for teachers have proven to be information-sessions. These researchers found out that the format in which the workshops are conducted is not developmental. At the beginning of each year, subject advisors conduct workshops where they provide teachers with policies and requirements of that year's work.

Teachers should be visited in schools, in their respective classrooms so that their needs could be identified and addressed. If there is no follow-up on what is happening in the classrooms, then teachers will not feel empowered, and the whole exercise of workshops would be just predestined. Professional development of teachers should be intended to improve the quality of teaching by improving on the skills and attitudes of teachers so that they can educate learners effectively (Luneta, 2012).

It implies therefore that the type of professional development programmes should be context-specific and address the classroom situations that physical sciences may be encountering, that resources should be aligned to the required content, and that teachers should be able to assess and keep learner records for accountability purposes.

Professional development of teachers should be an ongoing process, which addresses the needs of teachers working in a particular context who have the same problems and needs for development, and by coming together, even if their backgrounds differ, but their main common goal should be that of development for better teaching and learning. Luneta (2012) suggests that the needs-analysis of teachers should be used to obtain and enable educational needs to be defined and to set goals and priorities.

One of the main causes of unsuccessful professional development program for teachers is a lack of a comprehensive needs-assessment (Croft, Coggshall, Dolan, Powers& Killion, 2010; Archibald, Coggshall, Croft, & Goe, 2011). According to Luneta (2012), the consequences of insufficient or lack of needs-analysis are:

- *A one size fits all approach, where teachers with different instructional and content knowledge needs are pushed into one programme.*
- *Lack of connectivity between professional development programmes and classroom instructions and practice.*
- *Planning and implementation is top down from district officials and universities to the teachers who have little input in the design and execution of the programme.*
- *The programmes provide passive experiences, as fragmented and offer little opportunity for teachers to interact, exchanges ideas and experience*s (Luneta, 2012:371).

The following section describes the different professional development activities of teachers.

2.6.2 Professional Development Activities

Below is a list of professional development activities that can be undertaken individually or collaboratively by physical sciences teachers as part of a professional development plan. In the past, professional development focused on individual development, workshops, in-service and external delivery systems. Today, the emphasis is on school-based activities such as coaching, partnerships and team or group development (Kaplan, Cervello & Corcoran, 2009).

2.6.2.1 Lesson study as a professional development activity

Lesson study is a professional development activity that was started by Japanese teachers for over a century and it has spread internationally since the late 1990s (Akiba & Wilkinson, 2016). Lesson study embodies content-focused, coherent, continuous and collaborative learning activities of teachers. Lesson study is chosen as a professional development strategy because research shows that within a context such as lesson study, changes in knowledge and beliefs are to be expected (Lewis, Perry, Friedkin & Roth,2012).

Kaplan, Cervello and Corcoran (2009) explain this professional development activity as a process with four stages namely, *study, plan, teach and reflect*. According to these scholars, this professional development activity is a process that begins when teachers choose a predominant goal to guide their lesson. These goals may be part of the school's mission or they may be specific to the domain in which the lesson study will be endorsed. Teachers come together and identify the predominant goal that will underlie their lessons as they choose a topic and then set learner goals for the lesson.

During *study* phase, the lesson study teachers check the learners' knowledge and learner learning and previous experience teaching of the topic. They consider the entire chapter or unit that surround the lesson, they think about how the lesson they are planning fits into the unit and the competencies on which the lesson builds. They also examine the books and activities available for teaching the lesson before planning their own lesson.

In the *planning* stage, teachers pay attention to the minute details, they plan the lesson, choosing strategies, and sometimes they even create their own lesson plans and specify what will be written on the chalkboard and in what arrangement the particular writing will be. The lesson plan developed may use a four-column format with the following headings:

- *Learning activities*
- *Learner activity and expected responses*
- *Educator responses and things to remember and*
- *Goals and evaluations* (Kaplan, Cervello & Corcoran, 2009:5)

After the lesson has been planned, it is then *taught* by one of the teachers while other teachers observe. It is during the observation that other teachers walk around the classroom to evaluate the learners' learning. These teachers may talk to learners in order to clarify questions about understanding, but they may not help teach the learners.

After the lesson has been taught, during the *reflect* phase of the Lesson study, the teachers then discuss the lesson and their observations. This is where some changes may be effected, based on the observations. Then if needs be, the lesson may be re-taught by one of the other teachers.

It is during the re-teaching of the lesson that more quests such as other teachers in the school or district or subject advisors may be invited to observe the lesson, after which they also reflect on their observations. It is through the larger observations that a summary booklet of the Lesson study, the reflections of the Lesson study group is circulated to other teachers and can now become part of the next Lesson Study circle (Kaplan, Cervello & Corcoran, 2009).

In the case of South Africa, in physical sciences, teachers may decide to use the goals as they appear in the CAPS document, which serves as a guide for teachers, where they come together to plan, teach and reflect on their lessons.

Shuilleabhain (2015) refers to Lesson study as an investigation of teachers into their own practices through planning. He suggests the following steps as a guide to a successful lesson study:

- *Formulate/reflect on goals (study curriculum)*
- *Plan a selected or revised research lesson*
- *Conduct/observe research lesson*
- *Reflect on the research lesson using data generated within the lesson and*
- *Revise the research lesson* (Shuilleabhain 2015:7).

During the first step, teachers decide on an overall goal for their teaching which will guide their practices in a lesson study, they then access the curriculum (in this case physical sciences CAPS), decide on a topic to teach within that cycle and then build a lesson plan around particular objectives. After planning the content and materials for the lesson together, one educator conducts the lesson while other members of the lesson study group attend and observe that lesson. The lesson is then evaluated and revised for further teaching to other groups (Cajkler, Wood, Norton & Pedder, 2013). The observation is very important as all the members have been engaged in planning the lesson together.

Verhoef, Coenders, Pieters, Van Smaalen and Tall (2014) agree with the other researchers, that lesson study focuses on the learning processes, that teachers study their own practices together through peer observation, evaluation and review. This exercise can be of importance to physical sciences teachers, who are still struggling with concepts such as *mechanics.* Teachers can also form clusters like what they already have in different districts and plan lessons together. This exercise again serves as a very good professional development as there is no possibility for an educator who had a problem on such a topic before, to continue to have that problem.

Research studies (Stigler & Hiebert, 1999; Lewis, 2009 & Lewis, Perry, & Murata, 2006: 276) published about lesson study claim that:

- *It is the usefulness of the lesson for helping learners overcome their difficulties, and not teachers' performance in conducting the lesson, which shapes professional learning in lesson study. The understandings of teachers of difficulties that learners encounter with particular aspects of their learning are at the heart of a process.*
- *Pre-lesson planning and post-lesson evaluation meetings provide discursive opportunities for detailed planning and in-depth reflection about the quality of teaching and learning*
- *Collaboration in lesson study can help teachers to develop a sense of collective efficacy so that mandates like standards-based instruction feel less overwhelming* (Lewis *et.al.* 2006: 276).

This implies that when teachers engage in lesson study, they address learners' problems collectively. They are able to share ideas that may not be so clear if they face them alone in their classrooms.

2.6.2.2 Collaborations with Peers

Collaboration as a professional development activity have proven to be beneficial, both locally and internationally (Postholm, 2012 & De Monte, 2013). Collaboration is defined as teams of teachers who work interdependently to achieve common goals that are linked to the purpose of learning for all, for which members are held mutually accountable (Perez, 2015). Various professional-learning designs that show improvements in teaching and learning include some sort of collaboration among teachers in the same school or across grades. This system is termed horizontal collaboration (Berry, Daughtrey & Wieder, 2009). On-going studies suggest best practices for collaboration that are most tightly linked to effectiveness of teachers. These include:

- *Scheduling adequate time for collaboration*
- *Aligning collaboration structures for both horizontal and vertical collaboration*

- *Structuring collaboration meetings formally*
- *Creating an atmosphere of mutual trust* (Berry *et al.,*2009: 5-6)

Teachers like to work with themes that they are familiar and interested in, based on their practical experiences, and as a result, want to stipulate their own learning goals. According to Jones, Roland, Johnson, and Boyer (2016), teachers like being autonomous in the development of their own practice and they also want to co-operate and reflect upon practice with their colleagues to change and develop their instruction. However, through collaboration, teachers can share planning time, support each other, assess the curricula at a grade level meeting or even develop teach teaching or co-teaching. Bryk, Sebring, Allensworth, Easton, Luppesco *(*2010: 55) maintain that teachers *"relinquish some of the privacy of their individual classrooms to engage in critical dialogue with one another as they identify common problems and consider possible solutions to these concerns".* This implies that teachers who work in the same school, preferably teaching the same grade, may be comfortable in sharing ideas about a topic, plan the activities of that topic together, or even observe each other's lessons. Effective collaboration improves the performance of teachers and learners. Teachers may also be involved in collaborative action research.

2.6.2.3 Collaboration action Research

Collaborative action research is a process where teachers of the same school may decide to study their contextual problems and then come up with solutions (West, 2011). Action research is about the "action" and "research", where participants collaborate and identify their unique problems, come up with strategies to improve their situations. In this case, teachers who are part of the 'action' have the opportunity to learn from each other, particularly in a setting where there is a structure and protocol for revealing excellent teaching practice.

Teachers may collaborate with external professionals such as university personnel to improve teaching in schools (West, 2011). In the case of physical sciences teachers, they can collaborate with local university staff, identify a problematic content or even a topic in science, and come together to design some questions that may help to improve the teaching and learning of that topic.

The teachers may decide to provide the university staff with data relating to the problematic topic, or they can work together to come up with mechanisms to improve teaching and learning. Teachers can use their classrooms as research sites, whereby teachers can teach a concept in different ways to determine which had the greatest effect on learner learning. Teachers can also experiment to see what approach is most effective in facilitating cooperative learning among learners (De Monte, 2013).

2.6.2.4 Coaching

Coaching is also regarded as part of the professional development activities where teachers observe instruction from a specified person (coach) and then discuss the observation with the coach. However, this might be a problem if the coach is somebody who is not involved in teaching. The coach can be an expert from outside the school who might offer to teach certain content and let teachers observe how he teaches (De Monte, 2013).

It is critical to have access to people with expertise, such as science specialists, lead teachers or outside consultants. In order to meet this need, schools or Head of Departments (HODs) need to identify the expertise among colleagues in a school, across the district in the associations and organizations that surround school communities as well as in online environments and then provide mechanisms for teachers to access that expertise (Wilson, Schweingruber, & Nielsen, 2015). This is a very good exercise as sometimes teachers may learn and employ some of the pedagogical skills that they might be lacking. Physical sciences teachers can benefit from such people, especially the newly employed teachers who might still be struggling with the content or the different teaching methodologies. Teachers may also develop themselves in the use of technology.

2.6.2.5 The Use of Technology

De Monte (2013) observes that videos can also be part of professional development if used properly. Teachers may get in touch with other teachers in the same field to improve their teaching. The use of technology can also be extended to the use of social media such as WhatsApp, MyTeachingPartner (which is prevalent in America), Mycloud and others. Here a coach can view an educator's practice/lesson on video and work on improving the teaching without the need for real-time, on-site observation (DeMonte, 2013).

This is already happening in the Free State, where the Free State Department of Education is using various centres for memo discussions after examinations. Vodacom is responsible for data charges and an examiner sits somewhere in Bloemfontein, in front of a video camera, while teachers sit in their different centres to discuss the memorandum. Borko, Jacobs and Koellner (2010) also state the use of technology-related components such as digital libraries, we-based virtual learning environments and online and electronic conferencing features.

2.6.2.6 Professional Learning Communities

The professional learning community is a team, in which teachers have universal views on collaborating, sharing, reflecting on the needs of their teaching and learning practice (Hord, Roussin & Sommers, 2009 in Sai & Siraj, 2015). The community helps individuals in learning and makes them contribute to the learning community by making teachers to get more formal knowledge that is combined with practice knowledge. Teachers have frequent interactions between their teaching and learning, when they come together to plan and discuss the content, teaching methods and all the activities of peers' observations.

Teachers also pay more attention to learners' outcomes by testing and examining their own ideas. Kise and Russel (2010) and DuFour and Eaker (2008) state that teachers are able to share work from their classrooms, plan together and give and receive feedback from their peers. This exercise can be very helpful in South Africa, where the performance in physical sciences is fluctuating yearly. Teachers can come together, plan activities together, even those topics that they feel are challenging, like *mechanics* and share their classroom experiences with others.

2.6.2.7 Mentoring

Beginning to teach is now well recognized around the world as a particular and complex stage of teacher learning. Beginner teachers can sometimes feel overwhelmed if there are no induction programmes in place for them to be accustomed to teaching. These programmes may be in the form of mentoring. Mentoring takes an important place both in terms of what mentors bring to the induction process (Avolos, 2011).

During mentoring, new teachers develop identities, and this is normally accomplished through the training of mentor teachers. Various studies such as (Devos, 2010; Hennisse, Crasborn, Brouwer, Korthagen & Bergen, 2011; Smith, 2015; Ambosetti & Dekkers, 2010) have looked at ways in which mentor teachers have contributed to the development of new teachers. These studies reveal how teachers who mentor beginner teachers feel as they induct these new people into teaching. This process can be beneficial to physical sciences teachers as CAPS is too demanding, with the amount of work that teachers have to spend in the laboratories as well as in the classrooms. The theory that these beginner teachers possess from their training institutions may be too overwhelming if they are left alone. They constantly need someone who is experienced, to take their hand through their first year of teaching. This experienced teacher, who now resumes the role of a mentor in return will gain even more experience and may even have a chance to learn more things on the way.

2.7 WHY IS IT NOT POSSIBLE TO IMPLEMENT PROFESSIONAL DEVELOPMENT PROGRAMMES IN SOUTH AFRICA?

The design of professional development initiatives in science education for teachers should be informed by research (Shaughnessy, 2007; Sowder, 2007). While the South African Science and Mathematics Education research community has grown distinctly, teachers often regard professional development as just wasting their time as it has very little impact on their daily responsibilities in the classroom (Guskey, 2002).

They participate because they are obliged, partly because of their contracts, but often see it as something they must "*get out of the way*", so that they can get back to their teaching (Guskey, 2002). Development of teachers in the country is seen by many role-players as badly coordinated, poorly monitored, confusing and burdensome (Department of Basic Education, 2011).

Most of these professional development activities are possible but can be costly, that is why governments opted for cascade methods (Bantwini, 2009). This was adopted by South African government during the implementation of C2005 and NCS. This was done in such a way that a small number of teachers at each school attended a workshop, and were then expected to train their colleagues. These "experts" would move from one province to another (Bantwini, 2009).

The Department of Basic Education trained a group of selected officials from various provinces, who were expected to train the local subject advisors. The subject advisors, in turn, selected and trained one educator from each school with the mandate to go back to schools and train others. This "string" was too long to reach the classroom and the content of this training further neglected content knowledge and focused on skills (Bantwini, 2009). This model was criticized as placing teachers in a passive role and as a result, they become consumers of knowledge produced elsewhere, and that the workshop menu could be fragmented in content, form and continuity. A similar approach was still being used when the Revised National Curriculum Statements (RNCS) was introduced to teachers in 1998 (Bantwini, 2009).

In the year 2013 there were 24136 public schools in South Africa, employing 391829 teachers (DBE.2015). More than 11,000 of these schools are to be found in the four predominantly rural provinces, namely, Limpopo, Kwazulu Natal and Eastern Cape. The financial and logistical challenges posed by implementing effective school-based development programmes, incorporating on-site mentoring of teachers in all of these schools, were so large as to be practically overwhelming in the foreseeable future.

The other reason of not implementing the school-based programmes, besides the costs, is the highly unionized teaching fraternity of the country. Most of the good professional development activities meet with criticism from the unions, and it impacts on teachers (Mouton, Louw & Strydom, 2012). In his study, Bantwini (2009) discovered that in other cases, unions even banned the subject advisors from coming to schools to check on teachers' lesson planning. They believed that the process was unfair and would victimize teachers.

Unions continue to voice their frustration at the lack of meaningful, hands-on support for teachers (Bantwini & McKenzie, 2011). On their side, education departments appear unsure as to how to implement their vision through concrete development strategies which are to provide meaningful support opportunities to teachers with differentiated development needs.

Professional development leaders should also bring to their attention, the structures and culture within which the performance of teachers is embedded. These may include school calendars and schedules, union contracts, teacher evaluation processes, leadership practices and belief systems about learning, teaching and the change process (Guskey, 2002). Cultural interventions must help create norms that foster experimentation, collaboration and continuous improvement.

2.8 CURRICULUM 2005 AND PROFESSIONAL DEVELOPMENT OF TEACHERS

Critics of C2005 and CAPS have suggested that its difficulty assumes a level of educator competence which does not exist in the current South African system (Jansen, 1998). CAPS framework requires teachers to be curriculum developers, classroom managers and learning mediators in a system that has, at least partially, abolished traditional boundaries and subject disciplines. It requires them to develop these competences within an education system playing an entirely transformed social role in the "new South Africa," in which previously autocratic relationships between teachers, and between teachers and learners, are to be replaced by collaborative ones. It therefore certainly requires most South African teachers to reconceptualise radically the meaning of teaching itself.

In the context described above, professional development for the C2005 was inevitably going to pose difficulties, and there is widespread consensus that the programmes implemented up till now have been insufficiently effective. A long list of professional development of teachers' inadequacies has constantly been reported as the roll-out of the curriculum has progressed (Pudi, 2006; Stewart, 2007; De Waal, 2004; Dada, Dipholo, Hoadley, Khemba, Muller & Volmink, 2009; Naong, 2008). Participating teachers have complained about the inappropriate length and timing of workshops, the dubious knowledge and competence of facilitators, lack of consistency between the training and OBE methodologies, and insufficient focus on practical application of the OBE methodologies in school and classroom contexts.

Korthagen (2017) argues that in-service training without site-based classroom support is ineffective owing to varying contextual and resource problems in schools, while Attard (2017) also notes that, because teachers feel disempowered about taking ownership and control of their own professional development, there is an urgent need for collaborative, school-based development (especially for unqualified and under qualified teachers) if they were to be motivated to change their practices significantly.

Professional development of teachers continues to be the most important challenge where the improvement of South African schooling is concerned. With the post-1994 commitment to equity and redress, in 1998 unions negotiated the Development Appraisal System (DAS) with education departments that was aimed at equalizing the teachers' salaries to their counterparts in the government employment. It was based on the principle of teachers driving their own development. However, it became clear that sufficient, meaningful support of teachers was difficult to mobilize as a follow-up to the 'educator appraisal for development' exercise.

By 2003, a ministerial report on professional development of teachers led to the 2007 National Policy Framework for Teacher Education Development (NPFTED) (Department of Education, 2007). By 2008, the South African Council of Teachers (SACE) was given the responsibility of coordinating and quality-assuring Continuous Professional Teacher Development (CPTD) as well as overseeing funds from the DoE (DoE, 2008). By mid-2009, development summit of teachers resulted in various stakeholders developing a statement of principles about development of teachers and, by April 2011, the Department of Basic Education publicised an Integrated Strategic Plan for educator Development, which is still to be implemented.

2.8.1 External Support

Poorly conducted training in the form of workshops and seminars should be replaced by inviting speakers and experts from outside the Department of Basic Education. These external resource persons should have good educational knowledge, a high level of expertise in teaching their subjects, sound communicative abilities and the ability to create constructive relationships (Bjorklund, 2015 & Bantwini, 2011). They should also be able to share local and international experiences. Bjorklund (2015) and Bantwini (2011) claim that a lot of teachers feel that if support can be sought form external programmes, NGOs and book-publishers, the problem of inadequate training by the Department of Basic Education would be solved. Most teachers feel that this type of support is what they need right now, as it focuses on their specific needs, it is continuous and it is done by skilled personnel.

Apart from education departments having a weak impact with their professional development programmes, many Non-Governmental Organizations (NGOs) and service providers as suggested by Rogan & Grayson (2003), face similar challenges as their support interventions have encountered serious obstacles and produced little real or sustained changes in teachers and learner performances (Taylor, 2007). The support was seen to be too local and sketchy, as they offered short courses or workshops that do not put sufficient emphasis on content knowledge. Teachers need to receive programmes which systematically take them through the content of their specialised subject areas. In contrast to this notion, Singh (2011) and Lessing and De Witt (2007) are concerned with the inconsistent training of teachers across the country, that it might not be possible for such programmes to succeed as they will depend on whether schools will gain anything from them. Such programmes should align their activities with the Department of Basic Education's goals so that the original intensions of the policy-makers are met.

In the light of the above, it is evident that physical sciences teachers are really in need of an external support system, which will cater for their everyday problems in their classrooms. This brings us to a discussion on what should be done to implement new curriculum and how this process affects teachers' attitudes and behaviour (Taylor, 2000:15).

2.9 CURRICULUM AND ASSESSMENT POLICY STATEMENT AND PROFESSIONAL DEVELOPMENT OF TEACHERS

CAPS is not a new curriculum, but an amendment to NCS Grades R-12. Pinnock (2011) asserted that it still follows the requirements of the NCS grades R-12. After consultations with the relevant stakeholders, the Department of Basic Education designed this curriculum, to assist teachers by providing them with specific guidelines which stipulated what has to be done on a 'term-to-term and grade-by-grade basis (Motshekga, 2011 in Msibi & Mchunu, 2013). The curriculum is now written in content format rather than in outcomes format (Du Plessis & Mbunyuza, 2014).

This means that it is likely to employ the traditional methods such as teaching of content for examination purposes, rather than OBE methods, because OBE failed in many ways in South Africa. There is one single comprehensive document for each subject, this means it is highly subject-specific and fixed (Du Plessis, 2013).

However, in their research Du Plessis and Marais (2015) found that some teachers were still having some negative views about CAPS training. Poor training is still evident and teachers cannot access the subject advisors as they should (Bjorklund, 2015, Du Plessis & Marais, 2015). This is due to excessive paper work and administration that these subject advisors are faced with. The scarce number of subject advisors in our districts and the administrative duties assigned to these subject advisors add onto the problem of limited support (Phasha, Bipath & Beckmann, 2016). The activities of subject advisors are not well coordinated between the districts and circuits, such that some of them serve as coordinators at both district and provincial level, as a result, there is no follow up on the implementation of the curriculum.

Bantwini (2009) noted that it seems the problems that plagued RNCS might still continue because during the period of RNCS, clear goals were in place for teachers to follow, but there was no plan for how they should act to reach those goals. They noted further that results of implementation of CAPS may not be guaranteed due to the fact that formal support structures such as subject advisors and HODs do not offer the support as they should. However, teachers are finding ways to help each other in cases where these structures cannot be accessed, so this shows that teachers have taken it upon themselves for their own development and support.

Teachers are still struggling with language and teaching and learning resources are inadequate. Subjects that are mostly affected are physical sciences and mathematics. This is more evident in township schools and to those teachers and learners whose English is not their home language (Phasha, Bipath & Beckmann, 2016).

The issue of English being the language of learning and teaching can have consequences for teachers as it might alienate them from trusting the decision makers and in the long-run affect their belief in the reform (Lindensjo & Lundgren, 2000 in Phasha, Bipath & Beckmann, 2016). The problem of no access to enough resources might also further increase the problems with implementation (Du Plessis & Marais, 2015). The Department of Basic Education seem to be inconsistent with the distribution of resources, as access to these resources varies from school to school. Physical sciences teachers feel that the content is too congested and they cannot seem to finish the required work in time, or even manage to cover it (Kriek & Basson, 2012). There is no sufficient time allocated for physical sciences in school time tables, and this makes it impossible for teachers to finish in time for examinations.

The majority of South African teachers are under-qualified to teach physical sciences, and as a result, they are highly dependent on textbooks for content. In most cases they use rote learning as a teaching methodology (Kriek & Basson, 2012; Adu & Ngibe, 2014; Ramnarain, 2014). Learners and parents are also complaining about the amount of work required by CAPS, and as has been stated, most parents are not in a position to help their children due to the nature of the subject. There are teachers who are still feeling incompetent to teach physical sciences due to the new topics that have been added, and therefore display a negative attitude towards the subject. This impacts on the teaching and learning of physical sciences in the classroom, hence there is a need for further training (Mchunu & Imenda, 2015). It is therefore important to change the format of professional development of teachers that will suit the structure of CAPS and how teachers should be developed.

2.10 NEW AND INVENTIVE APPROACHES TO THE DEVELOPMENT OF TEACHERS

Reflecting on South African context where teachers lack content and Pedagogical Content Knowledge because of ill training and ineffective INSET programmes that address classroom issues, innovative and effective professional development approaches are needed to fill the gap (Dass & Yager, 2009). Inventive approaches promote close observation of the educator's own classroom, tie together educator's ability to intensify awareness of their own professional needs, promote individual and collaborative reflection about shared learning from their experiences, and promote the critical use of others' published ideas (Dass & Yager, 2009). These are regarded as better ways of improving classroom practices, where content Knowledge and Pedagogical Content Knowledge takes the form of reflection on action (Dass & Yager, 2009).

As a consequence of lack of effective classroom practices, problems and related theoretical debates, especially in South Africa, many new approaches to professional development have begun to emerge.

These approaches such as, collaborations, lesson study, mentorship programmes, peer-observations are mostly targeting science and mathematics teachers (Kaplan, Cervello & Corcoran, 2009). South Africa still needs to come up with approaches that provide opportunities to understand the personal and professional development needs of teachers, investigate those situations where they come together to form communities of learners (De Monte, 2013).

The following table shows the envisaged shifting of old professional development approaches to new approaches as seen by Dass and Yager (2009).

Table 2.4: Shifting emphases in professional development of teachers

From	To
Isolated, individual learning	Learning both individually and in the context of groups, such as the whole school and networks of teachers interested in particular subjects
Fragmented, one-shot “training”	Coherent, long-range learning
District-level, one-size-fits-all programmes	School-based learning tailored to the needs of all learners in the building
Bureaucratically convenient	Focused on learner needs
Outside the workplace	Embedded in the job and closely related to both learner and educator needs
Experts telling teachers what to do	Teachers taking an active role in their own growth
Skills that can be used by everyone and therefore available in depth to on one	Involvement of all teachers and instructional leaders in developing new approaches to teaching based on their needs
Teachers as passive receivers	Teachers and administrators as active makers of their own learning
Adult learning as an add-on that is not essential to schooling	Adult learning as a fundamental way of teaching and a transformation of schooling
Measuring effectively by attendance at workshops	Measuring effectiveness by improvements in teaching and learning

Adapted from Dass and Yager (2009:102)

The table suggests that teachers should shift away from old formats of training, where teachers were just seen as receivers of knowledge, without any say or inputs, rather, they should be involved in their training. Physical sciences teachers should participate in new professional development programmes that are aligned with the policies as assigned by OBE principles. These principles require teachers to be life-long learners and the instruction that learners are accustomed to should be learner-centred.

Teachers should be exposed to a variety of activities whose aim is to improve the teaching and learning of science. They should sometimes meet in science laboratories as well as classrooms, observe lessons and share ideas on practical work. They should also be responsible for their own development by identifying their developmental needs that have to be addressed by the programmes.

Steyn (2008) states that workshops, seminars and conferences are considered to be the traditional approaches to professional development. In his study, Steyn (2008) states that these approaches adopted a technical and simplistic view of teaching with the belief that teachers' knowledge and skills could be improved by using experts from outside schools and that those approaches were not effective since they did not sufficiently change teachers' subject knowledge pedagogical skills. However, the new approaches to professional development of teachers are school-based and they address the needs of resident teachers as they emerge as well as the needs of learners. The following table highlights some of the recommendations by Dass & Yager (2009), which suggest that there should be a clear shift from how professional development of teachers of science should be.

Table 2.5 Shift in Emphases Encompassed by the Standards for Professional Development for Science Teachers

Less emphasis on	More emphasis on
Transmission of teaching knowledge and skills by teachers	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of science and teaching knowledge in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as teachers	Staff developers as facilitators, consultants and planners
Educator as technician	Educator as intellectual, reflective practitioner
Educator as consumer of knowledge about teaching	Educator as producer of knowledge about teaching
Educator as follower	Educator as leader
Educator as individual based in a classroom	Educator as a member of a collegial professional community
Educator as target of change	Educator as source and facilitator of change

Adopted from (Dass & Yager, 2009:103)

The implication of this table is the acknowledgement that science is an inquiry-filled subject, which needs specific modes of teaching and that science should be incorporated through investigative methods rather than being delivered through lecture methods. Teachers have to take ownership of professional development, by mixing both internal and external expertise. Teachers should not only rely on external expertise as they themselves are knowledgeable of their contextual needs. They should be able to come up with strategies of improving their teaching and the use of modern technology as the subject demands that. In the modern way of teaching science, teachers should not be regarded as consumers of knowledge but rather, they should be producers of knowledge as they engage in different professional development activities.

Teachers should also be engaged in collegial and collaborative learning, where they meet with other teachers to plan and share activities that they want to engage learners in. In this modern day, teachers are seen as leaders instead of followers. They should also regard themselves as part of a collegial professional community where they attend educational conferences and seminars to share new knowledge and skills in science. These characteristics will render them as facilitators of change rather than targets of change. In order to understand professional development of teachers in South Africa, it is also advisable to learn how this process unfolds in other countries.
The next section describes the professional development activities as practiced in other countries outside South Africa.

2.11 PROFESSIONAL DEVELOPMENT ACTIVITIES IN OTHER COUNTRIES

Professional development of teachers as has been illustrated is practiced world-wide. Below is an account of the support of teachers in the European countries. Darling-Hammond (2017) describes different policy reforms in different overseas countries, how they perceive their educator professional development and how such programmes impact on the level of education and learner outputs. He researched about different educator professional development in countries such as Finland, Singapore, Canada, Ontario, Alberta, Australia and United States of America (USA).

The paragraphs that follows briefly explain how professional development programmes of teachers are carried out in Finland, Singapore, Ontario, Alberta and Australia.

2.11.1 Finland

Finland has a sophisticated, high-quality education system, in which all teachers at least hold a 2-year master's degree that comprises both strong subject-specific content and pedagogical content knowledge, which integrates both research and practice. Due to the importance of this profession in Finland, many teachers pursue a PhD and then still remain in teaching. This country has improved from a relatively poorly educated nation to a twenty-first century "powerhouse", booming a current literacy rate of 96%. Their view is that teaching should be "a long-term profession where people can grow into leadership positions and develop over time".

From as far as 1970s, major changes were done to professionalize and equalize resources for schools and support of teachers. They have systems for educator and leader development in place which operate throughout the whole country, to recruit, develop and retain talented individuals. The systems incorporate a full range of policies that affect the development and support for teachers and school leaders, which include the recruitment of teachers, their preparation, their induction their professional development, their career development and evaluation as well as to make sure that they retain them over time.

Here teachers are allowed time-off from their duties, to collaborate with their peers, in developing curricula and assessment strategies. They are also concerned that teachers need more support, hence decided to strengthen their induction and professional development, even for experienced and practicing teachers.

2.11.2 Singapore

Singapore has also shifted from hiring unqualified teachers but it also provides high-quality teachers. This was a good reform since its independence in 1965, and it has driven changes in recruitment, preparation, compensation, status and the professional development of its teachers. It applies strict standards for admission of teachers into the field, which include strong demonstration of academic ability and a passion to teach. Tuition at graduate level is paid by the government, and teachers receive salaries while they train. Every teacher-in training is assured of guaranteed employment after graduation. The National Institute of Education (NIE), designs and offers a strong induction and professional development which is highly compensated compared to other occupations.

Singapore also strengthens the process of connecting theory and practice by training and supporting senior and master teachers to become cooperating teachers and mentors in the educator preparation and during induction of beginner teachers. This is where emphasis is put on knowledge, skills and attitudes of teachers at each stage of their career. Just like in South Africa, teachers can even become curriculum specialists or even principals.

2.11.3 Ontario and Alberta

In Ontario and Alberta, the emphasis is on extensive pre-service preparation whose expectancy is a full two-years at graduate level. Ontario on the other hand has instituted a multi-year induction programme for beginner teachers, which includes intensive mentoring, appraisal and professional development. As it has recently been identified some gaps in the initial training of teachers, in areas such as classroom management, inclusive education, Ontario is expanding the expectations for pre-service education and revisiting its induction system.

2.11.4 Australia

Australia supports preparation of teachers, in most of the universities and as a result education candidates get free tuition. A number of education programmes are supported by the government.

Like any other large country, Australia has systems that operate at the provincial and state level, that include complementary components associated with recruiting, developing and retaining talented individuals whose main aim is to ensure that each school has effective teachers. Australia highly supports in-service professional development (OECD 2014).

2.11.5 Japan

Lesson study has been practiced by Japanese teachers for over a century (Makinae, 2010). Japanese teachers practice learner-centred problem-solving approaches in mathematics lessons to promote learners' conceptual understanding. In a lesson study, a team of three to six teachers goes through four specific stages. During the first stage the content of a chosen unit and learner understanding of the unit is studied, and then learning goal is aligned with the content and school goals. During the second stage, a lesson plan is developed for an experimental lesson called the "research lesson", and the third stage is whereby one team member teaches the research lesson in an actual classroom with learners and other team members observe the lesson to collect learner data, and during the fourth stage, discussions of the effectiveness of the lesson continue among the team members, based on the collected data and how to improve the lesson and teaching approaches to achieve the learning goal (Lewis, Perry & Hurd, 2009; Lewis & Hurd, 2011). According to Akiba and Wilkinson (2016), Japanese teachers engage in an average of two cycles of lesson study per year in an average-size prefecture in Japan.

Lesson study embodies content-focused, coherent, continuous and collaborative educator learning activities, and this is a characteristic of a professional development empirically shown to be associated with improved instruction and learner learning. In Japan, it is an institutionalised process that is embedded into organisational structures and routines that support educator leadership and collective ownership of professional learning process, continuous engagement in research-based professional learning and profession-wide networks for developing and sharing practice-based knowledge that is directly applicable to everyday practice of teaching (Akiba & LeTendre,2009 in Akiba & Wilkinson,2016).

2.11.6 Lesotho

Lesotho has adopted a distance education model to improve the quality of teaching in Lesotho primary teachers (Mohono & Van Tonder, 2006). Mentoring as one of the professional development activities has become an important method of supporting in-service teachers in distance education. The concept of distance education has been moved from passive lectures and information delivery towards more interactive student learning. Mentors do not lecture but promote discussion and guide responses with in-service teachers at one place or in many places simultaneously.

2.12 SUMMARY

In this chapter, a literature on professional development of teachers has been reviewed. An account of some professional development activities that are taking place in Europe and in other countries has also been highlighted to show the need for teachers to be supported. In this chapter, curriculum change as a process and what it entails has also been discussed, as well as the process of change that may be a factor for failed curriculum implementation in South Africa. Different reasons why proper professional development programmes or activities have not taken place in South Africa have also been discussed.

Chapter 3 will discuss the theory of Kirkpatrick as modified by Guskey (which incorporates CBAM) on evaluation of professional development, as a lens through which programmes can be evaluated after they happen, to support and improve teaching and learning.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 INTRODUCTION

As has been in the previous chapters, South Africa has seen many curricula changes since 1994, most of which were politically motivated, to remove the curriculum followed under apartheid. These changes were mainly to improve the quality of education (Phasha, Bipath & Beckmann, 2016). However, previous curriculum changes seemed ineffective as learners kept on performing poorly. This poor performance drew widespread criticism that was depicted in various studies (Taylor & Vinjevold, 2003; Jansen & Christie, 1999; Potenza & Monyokolo, 1998), as well as international comparison achievement tests such as the Trends in Mathematics and Science Study (TIMMS).

The literature review of this study is framed by theories within the constructivist paradigm. Constructivism is the learning theory which is based on the belief that each individual can construct knowledge. Knowledge is perceived as the construction of meaning and understanding within social interaction. The social surroundings are seen as decisive on how the individual learns and develops (Postholm, 2012). Individuals construct knowledge and learn through mediated acts in the encounter with one or more persons and the surroundings in which they live and act. Learners as well as teachers come with different experiences from their social lives (Brijlall, 2010). These experiences should be shared even in a teaching-learning situation, so that new knowledge can be constructed. As a theory of learning, constructivism is relevant in this study as the researcher wished to establish how teachers teach.

Physical sciences teachers have been applying their knowledge of this subject in the way they were trained, and if the way they are expected to do things change, then they would definitely need support.

The theory of socio-culture as depicted by Vygosky also applies to physical sciences teachers in South Africa. In applying Vygosky's socio-cultural theory, Warford (2011) states that teachers' learning is situated. If teachers have been taught with this in mind, then it would require them to relate to their previous experiences and the way they were trained, and there is no way teachers can be trained without awakening their previous knowledge and experiences during the learning process. Therefore, it is important for them to reflect back on their teaching (Postholm, 2008). Teachers learn though various courses, in school as they reflect on their own teaching and on observing others, but if these courses are not evaluated, then there will be no guarantee that what they learn through the different courses will be helpful.

This evaluation is derived from Guskey (2002) who developed and modified Kirkpatrick's framework of the five levels of professional development evaluation, for use in a school context. Guskey's model was further developed by Bubb and Earley (2010), which sought to facilitate professional development planning, as evidence suggests that planning professional development in advance can improve the outcomes for teachers and learners (Earley, Nelson, Higham, Bubb, Porrit & Coates, 2011). This framework can be used to assess and improve professional development programmes after they are initiated so that if there is a need to revisit the programmes again, then remediation would have been administered.

3.2 GUSKEY'S MODEL OF EVALUATION OF PROFESSIONAL DEVELOPMENT AS DERIVED FROM KIRKPATRICK

For the purposes of this study, only four of the levels will be discussed as they relate to teachers. The fifth level is not discussed because it focuses on the learning outcomes of learners, and for the purposes of this study, it is very important to look at ways in which the professional development of teachers can be evaluated and improved. In most professional development programmes, evaluation is mainly left to the experts, whereas this is an important aspect of the whole professional development (Guskey, 2000). Through the use of this model, Guskey (2000:40) had the following questions, which help how evaluation of the programmes can be done:

- *Is the program achieving the expected outcomes?*
- *Is the current program better than the previous one?*
- *Is it worth the costs? (Guskey*, 2000:40).

These questions suggest that every professional development programme must be evaluated as this has seen a way of reaching better decisions about the programme. It involves asking questions and gathering information about the programme, drawing conclusions and making recommendations. The evaluation of a professional development programme is determined by examining the achievement of the stipulated goals and objectives that are derived from the needs assessment (Hansen & Rush, 2008). Guskey (2002) asserted that if evaluation of professional development programmes is done properly, the information from such evaluations can be used to make relevant decisions about specific programmes, hence become the building block on which the next professional development will be planned.

The theory developed by Guskey (2000) is built on the belief that professional development evaluation can determine whether the planned activities could lead to the desired goals and purposes. The following critical levels of professional development evaluation were developed:

- *Participants' Reactions*
- *Participants' learning*
- *Organizational support and change*
- *Participants' use of new knowledge and skills*
- *Learners' learning outcomes* (Guskey (2000).

These critical levels of professional development evaluation infer that these levels are successive and interrelated with one level building on the other and indeed success at each level being necessary for subsequent levels (King, 2014). However, teachers may need support to progress through these levels. This support may be in the form of creating collaborative cultures of teaching and learning, such as professional learning communities or other forms of collaboration, team teaching practices, and peer coaching or collaborative consultation to improve the system's overall capacity (O'Sullivan, 2011).

According to Kirkpatrick's framework, the first level is the most common form of professional development evaluation and it is the simplest where initial teachers' experience of the professional development activities is measured. The second level focuses on measuring the knowledge, skills and perhaps the attitudes that teachers might have gained out of the professional development programmes/activities. This is where teachers might indicate how they can use what they have learned and how that knowledge can be applied to their respective classrooms. The third level focuses on the organization's support, advocacy, support and recognition. It is at this level, whereby it becomes evident of the positive or negative impact of the professional development programmes in schools and how these stakeholders can improve the implementation of these activities. The fourth level focuses on the use of the new knowledge and skills by teachers. At this level, the assessment of whether the new knowledge and skills gained by participants have had an effect on their professional development practice is done. The fifth level focuses on whether the professional development programmes had any effect on the learning outcomes of learners. These may include cognitive, affective and psychomotor outcomes.

The sections that follow will deal with how the levels of professional development evaluation as developed by Guskey (2000) could be related to what is happening with the teachers' perception of CAPS in South Africa, and whether evaluation of the professional development programmes is taking place, and if it is not, how the application of this model can help in South Africa.

3.2.1 The First Level: Participants' Reactions

Under the first level of evaluation of professional development programmes, questions that are related to participants (in this case, the teachers), can be classified according to the three broad categories. These categories include content questions, process questions and content questions (Guskey, 2000).

3.2.1.1 Content questions

According to Guskey (2000), content questions always addresses the relevance, the utility and timeliness of the topics explored through a professional development experience. These should focus on the new knowledge, the skills and the understandings of the professional development endeavour. They can also relate to the magnitude, the scope, the credibility and practicality of the change required to implement the new knowledge.

Teachers in South Africa are constantly critical of the training they receive in relation to CAPS, due to the limited time that is set for such training, unskilled trainers and due to the content that is detached from their teaching reality (Bjorklund, 2015). Mogashoa (2013) also shared the sentiments in his study. It was found out, through this study that some teachers felt that the time for the training is always limited, that the training is sometimes irrelevant to their classroom contexts. These, as Luneta (2012:365) put them, could be addressed through what is termed "characteristics of effective professional development" which are:

- *Alignment with goals of the Department of Basic Education, the Curriculum Assessment Policy statement (CAPS) and teachers' professional development needs*
- *Focus on the knowledge bases and the effective instructional approaches appropriate for high learning outcomes*
- *Inclusion on learning opportunities for acquiring new instructional strategies*
- *Provision of opportunities for reflection and collaboration among teachers and*

- *Inclusion of built-in follow up and continuous feedback* (Luneta,2012:365)

These characteristics, according to Luneta (2012) in Bjorklund (2015) denote that despite the different forms of professional development programmes, they must be relevant to the teachers' situations and constructed in such a way that teachers can gain from the experience, that teachers should be active and have the chance to relate the theories to their own practices. Normally if teachers have a say in determining what the content of the professional development activities will be, they express more positive perceptions (Borko & Putnam, 1995 in Guskey, 2002). If evaluation of professional development is done, the comments of the teachers can become more favourable if the content addresses specific problems and offers practical, relevant solutions that can be implemented immediately. Then it becomes important to evaluate the process questions that teachers may have in relation to the trainers of professional development.

3.2.1.2 Process questions

Guskey's model maintains that process questions relate to the conduct and organization of the professional development experience, here the main issue being on the trainers and specific activities that teachers were engaged in. Human beings have different learning styles and they react differently to any form of professional development. It is therefore advisable to include a variety of activities to cater for these diverse groups. The sentiment is also shared by Du Plessis and Mbunyunza (2014) that professional development should include a variety of teaching activities that can be shared by teachers who work together. Taole (2013:44) cited by Phasha, Biparth and Beckmann (2016) talked about the conduct of trainers that "*trainers need to be properly trained to avoid misinformation and misinterpretation of the policy documents by teachers".* It then follows out that, it becomes the responsibility of the provincial Education Departments, to provide further training to the presenters *(*Phasha, Bipath & Beckmann, 2016). It is also important to evaluate the context questions to determine where professional development of teachers will take place.

3.2.1.3 Context questions

Context questions generally relate to the setting of the professional development experience, and are designed to provide information on the background and current reality of the environment in which the professional development takes place. Questions that are likely to be included in evaluating teachers' reactions to these types of programmes may include:

- *Were the facilities conducive to learning?*
- *Was the room the right size for the group?*
- *Were the accommodations appropriate for the activities involved? (Guskey, 2002:97).*

These questions imply that it is important for professional development of teachers to be held under conducive environments. If the provincial education department is the one which organizes these, they should be able to cater for teachers' needs so that they feel they are part of a professional body.

Guskey (2002) suggests in his model that it is very important to attend to context conditions for a professional development program to be successful. The information may be gathered through the use of specialised evaluation forms or questionnaires which can be handed to teachers at the end of each professional development activity. Alternatively, focus group interviews or reflective journals can be used which either can be filled or recorded during the professional activity or at the end of such activity. The information gathered can be used to identify the type of follow up activities that might be needed, and the type of additional topics to be dealt with in the future. It is also important to have this feedback so as to guide the improvement in the design, format and conduct of future professional development experiences.

3.2.2 Level two: Participants' learning

At this level, Guskey's model suggests that in order for a professional development program to be effective, it has to be a learning experience to those who participate in it. Bubb and Earley (2010) have similar levels in their model, namely the Experience and Learning respectively. These levels also focus on the same issues with the important added element of a focus on attitudes- acquired or enhanced.

It is one of the important purposes of professional development to enhance the professional knowledge and skills of the teachers so that they might in turn improve learners' performance in classrooms. Guskey, (2000:122) suggests different questions that might be relevant to evaluate in this level and these are:

- Why is it important to assess participants' learning?
- What questions are addressed at this level?
- What type of learning are addressed?
- How will the information be gathered?
- What is measured and assessed?
- How will the information be used?

These questions suggest that it is important to have a direction on what to evaluate before the evaluation itself can be carried.

3.2.2.1 Why is it important to assess participants' learning?

In order to answer the first question, Guskey suggests three reasons namely, to validate the relationship between what was intended by the professional development program and what was achieved, the data are a primary indicator of the effectiveness of a professional development experience and the third reason is that the evidence is very important for implementation of the program. The funders or implementers need to know the important aspects that need to be revised or revisited so that relevant and appropriate adaptations can be made (Haden & Kirkley, 2010). If there are misconceptions, these have to be addressed prior to implementation or at the end of the program, so as to clarify any problems or difficulties experienced. It would therefore be important to check the type of questions that are addressed in this level.

3.2.2.2 What questions are addressed?

This is a question on whether participants of professional development, have indeed acquired the planned knowledge, skills and attitudes or beliefs. This implies therefore that during the programmes, learning goals should be identified. Dichaba (2013) suggests that it is very important for planners or trainers to reflect on the goals and objectives of their intended training before the commencement of such activities. They should identify participants who will attend and should make sure that identified participants have been appropriately oriented before they can resume with their training, and that these are specific, clear and measurable goals in place. In most cases, policy makers focus on outcomes of the educational change and they tend to neglect the implementation process (Bantwini, 2009). It also advisable after checking the type of questions addressed, to check the type of learning that is assessed.

3.2.2.3 What types of learning are assessed?

In assessing participants' learning, Guskeys' model classifies three types of goals, these are cognitive, psychomotor and affective goals.

- **Cognitive goals**

Cognitive goals relate to the specific elements of content and pedagogic knowledge of teachers. This means teachers need to understand the subject matter that they teach and how their learners perceive the content, before even engaging in training. The type of training should be content-specific.

- **Psychomotor goals**

Psychomotor goals describe different ways, skills and behaviours that teachers can acquire through a professional development program, in relation to how they teach their learners. Teachers need to be able to adapt their content to different learning context so that implementation of whatever they were trained on become effective. For instance, if follow-up activities are done effectively after workshops, then teachers would be able to apply what they have learned to check whether it is working for them.

- **Affective goals**

Affective goals are "the attitudes, beliefs or dispositions that participants are to develop as a result of a professional development experience" (Guskey, 2000:125). This may include assumptions and perceptions that they hold about teaching, learning and the schooling in general. For instance, it would be advisable to check the perception of teachers on the type of training they are provided with, in this case, how educator perceive CAPS training.

- **How will the information be gathered?**

Information on these categories may be gathered through pencil-and-paper assessments or evaluation forms, as well as interviews and reflective journals. For instance, at the end of training, teachers may be provided with questionnaires or evaluation forms to evaluate the training. Sometimes if time allows, some interviews may be necessary to gather enough evidence.

- **What is measured or assessed?**

Guskey's model suggests that here knowledge, skills and attitudes or beliefs that teachers gain during professional development programmes are assessed. Having engaged in professional development experience, teachers may recognize different learners' unique learning needs, be open to new instructional strategies and engage more regularly about teaching and learning issues. For instance, if there are any new instructional strategies that teachers learned as well as new skills that may help them to improve learner performance, it would be advisable for them to point them out.

- **How will the information be used?**

The information gathered at the second level provides the basis for making necessary changes. If there was anything that needed to be restructured, like if teachers had negative experiences, these can be changed. Steyn (2008) states that it is necessary to find appropriate professional development approaches to ensure that all teachers are equipped with the necessary knowledge and skills for improving learner performance. For instance, if teachers were not satisfied with the training content, that it was not contextualized according to their specific needs, then this point have to be clear, so that it can be addressed before the training can address the organizational support.

3.2.3 Level Three: Organizational Support and Change

This level checks the organizational support and change and its evaluation thereof. Evaluating organizational support and change is very important for any professional development program to be effective (Guskey, 2002). Professional development programmes should be clear so that organizations in which these programmes operate should render the relevant support. Policies at the national, regional district and school levels affect the professional development content, processes and effects. The ways in which districts and schools support the professional development of teachers become very vital as they direct whether the implementation of curricula is effective or not. Croft *et.al., (*2010) and Guskey and Yoon (2009) suggest that the most effective type of professional development is supposed to be job-embedded. These researchers suggested that three groups of people can actually help to support this job-embedded professional development. These are the state, the district and the school leaders.

In order to support the job-embedded professional development, Croft, *et.al.,* (2010) suggest that education leaders may

- *Help build a shared vocabulary around what is meant by professional development through regular communication vehicles*
- *Provide technical assistance to districts for choosing high quality approaches to professional development*
- *Promulgate guidance on proper use of funds for professional development*
- *Monitor implementation of professional development as required by federal grant regulations.*
- *Identify successful professional development practices within the state that can provide models to other districts and schools*
- *Align educator licensure and re-licensure requirements with high-quality professional development. For example, consider building a focus on educator candidates' readiness to participate in collaborative professional learning for purposes of improving the qualifications to be teachers (to obtain proper education qualifications like in Post Graduate Certificates for people with just general Degrees),*
- *Build comprehensive data systems to inform decisions about professional development, making data available to researchers to advance the field. Such data systems should include, at a minimum, data on teachers' performance, learner achievement linked to teachers, types and duration of professional development utilized by teachers at each school and educator retention information* (Croft *et.al.,*2010:10)

District leaders can also do the following activities to support the job-embedded professional development:

- *Engage in long-term strategic planning for human capital development that includes hiring of teachers who are prepared to engage in collaborative* *professional learning and developing effective teachers through thoughtful use of job-embedded professional development while promoting continuous learning for all teachers.*

- *Work to develop a school culture among teachers in which continued learning is considered an essential aspect of professional practice.*
- *Offer incentives and support for schools to provide and evaluate job-embedded opportunities for their teachers.*
- *Help principals identify effective instructional facilitators through principal professional development and performance review discussions.*
- *Help principals plan and support job-embedded implementation, establishing procedures to support school job-embedded facilitators to advance teaching and learning and meet school improvement goals.*
- *Help principals align evaluation of teachers with job-embedded professional development, providing tools developed with educator unions, universities or other educational organizations that support the ability of principals to recognize how teachers might strengthen their practice through participation in job-embedded professional development.*
- *Help principals provide educator collaborative learning time that is common to all teachers, distinct from planning time, and protected from administrative duties.*
- *Create policies that allow teachers to advance as instructional leaders, master teachers and job-embedded professional development facilitators while continuing to teach learners for part of their workday or week* (Croft *et.al.,*2010:11)

It is therefore important to evaluate and assess the organizations' support because they have a powerful influence on all aspects of professional development. Evaluating the culture, which refer to the values, beliefs and norms that operate within organizations is very vital. Organizations such as schools and the management teams (SMT) need to be brought on board in relation to professional development programmes. Management teams should plan and negotiate suitable time for professional development activities on the school calendars so that teachers can attend these activities. Lack of these plans may hinder the process as most teachers do not want to attend over the weekends and during school holidays (Geldenheys & Oosthuizen, 2015).

Sparks (2003) in Steyn (2008) states that it is important for principals to provide appropriate support to teachers to continue developing new classroom habits after professional development programmes. According to Steyn (2008), principals can provide individualized support by means of a motivational, supportive style of leadership. That support includes demonstrations of respect for teachers and concern about their personal feelings and needs. By identifying teachers' needs, motivating and supporting their development and working towards a collaborative school culture with shared values and norms, principals can play a key role in professional development. A study by Steyn (2011) also revealed challenges for management and states to encourage teachers to become committed to their own professional development.

There should be school subject area committees, organized by the SMTs, to ensure that teachers assist one another with the challenges they encounter, and offer the relevant support. School management teams (SMTs) should monitor and support in their respective classrooms so that teachers can have the opportunity to talk and learn about the problems they encounter in practice. Cunningham and Cordeiro (2000), cited by Phasha, Bipath and Beckmann (2016) shared the same sentiment, that monitoring and support in the form of class visits give the SMT an opportunity to observe teachers' work, provide motivation and exercise influence. School principals, as managers of school should also be trained so that they can offer necessary support to teachers.

They should also allocate teachers subjects that they are qualified to teach so that when these teachers attend relevant professional development programmes, they can gain new knowledge and skills for teaching these subjects (Croft *et.al.,* 2010). On the district level, the importance of proper training of subject advisors cannot be overemphasized. These subject advisors also need to have adequate knowledge of the subject they are responsible for. They should also provide adequate support materials like science equipment as it seems most schools cannot afford to purchase science equipment to support effective teaching and learning in schools.

The above-mentioned issues are very important because factors that lie within organizations are normally responsible for the failure for professional development programmes. So it is very important to gather such information to improve the planning and implementation of future efforts. After evaluating how the organization can offer support and change, it is imperative to check whether the new knowledge and skills derived from the professional development programme is of any use to the participants, and the levels at which they use such new knowledge.

3.2.4 Level Four: Participants' Use of New Knowledge and Skills

This level checks whether participants have learned any new knowledge and skills from their professional development practice (Mullis, Lepicki & Glandon, 2010). It focuses on changes in behaviour that have developed among the participants as a result of professional development. These changes must be defined by the training provider prior to the event, and may have resulted from any form of professional development such as seminars, workshops, as well as peer observations and mentoring.

However, the evaluation on this level must be made after participants/teachers have had sufficient period to reflect on what they learned and to adapt the new ideas to their particular contexts, more especially because implementation of new practices is usually a progressive and ongoing process (Mullins, Lepicki & Glandon, 2010; Darling-Hammond, Hyler & Gardner, 2017). It therefore implies that measures of the use may need to be gathered at several points in time.

Evaluating the participants' use of new knowledge and skills is not so simple because of the challenges that need to be met (Guskey, 2002). Mullis, Lepicki and Glandon (2010) suggest four procedural elements that have to be considered by the trainers:

- *define the behaviour objectives of the training*
- *specify dimensions of quality and quantity for the behaviour objectives*
- *determine time duration between training and evaluation*
- *determine methods of evaluation* (Mullis, Lepicki & Glandon, 2010: 10)

This means that it should be clear which actions or behaviours should and should not take place in relation to the newly acquired knowledge and skills. Secondly, there must be a clear distinction between the frequency and regularity of use as well as the appropriateness and adequacy of use. Then there has to be the determination of whether the adequate time has been allowed for relevant use to occur, and finally, there has to be flexibility that must be allowed for any contextual adaptations (Mullis, Lepicki & Glandon, 2010).

In as much as this determination is not so easy to do, the question on whether teachers can use what they have learned from professional development programmes effectively is just as important as learner performance. One cannot improve the learning for leaners without first improving the learning structural practices of all or most teachers (Fullan, 1996 in Guskey, 2000).

Specific professional development components are directly related to the increased use of new instructional practices and techniques. According to Guskey (2000: 181), these components include:

- *engaging teachers with content knowledge which is directly relevant to what learners are learning at that moment*
- *providing follow-up and support in new skills implementation*
- *developing an understanding of the rationale behind the new skills*
- *using peer study groups to learn about the new skills*

- *demonstrating the new skills live or through a videotaped session and*
- *studying the change process in trying new skills.*

The implication of these components is that teachers need to collaborate with each other to learn the new skills, and they have to be engaged in content knowledge that is relevant to what learners are doing at the time of innovation. Through peer teaching, teachers can improve on new skills and they can embrace understanding of the rationale behind the skills.

3.2.4.1 What questions are addressed at this level?

In this level, the main question that is asked is usually whether teachers can translate what they learned through a professional development activity to any change in their professional behaviours, and this cannot just be answered by a mere “yes” or “no”. There are at least three major aspects of use or implementation that need to be considered in addressing this question, and these are derived from the Concerns-Based Adoption Model of Change (CBAM) as designed by Hall and Loucks (1978a & 1978b), Hall, Loucks, Rutherford and Newlove (1975) The first of these aspects are the concerns that individuals experience as they go through the process of change, the second aspect is focused on the various degrees or levels of use involved in implementing new practices and the third aspect stems from the research linking professional development to improvements in learner learning. The aspects involve determining whether the new practices are really different from what teachers used in the past.

- **Stages of concern**

The following table shows the different stages of concern that teachers experience as they go through the process of change.

Table 3.1 Stages of concern

Category	**Stage**	**Label**	**Description**
Impact	6	Refocusing	Focuses on exploring broader benefits from the change, including the possibility of major alterations or adaptations
	5	Collaboration	Focuses on coordinating and cooperating with others regarding the change
	4	Consequence	Focuses on how the change is affecting learners, which learner outcomes are influenced, and which adaptations might be necessary to improve results
Task	3	Management	Focuses on the processes and tasks involved in applying the change and the best use of information and resources. Attention centres on efficiency, organization, management, scheduling and time demands
Self	2	Personal	Focuses on the demands of the change and one's adequacy in meeting those demands. Attention centres on one's role in the change process, the reward structure, decision-making and potential conflicts with existing structures and personal commitments
	1	Informational	Focuses on learning more detail about the change. Although unworried about one's personal involvement in the change, attention centres on gaining more information about substantive aspects of the change, such as general characteristics, effects, and requirements for use.
Awareness	0	Awareness	Little concern about involvement with the change is indicated

Adapted from Hall and Hord (1987: 3)

These stages have major implications for professional development. Firstly, they point out the importance of attending to where people are and addressing the questions they are asking when they are asking them. Often, professional developers attend to the how-to-do-it before addressing self-concerns of teachers. They normally want to focus on learners before teachers are comfortable with the materials and strategies (Korthagen, 2017).

Secondly, importance of paying attention to implementation for several years, because it takes at least three years for early concerns to be resolved and later ones to emerge. Teachers need to have their self-concerns addressed before they are ready to attend hands-on workshops and training.

Management concerns can last at least a year, especially when teachers are implementing a school years' worth of new curricula and also when new approaches to teaching require practice and each topic brings new surprises, just like in the case of South African C2005 and CAPS. Help over time is necessary to work out any holdup out and then to reinforce good teaching once use of the new practice smoothes out.

Finally, with all the demands on teachers, it is often the case that once their practice becomes routine, they never have the time and space to focus on whether and in what ways learners are learning. This often requires some organizational priority setting, as well as stimulating interest and concern about specific learning outcomes (Geldenhys & Oosthuizen, 2014). It is also a known fact that everyone has concerns-for example, administrators, parents, policy makers, professional developers-and that acknowledging these concerns and addressing them are critical to progress in a reform effort (Gulston, 2010). Professional developers who know and use the concerns model design experiences for teachers that are sensitive to the questions they are asking when they are asking them. Learning experiences evolve over time, take place in different settings, rely on varying degrees of external expertise, and change with participant needs (Bjorklund, 2015; Bantwini, 2011).

The kinds and content of professional development opportunities can be informed by ongoing monitoring of the concerns of teachers might be a question that relates to South African physical sciences teachers (Adu & Ngibe, 2014). The critical questions remain, whether these teachers were consulted before the implementation of the new curriculum and whether they were ready for such change (Adu & Ngibe, 2014; Ambross, Meiring & Blignaut, 2014).

3.2.4.2 Levels of use

The way in which individuals' behaviour towards the newly acquired knowledge can also be evaluated through checking the different series of categories through which they progress. The following table represents the different levels of use portrayed by individuals after acquiring new knowledge.

Table 3.2 Levels of use

Categories	Stage	Label	Description
Use	6	Renewal	Re-evaluates the quality of use and seeks major modifications or alterations to improve the impact on learners
	5	**I**ntegration	Makes deliberate efforts to coordinate with colleagues to achieve a stronger collective impact on learners
	4b	Refinement	Varies use within the context to improve the impact on learners
	4a	Routine	Establishes an appropriate pattern of use with little or thought given to improving its impact

	3	Mechanical	Focuses on day-to-day use, which tends to be disjoined and superficial, with little insight or reflection
Non-use	2	Preparation	Prepares for the first opportunity for use
	1	Orientation	Seeks information and explores the personal and resource requirements for use
	0	Non-use	Has no involvement and is doing nothing toward becoming involved

Adapted from King (2014: 96).

Each person will respond to a new program with unique attitudes and beliefs, and each person will use a new program differently. This table shows that levels of use may be categorized into three levels of non-use and five levels of use (Hall, George, Stiegelbauer, & Hord, 2006). From the lowest levels, individuals who are taking no action with respect to the new knowledge are depicted. These are people at orientation and preparation levels. These are individuals who have just received new knowledge and skills, but are still preparing to put this into use.

On the other hand, people at the Mechanical level are individuals who are implementing the new ideas but in uncoordinated and superficial manner, whereas individuals at the Routine level have actually established a regular pattern of use, even though they are showing minimal changes. Individuals at the Refined and Integration levels are making changes to improve effectiveness and are making deliberate efforts to coordinate with others who are also engaged in use. It is a group of individuals that are at the Renewal level, who are actively using the acquired knowledge, in such a way that they seek even more effective alternatives to improve the impact on learners (Mokhele & Jita, 2010; Mullins, Lepicki & Glandon, 2010).

In any professional development program, participants vary in their use of new knowledge and skills. Using the information from these variations can enable trainers to compare the evidence on the performance of learners in classrooms where the greatest use occurred with those where implementation was minimal, and use this for evaluation purposes and for validating the effectiveness of the change (Mullis, Lepicki & Glandon, 2010). This information can help the Department of Basic education in determining whether teachers do gain any new knowledge and skills through different professional development programmes, and how far they are with the use of this knowledge (Keshav, 2012). This can be also detected by checking the learner results in mathematics and physical sciences that are released annually. After checking the levels of use of the professional development programmes, it is also important to determine the actual differences between how the participants have been using with the present programme.

3.2.4.3 Differences in practice

According to the fourth level, another aspect related to participants' use of the new knowledge and skills is the determination of actual differences in professional development practice. This is the determination as to whether the observed practices are truly different from what the participants used in the past or from what other teachers are using at the present time (Joyce,1993 in Guskey, 2000).

In most cases, those who were the first to be involved in professional development programmes show cases of effectiveness as that already form part of their usual practice. If that is the case, then there is no real change and no innovation and there will not be any obvious improvements in learner performance. It is again very difficult sometimes to determine whether the changes that teachers experience is due to their participation in professional development due to the fact that teachers work in diverse, complex situations where multiple factors affect their behaviours (Nel, Nel & Hugo, 2012; Ramnarain, 2014). Different factors such as the changes in leaderships, personal life experiences, changes in their jobs may have an effect on how they perceive new knowledge, and these may have influenced their professional development. It implies therefore that, it is of importance to evaluate professional development activities, to check whether the practices that result from participants' use of their new knowledge and skills are really different. This is therefore a very important aspect of evaluation at level 4.

3.2.4.4 How will the information be gathered?

At this level, it is very crucial to identify accurate, appropriate and sufficient indicators of use. In identifying these indicators, the developers of the professional development program should define actions or behaviours which should be evident at the classroom or school level, and by doing so, they should address questions such as, "What would we expect to see if effective implementation were taking place?", How could we determine if participants' new knowledge and skills had actually found their way into practice?", which specific actions or behaviours distinguish effective use from ineffective or inappropriate use?" (Gyskey, 2002:189).

The answers to these questions can be gathered through observations, participant interviews or conferencing, supervisor interviews or conferencing, learner interviews, questionnaires, focus groups, implementation logs and reflective journals and portfolios.

3.2.4.5 How will the information be used?

The information gathered from this evaluation is important for both summative and formative evaluations (Muijs & Linsay, 2006). It can be used to facilitate better and higher quality implementation of new and more effective practices, and to document implementation efforts, as it provides evidence on current levels of use. Through that, restructuring of future programmes and activities to facilitate better and more consistent implementation is inevitable (Mullins, Lepicki & Glandon, 2010).

3.3 SUMMARY

Continuing professional development is one of the main elements in ensuring maintenance and further development of quality provision in any profession. Guskey (2002) suggests that when designing professional development programmes, one need to work backwards, starting with the last level, both planning the professional development activity and the evaluation itself. It is therefore important that schools evaluate the effectiveness of professional development programmes they have undertaken in order to inform future policies and activities. In as much as it is not so easy to prove the impact of professional development on teachers, one would need to control all other factors that may influence the results and to know the cost-effectiveness of different modes of professional development (Mullins, Lepicki & Glandon, 2010). Chapter four will then discuss the methodology designs that were followed in conducting this study.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

Chapter 2 discussed the literature on professional development that serve as support mechanisms for teachers, and their impact on physical sciences teachers. In chapter 3, a model of evaluation of professional development was discussed, with the aim of suggesting how professional development programmes of teachers should be assessed and evaluated to check on their relevance in schools.

This chapter describes the research design, the research sample, data collection instruments, procedure for data collection and data analysis methods with specific reference to the relevance of the mixed methods research which include both qualitative and qualitative research. In order to illuminate some ways to test or maximise the validity and reliability of the qualitative research design used in the study, triangulation was used. The research methodology was based on the main purpose of the research as well as research questions that are outlined in Chapter 1. The following section describes the research design that was used in the study.

4.2 RESEARCH DESIGN

Research design is explained by Kumar (2014) as how the study is to be carried out. It is the required execution of certain stages in the research process. Any plan of action or structure of the investigation used to answer the research questions and to help solve the problems stated in the study is the research design (Ravitch & Carl, 2016). In a research study, the researcher may choose to use different approaches interchangeably or at times, use both approaches to conduct research (Leedy & Ormrod, 2015). However, the researcher needs to decide on the research design and methodology intended for use in the study.

The study followed the multiple methods approach, which employs the use of both qualitative and quantitative research methods (Fraenkel, Wallen & Hynn, 2015; Gall & Borg, 2015a; Edmonds & Kennedy, 2017). Data are given priority, and involve the integration of data at one or more stages in the process of research (Gray, 2011). Creswell (2012:535) argues to the fact that this procedure *is not simply the use of both quantitative and qualitative design in one study rather it needs to be a "convergence of philosophies, traditions, methods, logic and principles of adequacy and integrating, linking or embedding the two strands.* This notion was also shared by McMillan (2012) who states that the purpose of mixed methods approach is to collect quantitative and qualitative data simultaneously or sequential but to have one form of data play a supportive role to the other form of data (Creswell 2012; Swain,2017).

This design can be used when one type of research (qualitative or quantitative) is not enough to address the research problem or answer the research questions. Swain (2017: 196) states that *quantitative and qualitative components can be considered "integrated" to the extent that these components are explicitly related to each other within a single study, and in such a way as to be mutually illuminating, thereby producing findings that are greater than the sum of the parts.*

The combination of qualitative and quantitative approaches could be for a variety of purposes such as:

- Triangulation – achieve or ensure corroboration,
- Complementarities – clarify, explain or otherwise more fully elaborate the results of analysis and
- Development – to guide the use of additional sampling and data collection and analysis techniques (Swain, 2017).

Swain (2017) has stated some reasons why the use of mixed methods may be necessary. This may be used to clarify and explain relationships found to exist between the variables, and to explore such relationships in depth. This is done to confirm or cross-validate the discovered relationships, to see if when qualitative and quantitative designs are compared, there is any convergence on a single interpretation of a phenomenon. If they do not converge, the reasons for the lack of convergence can then be investigated.

In this research, the quantitative data displayed some contrasting responses (cf. Tables: 5.3, 5.4, 5.5, 5.9, 5.14, 5.17, 5.18, 5.19) that needed to be explored further, using qualitative approach (cf. 5.3.2.1 and 5.3.2.2), and to check whether some of these responses would indeed converge so that the true interpretation of the results would be possible.

The researcher wanted to obtain more detailed, specific information about the real problems that were encountered by physical sciences teachers in the Lejweleputswa district, and the type of professional support that they would envisage to be suitable for them as they embark on implementing CAPS. Both quantitative and qualitative research designs were deemed appropriate for this study as they involve identification of the research questions, gathering of information to answer the questions, analysing and interpreting the information, and lastly, sharing the results with the participants and all stakeholders. The following section describes the quantitative research approach that was used in the study.

4.2.1 Quantitative Research Approach

Leedy and Ormrod (2015) describe quantitative research designs/approaches as one which focuses on phenomena that occur in their natural settings, and that involve capturing and studying the complexity of those natural phenomena. Quantitative research is described as, *a research strategy that emphasises quantification in the collection and analysis of data* (Bryman, 2012: 35). It means quantitative research denotes amounting something. This research method attempts to investigate the answers to the questions starting with how many, how much, to what extent (Rasinger, 2013). In other words, the method lays heavy stress on measuring something or variables existed in the social world. Quantitative research designs involve numerical data that can be analysed using statistics. Its main purpose is *to seek explanations and predictions that will generalize to other persons and places and to identify relationships among two or more variables, based on the results, to conform or modify existing theories or practices* (Leedy & Ormrod, 2015:98).

Quantitative research is also a broad approach to the study of social phenomena, as it is conducted in natural settings and therefore it is naturalistic and interpretive. It assumes that humans use what they see, hear and feel to make meaning of social phenomena (Rossman & Rallis, 2017). It involves *simultaneous processes of collecting and analysing data, developing and modifying theory, elaborating or refocusing the research questions and identifying and addressing validity threats* (Maxwell, 2013:2).

In this research, questionnaires were used to gather information on the type of problems that are encountered by physical sciences teachers in the Lejweleputswa district and the type of professional development support that these teachers have been provided by the Free State Department of Education.

4.2.2 Qualitative Research Approach

The term qualitative research can mean different things to different people (Strauss & Corbin 2008). Clark, Vicky and Creswell (2015:286) define qualitative research designs *as sets of procedures for collecting, analysing and reporting text and image data to answer research questions by exploring participants' views.* A qualitative research method is broadly regarded as the research instrument aimed at the contextual understanding of the phenomenon and it presents facts in a narration with words. (McMillan & Schumacher 2011). It enables the researcher to explore the phenomena from an insider's perspective. The focus on one phenomenon allows the researcher to be immersed in the situation that is being studied (McMillan & Schumacher, 2011). McMillan and Schumacher (2011:15) also indicate that qualitative research methodologies are *identified as dealing with data that are principally verba*l.

Qualitative researchers focus on individuals‟ social actions, beliefs, thoughts and perceptions. In terms of this approach data are collected by interacting with research participants in their natural settings such as schools, and there is no manipulation of variables, simulation or externally imposed structures in the situation. It involves data collection, that is, a collection of extensive data on many variables over an extended period of time in a naturalistic setting. Thus qualitative research can be regarded as *pragmatic, interpretive and grounded in the lived experiences of people* (Marshall & Rossman, 2010:16). The literal deductive meaning from qualitative research is that of quality enquiry and not quantity. The verbal word can be regarded as the core of qualitative research approach.

It is for this reason that the researcher conducted a series of focus group interviews with different physical sciences teachers in the Lejweleputswa district, to explore their perspectives and experiences regarding the implementation of CAPS and the type of support they were provided with.

Yin (2009:15) argues that, *since qualitative research approach studies human behaviour, its data is mainly verbal in nature*. Adding to a range of advantages of qualitative methodologies, Mason (2009:1) maintains that qualitative methodology *can contribute towards exploring a wide array of dimensions of the global world, including the weave and texture of everyday life; the understandings, experiences and imaginings of our research participants; the way that social processes, institutions, discourses and relationships work; and the significance and the meanings that they generate.*

Qualitative research approaches serve the following purposes as depicted by Leedy and Ormrod (2015).

- *Exploration. They can help researcher to gain initial insights into what has previously been a little studied topic or phenomenon*
- *Multifaceted description. They can reveal the complex, possibly multi-layered nature of certain situations, settings, processes, relationships, systems or people.*
- *Verification. They allow researchers to test the validity of certain assumptions, claims, theories or generalizations within real world contexts.*
- *Theory development. They can enable the researcher to develop new concepts or theoretical perspectives related to a phenomenon*.
- *Problem identification. They can help researchers uncover key problems, obstacles or enigmas that exist within the phenomenon.*

* *Evaluation. They provide a means through which researchers can judge the effectiveness of particular policies, practices or innovations* (Leedy & Ormrod, 2015:271).

The above purposes of qualitative data irradiate what this methodology entails, however, Marshall and Rossman (2011) also echo some of the attributes of both the Qualitative Research and Qualitative Researchers as follows:

Qualitative research

* *Takes place in the natural world.*
* *Uses multiple methods that are interactive and humanistic.*
* *Focuses on context.*
* *Is emergent rather than tightly prefigured.*
* *Is fundamentally interpretive.*

The qualitative researcher

* *Views social phenomena holistically.*
* *Systematically reflects on who he is in the inquiry.*
* *Is sensitive to his personal biography and how it shapes the study.*
* *uses complex reasoning that is multifaceted and iterative* (Marshall and Rossman,2011:3)

Other advantages of qualitative research approach (Rubistein, 2009: 2) are as follows:

* *To gain a complex understanding of a problem or issue, especially the 'what', 'how' or 'why';*
* *To develop a more complete picture of the context or setting of a problem or issue;*
* *To develop theories*
* *To empower people to share their experiences; and*
* *To assist quantitative inquiry* (Rubistein, 2009: 2)

Quantitative research approach uses objective research methods to uncover the truth. This implies that the researcher was detached from the research, and normally used methods that maximised objectivity and minimised the involvement in the research. The section that follows will describe the population and sample selection for the study.

4.3 POPULATION AND SAMPLE SELECTION

The following section describes the unit of analysis (population) and how this was selected by the researcher.

4.3.1 Population

Population is defined as a group of individuals who have the same characteristics (Clark, Vicky & Creswell, 2015; Creswell 2012 and Johnson & Christensen, 2012). It is referred to as a larger group on which a researcher hopes to apply the results (Fraenkel, Wallen & Hyun, 2015). There is a distinction between the population which the researcher would ideally like to generalize the study results and the population from which the researcher can realistically select the subjects. These, according to Gay, Mills and Airasian (2011), are referred to as *target population* and *accessible population* respectively. In most studies, the chosen population is generally a realistic or accessible population, and a researcher has to be sure of how he chooses the participants for the research. The population of this research is the all physical sciences teachers in the Lejweleputswa district, who supposedly receive professional support from the same subject advisor, and in the same Free State Department of Education. The research sample is described in the following section.

4.3.2 Research Sample

A research sample is a group on which information is obtained (Gliner, Morgan & Leech, 2009; Clark, Vicky & Creswell, 2015). Fraenkel, Wallen and Hyun (2015) described sampling as a process of selecting a number of individuals for a study in such a way that the individuals represent the larger group from which were selected and it is part of the population from which it is selected. It is important for a researcher to select a sample because the goodness of the sample determines the generalizability of the results. Sample selection is the primary technique used to collect data and the manner in which cases rich in information, present themselves. McMillan (2012) and Fraenkel, Wallen and Hyun (2015) state that the purpose of sampling is to obtain a group of participants who will represent a larger group of individuals and provide targeted responses. The reasoning behind sampling is associated with the purpose of the study and the research problem studied, and it is therefore of utmost importance to select the relevant sampling techniques that will render suitable results (Gay, Mills & Airasian, 2011). In this study the research sample refers to all township and semi-urban secondary school physical sciences teachers in the Lejweleputswa district who actually took part in responding to the questionnaire and who participated in the interviews. Having discussed the research sample, the following paragraph describes the sampling technique that was used in the study.

4.3.3 Sampling Techniques

A sampling technique is a strategy or procedure of selecting individuals on which information is obtained (Fraenkel, Wallen & Hyun, 2015; McMillan, 2012; Creswell *et al.,* 2016). Gay, Mills and Airasian (2011) suggest that decisions about which sampling method is going to be used, should be taken early in the overall planning of a piece of research. Factors such as expense, time and accessibility, frequently prevent researchers from gaining important information from the whole population, therefore, they often need to be able to obtain data from a smaller group or subset of the total population in such a way that the knowledge gained is representative of the total population.

Gay, Mills and Airasian (2011) state that researchers need to consider four factors in sampling, and these are:

- The sample size
- The representativeness and parameters of the sample
- Access to the sample and
- Sampling strategy to be used.

These factors are briefly discussed in the following paragraphs.

Sample size: The correct sample size depends on the purpose of the study and the nature of the population under screening. Sample size is also determined to some extent by the style of the research. It may also be constrained by cost, in terms of time, money, stress, administrative support and resources (Gay, Mills & Airasian, 2011; Leedy & Ormrod, 2015). The sample size of this research is indicated in item 4.3.3.1**.**

The representativeness of the sample: The researcher in this case may need to consider the extent to which it is important that the sample in fact represents the whole population, if it is to be a valid sample (Fraenkel, Wallen & Hyun, 2015). In this research the representativeness of the sample was…the fact that physical sciences teachers were from three out of the five Clusters of Lejweleputswa district (cf.4.4.2 and 5.3.2.1).

The access to the sample: Here the researcher needs to ensure not only that access is permitted, but is in fact practicable. The researcher requested permission from the Free State Department of Education to access the respondents for the questionnaire and the interviewees (cf. Appendix A, B, C and Appendix D).

The sampling strategy to be used: There are two main methods of sampling, namely probability (random sampling) and non-probability (purposive sampling) (Gay, Mills and Airasian, 2011; Mcmillan, 2012; Leedy & Ormrod, 2015; Johnson & Christensen, 2012). These are the methods that were employed in this study (cf. 4.3.3.1 & 4.4.2)

The following paragraph discusses the non-random sampling technique

4.3.3.1 Non- Random Purposive Sampling

In this study, the researcher used non-random purposive sampling because of time constraints and costs. Non-random sampling is defined as a process of selecting a sample that is believed to be representing a given population, using one's experience and knowledge of the group (Gay, Mills & Airasian, 2011; Johnson & Christensen, 2012; Fraenkel, Wallen & Hyun, 2015; Leedy & Ormrod, 2015; Creswell, 2012). The fact that the researcher was a physical sciences educator at some point, this experience helped with the selection of schools whose teachers would participate in the study. In this study, the sample was made up of secondary schools in the Lejweleputswa district (mostly township schools where there seem to be no improvement in the results of physical sciences in Senior Secondary Examinations).

A list of secondary schools which fall under the jurisdiction of Lejweleputswa district was obtained and then only schools that are in townships and semi-urban were chosen. One hundred questionnaires were then distributed by the researcher to all the schools that were selected and forty-eight of these questionnaires were returned. This made up 46% return rate as only 46 were usable. Focus-group interviews were also conducted in three of the five clusters of the Lejweleputswa district and each interview lasted for one hour. In each cluster, there were seven teachers who participated.

The following section describes the data collection instruments that were employed in the study.

4.4 DATA COLLECTION TOOLS

The researcher used literature review, a questionnaire, and interviews to gather data.

4.4.1 Literature Review as Data Collection Tool

The literature review can be used as a data collection tool in order to gather as much background to the problem as possible. Data is compared to the literature reviewed and when it is analysed, it a gives a comprehensive overview of existing research as a preliminary step in the researcher's preparation for the study towards creation of an external support framework for physical sciences teachers. Literature review also provides necessary assistance and guidance needed for the problem to be investigated. Literature study has been defined by Clark and Creswell (2015:119) as "*a written synthesis of journal articles, books, and other documents that summarizes and critiques the past and current state of information about a topic*". No new researcher can start on his own effort without consulting what expert source have written about the topic being investigated, and then come up with true perceptions of or ideas of respondents (Leedy & Ormrod, 2015).

In this study, literature on the professional development of teachers and the impact of curriculum change and implementation (specifically on science teachers in South Africa) was studied in detail. A review of literature on professional development of teachers in other countries also formed part of the study so as to compare what is happening here in South Africa. Both primary and secondary sources were used to establish what other researchers found on curriculum change and implementation.

The following section describes the use of interviews as a research instrument used to collect qualitative data.

4.4.2 Interviews as Data Collection Tool

An interview is defined *as an exchange of views between two or more people on a topic of common interest, which sees the centrality of individual interaction for knowledge production* (Cohen, Manion & Morrison, 2008: 349). Ravitch and Carl (2016) and Creswell *et.al., (*2016) assert that researchers adopting a qualitative perspective are more concerned in understanding individuals' perception of the world. They seek insight rather than statistical analysis. It is for this reason that the researcher conducted interviews to validate gathered data through the questionnaire.

The researcher used focus group interview technique in order to gather more information on the need for a quality support framework for physical sciences teachers. Focus group interview is a process of collecting data from a group of people sharing the same sentiments about a specific topic (Creswell, 2012; Johnson & Christensen, 2012; Gay, Mills & Airasian, 2011; Neuwenhuis*,* 2016). According to McMillan and Schumacher (2011), focus group interview is a strategy for obtaining a better understanding of a problem or an assessment of a problem and concerning a new product or idea by interviewing a purposefully sampled group of people rather than each person individually.

The focus group can be one group, but it can also be several dozens of groups. McMillan and Schumacher (2011) and Neuwenhuis*,* (2016) state that by creating a social environment in which group members are stimulated by the perceptions and ideas of each other, one can increase the quality and richness of data through a more efficient strategy than one-on-one interviewing.

The importance of using multiple groups is that participants must be similar, so as to form patterns and trends across groups. This is done to gather information by asking individuals to respond to questions posed by a researcher, and then asking the participants to prioritize the ideas or suggestions of all group members (Fraenkel, Wallen & Hyun, 2015).

In focus group interview, the researcher collects shared understanding from several individuals as well as getting views from specific people (Gay, Mills & Airasian, 2011). This technique is advantageous in that the researcher poses questions and every participant is free to share his sentiments. The process prevents the domination of the discussion by a single person, encourages all group members to participate, and results in a set of prioritized solutions or recommendations that present the group's preferences. The group setting attempts to create a synergistic environment resulting in a deeper, more insightful discussion.

The researcher made inquiries from the physical sciences subject advisor, about the clusters in which his jurisdiction lies, and then appointments were done with three different groups of teachers from different clusters within Lejweleputswa district. These groups of teachers were then summoned to a common venue (but during different dates) whereby the researcher conducted the interviews.

The researcher invited physical sciences from the different clusters in the surrounding towns of Lejweleputswa district. There were three groups from three of the five clusters of physical sciences teachers, and each group consisted of five to seven teachers. From these groups, the researcher gathered information on the problems that were encountered by physical sciences teachers. The type of support that these teachers received from their subject advisor and external stakeholders and its impact on their teaching of physical sciences also formed part of the discussions. The teachers were also asked to describe the type of support that they envisaged as important and suitable for their individual day-to-day teaching of science.

The interviews were tape-recorded with the permission of the participants and conducted in English, in is some cases, as need arose, participants we allowed to use their own vernacular languages to stress some points. The focus group interviews answered the following research questions:

- What problems are encountered by physical science teachers when implementing CAPS?
- What type of support programmes are provided to physical sciences teachers?
- How best could teachers be supported to improve physical sciences teaching in schools?

Although the focus-group interview strategy has advantages, it also has the following weaknesses:

- The limitation of idea generation to the meeting itself (Gay, Mills & Airasian, 2011). This was addressed by ensuring that these meeting took place at central schools which were known to participants, places where they normally convened during workshops.
- The lack of anonymity, which may limit participants' willingness to express their views (Johnson & Christensen, 2012). The participants were assured anonymity through the consent forms that they had to sign before the discussions could start.
- The necessity for all members to be capable of, and comfortable with, expressing their ideas verbally to the group (Gay, Mills & Airasian, 2011; Neuwenhuis, (2016). The fact that these were teachers who always met for workshops, and that most of them were familiar with the researcher being a former physical sciences educator, participants did not have a problem to open up.

- The nature of the questions that were put up for discussion also made it easy for the participants to feel comfortable in answering. In instances where language was a barrier, participants were encouraged to elaborate their views using their own languages.

- The time commitment required from participants, and the necessity for them to attend a specific location at a given time, which may limit participant members (Johnson & Christensen, 2012 ;). The participants were afforded enough time to reach the designated school in which the interviews would be conducted. The researcher organised these meetings during the weekends where the selected participants gave assurance that they would avail themselves.
- The lack of generalisability of the results to the wider population due to the specific characteristics of the participants (both in terms of who is nominated to attend, and who agrees to participate) (Johnson & Christensen, 2012). This would then mean that, even though all the teachers who participated in the study belonged to the same jurisdiction, received the same training from the same education department, their responses would not represent the whole population. Only three clusters were involved in the qualitative study.
- The limited nature of the data (i.e. in terms of number of respondents) often requires a follow-up survey or other quantitative methodology prior to making final decisions about the issue (Johnson & Christensen, 2012). This was addressed through a follow-up interview with the subject advisor, which took place after the meeting with teachers.

The researcher also interviewed the physical sciences subject advisor responsible for support of physical sciences teachers in the Lejweleputswa district. The aim here was to gather relevant information on the type of support that these officials provided science teachers with, how they provided that support and the response they get from teachers during these periods. It was also to get an idea on the number of teachers who have been trained since 2012 in relation to the implementation of the CAPS. This information was also elicited through questionnaires.

The use of both instruments (interviews and questionnaires) can be for the mere reason that, the same consideration used for constructing questionnaires may also be used in constructing interview schedules. The main advantage for using them is that they provide the researcher with the opportunity for face-to-face interaction with respondents and their flexibility (Fraenkel, Wallen & Hyun, 2015). The researcher was able to adjust questions to get valid information. The researcher used both these techniques because of the following factors that had an influence on her choice:

- Questionnaires may not elicit as a high completion rate as expected;
- Systematic differences in the characteristics of respondents.

Fraenkel, Wallen and Hyun (2015) state that interviews are the most used method for qualitative research, where both the researcher and respondent influence each other. Interviews involve a process of unveiling personal feelings, beliefs, wishes, problems, experiences and behaviours. Interviews however may be time-consuming and expensive to run than questionnaires, may be biased and offer less assurance of anonymity than mailed questionnaires, have less standardized question wording and if the respondents are busy, they may not be easily accessible (Johnson & Christensen, 2012).

4.4.3 The Questionnaire as a Tool for Data Collection

A questionnaire is a self-report data collection instrument that each research participant fills out of a research study (Kumar, 2014 and Creswell, 2012). Questionnaires are used by researchers to obtain information about the thoughts, feelings, attitudes, beliefs, values, personality and behavioural intentions of research participants. Questionnaires are relatively economical, have standard questions, ensure anonymity, questions can be written for specific purposes and can be delivered and collected by hand (Kumar, 2014).

For purposes of this study, the researcher formulated a set of questions and statements, appropriate to the research problem with the aim of finding justification for the existence of such in-service training and its possible extent. Questionnaires were used as primary instruments to collect data on the types of support programmes that teachers were exposed to in the years 2012-2015 and the impact such activities had on physical sciences teachers. The questionnaire was constructed to gather data that answered the following research questions:

- What type of support programmes have been provided by the Department of Basic Education for physical sciences teachers in the Lejweleputswa district?
- How best can teachers be supported to improve physical sciences teaching in schools?

Prior to selecting the questionnaire over other data collection methods, the key advantages and disadvantages of questionnaires pertaining to the study were considered. Ravitch and Carl (2016:172-173) listed some advantages and disadvantages of questionnaires.

4.4.4 Advantages and Disadvantages of Questionnaires

The following are some advantages of questionnaires.

- *They can be an efficient way to collect data from a range of people across locations*
- *Responses can be easier to compile and analyse than other forms of data*
- *Significant amounts of information can be collected from a large number of people in a short period of time.*
- *They are relatively cost and resource effective.*
- *Individuals can remain anonymous.*
- *They can be carried out by the researcher or by any number of people with limited effects on their validity and reliability.*
- *The results of questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package* (Ravitch & Carl, 2016: 172).

Questionnaires may also have the following disadvantages:

- *Responses provide only a limited amount of information without explanation and contextualization.*
- *They work best when their questions (or items) are objective (for instance, one's age) rather than subjective*

- *They do not tend to generate rich or contextualized data, and therefore responses can be hard to analyse.*
- *They can be inaccurate because people tend to give socially acceptable responses even when the questionnaire is anonymous.*
- *There is no way to know if a respondent is being truthful.*
- *It can be difficult to tell how much thought has gone into responses, which can affect accuracy.*
- *People may read and understand questions differently and therefore reply based on their own interpretation of the question (and there is no mechanism to know).*
- *There is a level of researcher imposition in the design of questionnaires, which means that there is much that researchers are not able to learn.*
- *They can restrict access if disseminated via internet since that requires a networked computer.*
- *They require literacy and therefore might marginalize those who are not literate* (Ravitch & Carl, 2016:173).

In this study, the researcher experienced a low response rate from the participants and some of the reasons put forward were that teachers were too busy preparing for the common examinations. Certain disadvantages over which the researcher had no control, for example, incomplete or poorly completed responses, may possibly affect the research negatively. Cost is often an important element when it comes to deciding on the best method of distributing a questionnaire and this normally depend on the size and the location of the sample (Leedy & Ormrod, 2015). This was a case in this study because the researcher had to travel long distances to deliver the questionnaires, and in some instances, due to distance, the respondents were sometimes absent from school or the researcher would find schools closed for the day. Based on this information, the rationale for using a questionnaire can be indicated as:

- *Less expensive*
- *Less time-consuming*

- *Greater anonymity afforded to respondents and*
- *Large numbers of respondents can be reached* (Ravitch & Carl, 2016: 173).

Questionnaires must be carefully planned, constructed, and distributed to yield useful data.

4.4.5 Questionnaire Design

A questionnaire can be defined as a list of carefully structured questions, chosen after testing, with the view of eliciting reliable responses from a chosen sample. The aim of a questionnaire is to find out what a selected group of participants do, think or feel (Ravitch & Carl, 2016).

A self-administered questionnaire was designed by the researcher, based on the steps outlined in the following sub-sections

- **Questionnaire Planning and Components**

Leedy and Ormrod (2015) indicate the elements that need to be considered during the planning stage of the questionnaire. These include:

- Costs
- Production or design time frames
- Distribution, collection and analysis processes
- Time-span for receiving results (Leedy & Ormrod, 2015).

In line with the above, a budget was drafted to establish the costs involved in carrying out the study. In addition, time was scheduled for the design and distributing the questionnaires. Furthermore, a reasonable amount of time was set aside for collecting responses but unfortunately, due to the short term and many school holidays (second term of school), everything was delayed. Time was also scheduled for obtaining the required permission from the Free State Department of Education, (it took a year to be granted permission) and that also hampered the processes a lot.

- **General Considerations**

The use of questionnaire is very tricky in that there is no one to explain the meaning of the questions to respondents. Therefore, it is important that questions contained in a questionnaire be simple, clear and understandable (Leedy & Ormrod, 2015). It is also important that questions be presented in an interactive style, be easy to read, pleasant on the eye and the sequence of questions should be easy to follow If the questionnaires are cluttered, cramped or messy, this might increase the potential of mistakes dramatically (Ravitch & Carl,2016). Furthermore, the length of the questionnaire should also be taken into consideration. If a questionnaire is perceived as being too long, it might be abandoned, returned incomplete or filled in randomly (Leedy & Ormrod, 2015; Gay, Mills & Airasian, 2011).

- **Steps in Designing the Questionnaire**

It is essential to have a substantial amount of knowledge regarding the subject/topic, to ensure that the most appropriate questions are asked. This was the case in this specific study because the researcher was a physical sciences teacher for a long time. It is also important to keep the potential audience in mind, as this will guide the level of question complexity (Leedy & Ormrod, 2015; Ravitch & Carl, 2016).

The length of the questionnaire also depends on the type of respondents who will be participating in the study. On average, depending on the individual respondents, a questionnaire should only require up to ten minutes to complete. If it takes longer than that, it might risk causing the respondents to postpone completing the questionnaire until they have more time (Leedy & Ormrod, 2015; Ravitch & Carl, 2016).

Some quantitative researchers believe that classification questions are best placed at the beginning of the questionnaire, so that the respondents gain confidence in answering easy questions. Other questions that follow should be done in such a manner that it takes potential respondents into consideration and should require the minimum time and effort to respond (Leedy & Ormrod, 2015). The following steps were followed in the design of the questionnaire:

- Relevant sets of questions which already existed were adopted, adapted and modified from OECD - Teaching & Learning International Survey: TALIS.
- New questions were drafted in line with the literature review undertaken in this study. These are: professional development programmes, needs and support opportunities; in-school professional development.
- The response categories for each question were decided upon, taking into consideration the effect of the response category which translates to different data types that demand quite distinct statistical treatment. These included YES/NO responses and "NO IMPACT" to "LARGE IMPACT", "INHIBITS EFFECTIVE INSTRUCTION" to "PROMOTE EFFECTIVE INSTRUCTION".
- Each question and response choice was carefully analysed, with the view of determining whether the questions might be seen as ambiguous, leading, confrontational, offensive, based on unwarranted assumptions, double-barrelled or pretentious. The pilot study as suggested by (Johnson & Christensen, 2012), was undertaken with some physical sciences teachers and some HODs that were known to be experienced, to check the structure of the questions.
- The wording of certain questions was reformulated in line with the above considerations. These questions were then assessed by the research supervisor. Most of the questions that appeared on Section C of the questionnaire were reformulated (cf. Appendix A).
- The questions were put in an order that was deemed logical.
- The instructions for completing the questionnaire were then formulated. These instructions were then assessed by the research supervisor to ensure that they appeared clear and unambiguous, and were reformulated where necessary.
- Every effort was made to construct a clear, logical, professional and aesthetically pleasing questionnaire layout and design.
- A cover letter was then drafted, which explained the purpose of the study and why the respondents' input was required.

- **Content**

Questions rely on written information supplied by people in response to questions asked by the researcher (Leedy & Ormrod, 2015). The information in questionnaires tends to fall into two broad categories, namely, facts and opinions.

Facts:

- Factual information does not require much in the way of judgement or personal attitudes on the part of respondents. For example, their address, age, marital status, qualifications, work-load and so forth.

Opinions:

- Opinions, attitudes, views, beliefs and preferences reveal information about feelings, express values, and weighed-up alternatives, in a way, calls for a judgement about things, rather than the mere reporting of facts.

Both categories were used in the questionnaire designed for this study. The questionnaire consisted of four sections (cf. Appendix A):

- **Section A** covered biographic background which included age, sex, highest qualification, teaching experience and work load of teachers. This information was elicited because the researcher wanted to check the type of teachers that were trained for CAPS.
- **Section B** sought information on the type of in-school professional development, such as appraisal of teachers, influences of such professional development activities in science instruction. This information was elicited because it was important in answering the research question 2.
- **Section C** covered the professional development and professional development needs of physical sciences teachers. This information was elicited because it would answer research question 3.
- **Section D** covered the professional development support opportunities that are offered by different stakeholders. This information was elicited because

it would answer research question 4 and help the researcher to recommend a suitable support framework.

- **Section E** concentrated on the general feeling about the new curriculum as depicted in CAPS – physical sciences. This information was elicited because it would help the researcher to formulate a suitable support framework for physical sciences teachers.

The questionnaire mostly was comprised of closed-ended questions, as open-ended questions sometimes tend to provide data that is difficult to code and analyse. In close-ended questions, respondents must select from the predetermined responses provided by the researcher. The goal is *to provide a common stimulus (item stem, response categories) to ensure maximum comparability of responses* (Johnson & Christensen, 2012: 170).

Closed-ended questions: Questions which require respondents to choose from a range of predetermined responses and are generally easy to code and to statistically analyse. Closed-ended questions were used in order to retrieve the maximum amount of information without imposing on the time and resources of the respondents.

Examples of four types of closed-ended questions that were used are:

- **Mark the correct space** type questions were used to obtain information regarding the biographic background of teachers, age, sex, teaching experience, highest qualifications, and work load (how many learners are taught per specific stream and how many periods per week in a stream).
- **YES/NO** questions were used mostly in Section **B** where the researcher wanted to know the type of in-school professional development activities.
- **A Likert** scale was also used where respondents were requested to indicate whether they strongly agree, agree, disagree or strongly disagree with statements.

The researcher carefully considered not to use the following types of questions as they tend to confuse the respondents:

- Poorly worded questions**-** Complex terms and language, ambiguous questions, double negatives and double-barrelled questions.
- Biased, leading or loaded: Easy to agree' statements, 'hard to disagree with' statements and leading questions.
- Problematical for the respondent: Recall-dependent questions, offensive questions that assume knowledge, questions with unwarranted assumptions and questions with socially desirable responses.

▪ **Administration of the Questionnaire**

In this study, the researcher was responsible for handing out and distribution of the questionnaire to the physical sciences teachers in all the schools that were selected. These were accompanied by cover letter (cf. Appendix F), requesting voluntary participation in the study. The cover letter or rather, the consent letter was a requirement from the Free State Department of Education. In this letter, an assurance of anonymity and confidentiality was provided. The researcher's contact details were also communicated to enable respondents to make contact if clarification of any sort was needed (cf. Appendix F).

Potential disadvantages regarding the administration of the questionnaire were limited to:

- A concern about anonymity by respondents.
- A concern regarding respondents potentially altering the questionnaire.
- The fact that respondents could complete the questionnaire at any time suitable to them.
- Due to the anonymity clause, it was unfortunately not possible to determine which of the respondents were slow in their filling in of the questionnaire. The only thing that the researcher relied on was to communicate with the

Heads of departments (HODs) to make sure that questionnaires were collected at the time of the researcher's visit.

After the questionnaires were returned, they were inspected and sent to the statistician who advised on the capturing of the raw data. Descriptive statistics depicting the central tendencies in the data was used to analyse data. The central tendencies were the frequencies, the mean and the standard deviation.

The following section highlights an analysis for collected data.

4.5 DATA ANALYSIS

Data analysis is a process of selecting, sorting, focusing and discarding data with the purpose of bringing order and structure to the collected data (Creswell *et.al.* 2016). The following paragraphs explain procedures that were undertaken to analyse quantitative and qualitative data.

4.5.1 Procedures for Analysing Questionnaire Data

Gay, Mills and Airasian (2011) assert that quantitative analysis of the responses obtained from a questionnaire need to be summarised and portrayed clearly. Once the research has been carried out, the next step for the researcher is to see whether or not the data collected support or contradict the research questions or hypothesis (if one has been put forth). Creswell (2012) indicates that even though interpreting data is a skill, the ability to interpret data correctly is essential and important in any research. For this reason, the researcher sought the services of a statistician. Most empirical studies are analysed on a statistical basis to offer the researcher the opportunity to analyse the responses and identify whether the results are skewed (Creswell, 2012).

This section attempts to highlight how statistics were used to analyse questionnaire data.

4.5.2 Collection and storage of data

After administering research instruments, the collected data are scored and processed to facilitate analysis (Gay, Mills & Airasian, 2011). The data so collected, should be scored accurately and consistently to avoid inaccurate or misleading conclusions being drawn from them.

Data from the questionnaire may take many forms, and when they take numerical forms such as scores or frequencies, the usual course of action is to perform an appropriate type of statistical analysis (Creswell, 2012). Statistical analyses are commonly associated with quantitative research. Unless the quantity of the research data is very limited, most statistical analyses are done on a computer. In this study, the Microsoft Excel was used to capture and store data derived from questionnaires, while the Statistical Package for the Social Sciences (SPSS) was used to analyse and interpret quantitative data.

Different measurement scales were used to allocate scores which included:

- **Nominal scale** which are numbers arbitrarily assigned to represent categories, for example 1= Mathematical Literacy, 2= Mathematics, 3= Physical Sciences.
- **Ordinal scale** which rank in order, the categories in some meaningful way through the use of the Likert scale, for example 1=strongly agree, 2= Agree, 3= not sure response, 4= disagree and 5= strongly disagree

The following table summarises the different ways in which questions were numbered and arranged in the questionnaire.

Table 4.1: Numbering of questions in designed questionnaire

Questionnaire	Numerical allocation
Section A	Numbers were used to represent the biographical information, for example, the first question (under highest qualification) was scored: 1= 20-30, 2=31-40, 3=41-50, 4= 51 years and above
Section B	This section consists of three questions, in which participants were requested to indicate their participation in any of the professional development activities (in the past three years), and the impact it had on them. This was in a scale 1=yes and 2= no
Section C	Under this section, participants were required to indicate their professional development needs and the influence they had on science instruction, as: 1=inhibits effective instruction, 2=neutral, 3=promotes effective instruction and 4= N/a
Section D	In this section professional development support opportunities were discussed and YES/NO answers were required in most questions where 1= Yes and 2= No in some questions 1= always, 2= often, 3= sometimes, 4= seldom and 5= never
Section E	General feeling about the new curriculum (CAPS) in Physical sciences comprised this section, where a Likert scale was used: 1= strongly agree, 2 = agree, 3 = not sure response, 4 = disagree and 5 =strongly disagree. For the remaining questions, a Yes/No response was sought.

According to Fraenkel and Wallen (2015), a common way to list quantitative data is to prepare a frequency distribution which is done in rank order from high to low; all scores are to be summarised. Below is a summary of the descriptive analysis that was used in this study.

4.5.3 Descriptive statistics

Descriptive statistics is the first step in the analysis of data. Describing data usually means computing a set of descriptive statistics known so that the general characteristics of a set or distribution of scores is achieved. Descriptive statistics is a means to identify the characteristics of an observed phenomenon or exploring possible correlations among two or more phenomena (Creswell, 2012; Leedy & Ormrod, 2015; Creswell *et.al.,* 2016)

The method of analysis that was used to analyse questionnaire data was frequency, the mean and the standard deviation (SD). In this study, descriptive statistics was used to observe and compare the number or percentage of values as outlined in the four-item Likert scale. Then the results were triangulated with interview data, to check for correlation or convergence of responses. The following section highlights how triangulation as a form of mixed methods research design was done in this study.

4.5.4 Triangulation

Triangulation is the process of corroborating evidence from different individuals, type of data, or methods of data collection in descriptions and themes in qualitative research (Creswell, 2015: 259). Each information source is examined and the researcher finds evidence to support a theme, and this exercise normally warrants that the study is accurate because the information is drawn from multiple sources, individuals and processes. Swain (2017) indicates that this mixing of data types, is often thought to help in validating the claims that might arise from an initial pilot study.

Most researchers use triangulation to increase validity of their research (Creswell, 2012). By combining multiple observers, theories, methods, and empirical materials, researchers can hope to overcome the weakness or intrinsic biases and the problems that come from single method, single observer and single theory studies (Gay, Mills & Airasian, 2011).

The purpose of triangulation in qualitative research is to increase the credibility and validity of the results. If the findings from all the methods draw the same or similar conclusions, then the validity in the finding has been established (Johnson & Christensen, 2012 and Fraenkel, Wallen & Hyun, 2015). In this study, the authenticity of the quantitative results was questionable due to the time teachers took to fill in the questionnaires, hence there was a need to use interviews to validate their claims. Qualitative data was also corroborated into themes and these were analysed accordingly (cf. 5.3.2.1 and 5.3.2.2; 6.3-6.4).
The following paragraphs discuss ethical considerations that were undertaken in this research.

4.6 ETHICAL CONSIDERATIONS

Ethical considerations and ethical behaviour are as important in research as they are in any other field of human activity (Gay, Mills & Airasian, 2011). Ethics generally are considered to deal with beliefs about what is wrong, proper, good or bad (McMillan & Schumacher 2011). McMillan (2012) suggests that ethics are a set of moral principles that are suggested by an individual or group, which are subsequently widely accepted, and offer rules and behavioural expectations about the most correct conduct towards experimental subjects and respondents, employers, sponsors, other researchers, assistants and learners.

In qualitative research, the most common tools used for data collection are interviews and participant observation. Researchers have a moral obligation to uphold confidential information since they are privileged to access intimate information from subjects (Neuman, 2009). In this study, teachers were assured anonymity to avoid victimisation by the subject advisors as well as their school principals. The participants were known to the researcher and anonymity was not going to be possible. However, participants were assured by the researcher that their identities will not be revealed to the reader and the raw data collected will not be released to any third party.

The following basic principles of ethical considerations in social research (McMillan & Schumacher, 2011) which are relevant to this study were taken into account: informed consent was obtained from the participants, the researcher guaranteed privacy, confidentiality and anonymity of participants, and never coerced subjects to participate in the research; they all gave informed consent to participate in this research. The researcher informed the participants of the purpose of the study and that their consent would be done in a written format. The participants were informed of their rights to withdraw their participation in the study if they felt the above mentioned ethical issues were not adhered to. Both ethical and general considerations were entrenched as far as possible during the design of the questionnaire for this study.

4.7 TRUSTWORTHINESS OF THE DATA

Trustworthiness of the study as has been mentioned in the previous chapters, is the truth value of the findings (Creswell, 2013). Trustworthiness has to do with the consistency, stability and repeatability of the participant's accounts as well as the researcher's ability to collect and record information. In this study, the trustworthiness of the data collected was established through credibility, reflexivity, reliability, transferability, dependability, the authority of the researcher and referential adequacy, structural coherence and validity.

4.7.1 Credibility

Credibility has been defined as the stability and plausibility of data (Creswell, 2013; Gay, Mills & Airasian, 2011; Leedy & Ormrod, 2015; Creswell *et.al*., 2016). Credibility *can be established using multiple approaches, such as checking the accuracy of the data and interpretation with participants in a study or through developing themes and codes using multiple data sources* (Creswell, 2015:258). In this study, the researcher ensured the credibility by choosing physical sciences teachers who work in the township schools. Each focus group interview lasted for one hour, until no data were revealed. The researcher also allowed some ex-colleagues, who were for some reason or the other, not part of the study, to determine whether the findings of the study are credible to the physical sciences teachers. Prolonged engagement with the participants increases the credibility of the findings (Creswell, 2009; Creswell, 2013; Creswell *et.al.,* 2016). In this regard, the researcher has worked in a township secondary school as a physical sciences educator for a long time before being a lecturer at the university.

4.7.2 Reflectivity

Reflexivity is a self-reflection by the researcher on his/her biases and predispositions. Through reflexivity, the researcher become more self-aware and they monitor and attempt to control their biases (Johnson & Christensen, 2012; Leedy & Ormrod, 2015; Gay, Mills & Airasian, 2011; Creswell, 2012). The researcher was reflective in order to monitor the process of data collection and analysis. The researcher was aware of her assumptions and values throughout the research process. She remained objective during the research process and could analyse the data collected without bias.

4.7.3 Transferability

Transferability refers to the extent to which the findings can be applied in other contexts or to other respondents (Creswell, 2013; McMillan, 2012; Creswell *et.al.,* 2016). *Transferability from one setting to another can be established by establishing the context of a study and giving detailed descriptions of the procedures* (Creswell, 2015: 258). The results of this qualitative study is mainly applicable to the physical sciences teachers in the Lejweleputswa district and their subject advisor who participated in the study. However, the transferability of this study could also be evaluated by other researchers who might find this study interesting and worthy of further research.

4.7.4 Dependability

According to Creswell (2013) and Creswell *et.al.,* (2016), a study should provide its audience with evidence that, if it were to be repeated with the same participants in the same context but with a different researcher, findings would be similar. Dependability *enables a researcher to repeat a study by using overlapping methods and in-depth methodological descriptions of the procedures* (Creswell, 2015:258). To ensure dependability, the researcher collected information from different sources (a literature review together with focus group interviews with the physical sciences teachers and their subject advisor respectively) in order to compensate for the possible weakness in one source with the strengths of the other.

4.7.5 Confirmability

Confirmability can be achieved with processes that ensure that data collected were neutral, objective and unbiased (Creswell, 2013; Fraenkel, Wallen & Hyun, 2015; Creswell *et.al.* 2016). To ensure confirmability, the researcher kept audiotapes and transcriptions of focus group interviews as an audit trail, and these were repeatedly listened to and transcribed verbatim.

4.8 VALIDITY AND RELIABILITY OF THE RESEARCH INSTRUMENTS

The following paragraph describes validity of the interviews and reliability of the questionnaire.

4.8.1 Validity of the Interviews

Validity is the degree or an extent to which a tool actually measures what is intended to measure or the extent to which findings correctly represent what is happening in the situation (Gay, Mills & Airasian, 2011; McMillan, 2012; Creswell, 2012; Creswell, 2010; Creswell & Clark, 2011, O'Cathain, 2010; Leedy & Ormrod, 2015). Validity is often related to the operationalization of concepts (Gay, Mills & Airasian, 2011). This means that the researcher needs to be able to demonstrate that concepts can be identified, observed or measured in the way it has been planned. Johnson and Christensen (2012) argues that experimental validity that includes both internal and external validity for interpreting the results for generalisation should be followed. The researcher had to identify the measures of validity and the interpretation of answers from the respondents.

The researcher interviewed the teachers before she could interview the subject advisor. This was done to establish the relationship between the information given by the teachers and the subject advisor, and to check whether it was validated. The physical sciences teachers' interviews were mainly based on research questions one, two and three, whereas the subject advisor's interview was based mainly on research questions two and three (cf. 1.6.1, 1.6.2, 1.6.3).

4.8.2 Reliability of the Questionnaire

Reliability of a study refers to the accuracy of the researcher's study methods and techniques, and to what degree it can be maximised. It also refers to the consistency of scores or measures from one administration of an instrument to another and from one set of items to another (Fraenkel, Wallen and Hyun, 2015). If there is consistency with which the research tools produce the same results, then reliability will have been measured (Leedy & Ormrod, 2010; Leedy & Ormrod, 2015; Gay, Mills & Airasian, 2011; McMillan, 2012).

Reliability is traditionally associated with accuracy, stability, consistency and the repeatability of the study. This means the ratio to which a test constantly measures what it is intended to measure. In order to ensure reliability, the questions formulated were discussed several times with the former supervisor, who was also my statistician, so that questionnaire and interview questions could be accurately constructed for data gathering.

The following paragraph describes the challenges that were experienced by the researcher during data collection stage.

4.9 CHALLENGES EXPERIENCED BY THE RESEARCHER DURING DATA COLLECTION

In general terms, any research has its problems and in this study some of these problems also surfaced. The researcher could not fully determine the extent to which this study reflected reality. The time taken for questionnaires to be collected may have affected the responses and the respondents, as the researcher had to extend the time due to some questionnaires not filled in. In other words, there was no guarantee that the respondents took enough time to read and understand the questionnaire as they claimed to be busy.

The following paragraphs discuss some of the problems that were encountered during this study.

4.9.1 Problems relating to the questionnaires

The researcher had to deliver questionnaires by hand to all the schools that offer physical sciences in the Lejweleputswa district. Most of the schools are very far and in most cases, questionnaires had to be left in the principals' offices, who most of the time had other commitments and would forget to pass them onto the relevant recipients.

The return-rate of the questionnaires was also affected by the distance and the fact that the schools around Lejweleputswa seem to be over-researched, then teachers are now reluctant to participate in research studies. In instances where questionnaires were not filled in, the researcher gave the respondents another chance and then promised to collect them during the next visit, but in most cases, they would still not be completed. The excuse that was given would be the time was limited, respondents were committed with extra classes for Grade 12 and they could not get time to complete the questionnaire. After consultation with other researchers, the researcher concluded that the 46% turnout was reasonable and acceptable. This conclusion was brought about by the fact that there was no other way to convince respondents to participate in the research as this was voluntary.

4.9.2 Problems relating to the interviews

The researcher made necessary appointment with the subject advisor, but it took him a long time to respond, due to his workload. The interview was conducted about eight months after the appointment was made. Even though there were two subject advisors for physical sciences, sometime during my study, there was a reshuffling of officials, such that the second subject advisor was deployed to the Provincial Free State Department of Education before she could be interviewed. The researcher did not experience any problems with the focus group interviews, except that the researcher had a difficult time from detaching herself from the study as there were teachers that were familiar to her as she worked as a physical sciences educator in the same district before.

4.10 SUMMARY

Chapter four described the research design and methodology of this study. Data collection instruments used for data collection are supported with reasons for their specific selection and use. In this chapter, both quantitative and qualitative research designs were discussed and the reasons for their selection were also highlighted. The chapter also discussed the questionnaire and focus group interviews as data collections instruments that were used to gather data in this research. It also discussed ethical considerations and trustworthiness of data. It highlighted the validity and reliability of the two research instruments. It ended by providing challenges that were experienced by the researcher during data collection. The results of the data collected through the questionnaire and focus group interviews as well as unstructured interview with the subject advisor are presented in the following chapter.

CHAPTER 5

DATA PRESENTATION AND ANALYSIS

5.1 INTRODUCTION

Chapter four presented a broad presentation and discussion of both qualitative and quantitative research processes in this study, and also the role of the researcher and data generation methods. However, a brief discussion of quantitative research was also presented in chapter four because of the quantitative nature of some of the data generated. Data collection methods in qualitative research discussed in chapter four included focus group interviews and individual interviews of an official from the Free State Department of Education at Lejweleputswa district.

A detailed description and discussion of the rationale for using focus group interviews, its characteristics, advantages and disadvantages, formed part of chapter four. Design of the present study, choice of participants, data gathering, presentation, analysis, as well as issues of reliability and validity in the present study have been explained and discussed in chapter three. Chapter four further discussed the ethical considerations in order to ensure confidentiality of the participants. This chapter presents the research findings from questionnaire and interviews responses. The findings are qualitatively and quantitatively presented in line with the four objectives of the study as indicated in Chapter 1.

Creswell (2012) and McMillan and Schumacher (2010) state that data analysis is a process of bringing order, structure and meaning to the mass of collected data. Descriptive statistics was used as suggested by Leedy and Ormrod (2015) to determine points of central tendency in the data, amount of variability and the extent to which variables are associated with one another. The points of central tendency that were determined were, the frequencies, mean and standard deviation (SD). The computations were done with the help of the SPSS computer program. The SPSS software used to perform the statistical procedures was chosen in line with the type of data that was captured.

Furthermore, this chapter is divided into two sections, presentation and analysis of quantitative data, presentation and analysis of qualitative data.

The following are the response rates that were picked from the quantitative data. The following section deals with the quantitative data presentation and analysis**.**

5.2 PRESENTATION AND ANALYSIS OF QUANTITATIVE DATA

To analyse the quantitative data and answer four of the research questions, descriptive statistics was used to determine points of central tendency in the data, amount of variability and the extent to which variables are associated with one another. The points of central tendency that were determined were, the frequencies, mean and standard deviation (SD). Using SPSS version 20.0, the quantitative data were first prepared through the screening and cleansing process (Pallant, 2007) in order to ensure accurate analysis, reliability and validity of the instruments. The survey data were analysed through the descriptive statistical process to check for missing data. Questionnaires returned missing more than two values, were excluded from the study. Originally, 50 completed questionnaires were collected from teachers' respondents with 4 excluded due to missing more than two values within the survey leaving 46 complete and usable cases.

This section deals exclusively with determining the type of educator support activities that physical sciences teachers in Lejweleputswa were engaged in during the period from 2012 to 2015 and the impact of these professional development activities on these teachers.

5.2.1 Biographical Data for Teachers

This section provides biographical data for teachers according to age, gender, qualification and work-load. It also illustrates the number of counts and percentage response.

Table 5.1 Biographical data for teachers expressed as percentage scores

Age	20 – 30 years	31- 40 years	41 – 50 years	51 years and above	
	21.7	39.2	32.6	6.5	
Gender	Male	Female			
	Count 28	Count		18	
	60.9	39.1			
Highest Qualification	PTC	DEP	B Ed	B Ed Hons	M Ed
	2.2	26	52.2	19.6	none
Teaching Experience	0-5 years	6-10 years	11-15 years	15 years and above	
	26.1	21.7	19.6	32.6	
Average number of learners per class	21 - 30 learners	31 - 40 learners	41 - 50 learners	51 – 60 Learners	61 and above
	6.5	39.1	50	2.2	2.2

Table 5.1 illustrates the descriptive statistical analysis representing the variables for gender, highest qualification of teachers, their teaching experience and the average number of learners taught. Out of the surveyed 46 participants, 18 (39.1%) were females and 28 (60.9%) were males. This shows that more male teachers are teaching physical sciences in schools and it says a lot on the concept of physical sciences being regarded as difficult by most female teachers and it also shows the need for female science teachers in our schools.

The descriptive statistics representing the variable for age of the survey respondents also shows a majority (39.1%) were between the ages of 31 and 40 years, with the second highest category of respondents being between the ages of 41-50 years

(32.6%). As far as the experience of teachers is concerned, there is a clear indication that the majority of teachers might retire very soon, and this calls for concern as it means only non-experienced teachers will be left to teach physical sciences when these teachers retire. The cumulative percentage after combining the three age categories (31-40, 41-50 and 51 and above), represents 100% of the respondents surveyed. This demographic data is relevant as the accumulative percentage of teachers between 41-50 years is 93.5%, depicting an active age range that teaches physical sciences in schools.

This table also shows the descriptive statistics representing the variable for the highest qualifications of respondents that were recorded. It seems a lot of physical sciences teachers have a degree in teaching this subject (52%), and 19.6% have even advanced their qualification to an Honours degree. There is no doubt that in terms of experience and qualifications, the teachers possess all that is needed to teach efficiently. However, there are still some teachers who are having education diploma (26.1%). Only 2.2% of the respondents who participated in this study hold a Primary Teaching Certificate (PTC) which is an under-qualification programme. This implies that the provision of quality physical sciences is compromised in some schools if there are still teachers who are lowly qualified to teach this demanding subject. The CAPS is a demanding curriculum which requires teachers who are adequately qualified and competent to implement it effectively in the classroom.

Out of the 46 participants, 32.6% of these have been teaching for 16 years and above. This may imply that more teachers have been trained by the subject advisor and other officials to implement CAPS but the question still remains, whether the teachers have been sufficiently supported. However, there were 12 teachers with an experience ranging from 0 years to 5 years (26.1%); these may be teachers who have just graduated and probably have not had adequate training in teaching CAPS. Only 21.7% have been in teaching for a time of between 6 and 10 years, and 19.6% have been in teaching for more than 12 years.

The table also shows that most teachers have to teach between 41- 50 learners in a class (50%). However, 39.1% of the respondents teach between 31 and 40 learners, which is the acceptable average per teachers. There were extreme cases where an educator was responsible for 51 to 60 learners and another was teaching more than 60 learners in a class, so these cases form the basis of poor performance in physical sciences teaching due to overcrowding**.**

Table 5.2 Physical sciences teachers' workload expressed as percentage scores

Subject	**Grade 10**	**Grades 10 & 11**	**Grades 10 & 12**	**Grade 11**	**Grades 11 & 12**	**Grade 12**	**Grades 10,11,12**
Mathematical Literacy	6.5	84.8	4.3	0	2.2	2.2	0
Mathematics	8.7	82.6	0	0	4.3	0	4.4
Physical Sciences	23.9	4.3	26.1	4.3	13	6.5	21.9
Total periods per week	**1- 4 periods**	**5 - 9 periods**	**10 - 14 periods**	**15 - 19 periods**	**20 - 25 periods**	**26 periods and above**	
	4.3	21.7	10.9	10.9	15.2	37	

The issue of workload has a bearing on curriculum implementation such as CAPS. Overloaded teachers may not in any way be able to implement curriculum to the best of their abilities.Table 5.2 shows the descriptive statistical analysis representing the variable of the subjects that are taught by the respondents. In FET, learners choose between mathematical literacy and mathematics. Those who are doing Mathematics are the ones that are also doing physical sciences and sit for the final examinations at the end of Grade 12. For this reason, data was collected from all these teachers as there was no other way of separating these teachers from these subjects.

Out of the forty-six teachers who filled in the questionnaire, 84.8% of these teachers offer mathematical literacy in Grades 10 and 12. Only 2.2% offer this subject only in Grade 12.

Mathematics is taught in all physical sciences classes and 4.4% of the teachers offer this subject in all the grades (10-12). 82.6% offer this subject in Grades 10 and 11, and only 8.7% teach mathematics in grade 10. It was also shown that 21.9% of the teachers that responded teach physical sciences in all FET Grades (10-12), 23.9% teach in Grade 10 only, 4.3% teach in Grade 11 and only 6.5% teach this subject only in Grade 12. Those who teach physical sciences in grade 10 and 12 made up 26.1% whereas 13% teach it in Grade11 and 12, and 4.3% teach it in Grade 10 and 11, whereas 23.9% teach physical sciences in Grade 10. These variances in the way the workload is distributed may have an impact on the teaching; hence the results of physical sciences in Grade 12 because of the structuring of the curriculum. Generally, teachers are overloaded considering the fact that they still have paperwork to attend to, extramural activities, feeding scheme, attending meetings and workshops, and many more activities.

The total periods (work load) of teachers per week are illustrated. It seems most teachers are overloaded in terms of the number of periods per week. This may be that most teachers are also involved in GET phase and as a result this affects their performance in FET. Out of the forty-six teachers who responded, 37% of these teachers have more than 26 periods in a week, 21.7% teach between 5 and 9 periods and 15.2% teach between 20 and 25 periods per week, 10.9% teach between 10 and 19 periods per week and only 4.3% are fortunate enough to teach less than 5 periods in a week.

5.2.2 Professional Development

In this section, the different types of professional development that physical sciences teachers were involved in from the year 2012 to 2015, as well as the impact of those activities on teachers were explored.

Table 5.3 The Impact of professional development strategies expressed as percentage scores

Professional Development	Participation		Impact				Measures of Central Tendency	
			No impact	**Small impact**	**Moderate impact**	**Large impact**	**Mean**	**SD**
	No	**Yes**						
Workshops/courses	4.3	95.7	0	6.6	35.6	57.8	3.51	0.626
Education conferences	39.1	60.8	4.7	7.0	58.1	30.2	3.88	1.138
Qualification program	35.2	64.8	2.3	4.7	30.2	62.8	4.51	0.98
Observation visits	30.4	69.6	4.7	2.3	9.3	83.7	4.37	0.070
Network of teachers	34.8	65.2	6.7	8.9	52.8	31.6	3.67	1.148
Mentoring, peer observation and coaching	26.1	73.9	11.4	9.1	52.2	27.3	3.41	1.263

In Table 5.3, the impact of participation in the work-related professional development activities such as workshops, educational conferences, improving qualifications, observation visits, taking part in educator networks and mentoring have been shown. A very large number of teachers seem to have attended workshops and courses in physical sciences (95%) and only 4.3% did not attend any workshops. There was however, a percentage of respondents that felt that these factors were not applicable to them. Out of the 46 respondents, 57.7% agreed workshops had a large impact, whereas 6.6% felt that it had a small impact. However, 35.6% of teachers felt it had a moderate impact.

A considerable amount (60.8%) of the respondents have participated in education conferences or seminars where teachers and researchers present their results and discuss educational matters and only 39.1% seemed not to have attended such activities. 30.2% of the respondents felt that it had a large impact whereas only 4.7% of the respondents felt it had no impact at all. However, 58.1% of the respondents felt it had a moderate impact and 7% of the respondents felt it had a small impact.

In this table participation of teachers in a network of teachers specifically formulated for professional development has been illustrated and it shows that 65.2% of teachers have participated, whereas 34.8% of teachers have not. Out of the forty-five questionnaires, 31.6% of teachers agreed that it had a large impact, whereas only 6.7% said it had no impact. However, there were those teachers who felt it had a moderate impact (52.8%) and another 8.9% of teachers felt it had a small impact on their teaching.

Teachers also showed participation in mentoring and coaching as well as peer observation as part of a formal school and out of the 44 questionnaires analysed, 73.9% of teachers seemed to have participated, whereas 26.1% of those teachers seemed to have not participated. 27.3% of the respondents have shown that it had a large impact, whereas 52.2% of the respondents said it had a moderate impact. However, 9.1% of the respondents said it had a small impact and 11.4% of these respondents said it had no impact at all.

Out of the responses, 64.8% of the teachers seem to have gone through a qualification improvement, whereas 35.2% have not had any qualification improvement in three years and 62.8% of the respondents felt a large impact on their teaching, 30.2% of the respondents have shown a moderate impact, whereas 2.3% of the respondents felt there was no impact at all. A small number of respondents (4.7%) felt that improvement of qualifications had a small impact on their teaching. Out of 43 respondents, 69.6% of the teachers participated in observation visits and only 30.4% of the teachers did not participate.

Out of the 43 usable questionnaires, 83.7% of the respondents felt a high impact of this activity, whereas 4.7% of the respondents felt that there was no impact at all in their teaching. However, 9.3% of the respondents felt that there was a moderate impact and only 2.3% of the respondents felt a small impact in their day to day teaching of physical sciences. The mean analysis showed that improvement of qualification has a high mean of 4.51 and a standard deviation of 0.98, whereas participation in mentoring, peer observation and coaching shows a lowest mean of 3.41 and a deviation of 1.263. This would then mean teachers prefer to improve their qualifications as the best professional development activity than to participate in any other activity, and they also feel that this has a large impact on their teaching of physical sciences. There seemed to be a disagreement on the participation in mentoring and peer observations as having a large impact on their teaching that is why the mean is so low (3.41) and a standard deviation of 1.263.

Table 5.4 Professional training in the past three years expressed as percentage scores

Provision of professional development training	**Yes**	**No**
a) organised by the Department of Basic education	93.5	6.5
b) organised by the university staff	26.1	73.9
c) organised by NGOs	19.6	80.4
d) organised by experts such as book authors or curriculum developers	15.2	84.8
Type of training attended	**Yes**	**No**
a) curriculum content	82.6	17.4
b) practical work	67.4	32.6
c)CAPS	87	13
d)assessment	56.5	43.5
Duration of training	**Yes**	**No**
a) once per term	31.8	68.2

b) once every two weeks	2.3	97.7
c)once every school holiday	13.6	86.4
d)twice a year	34.1	65.9
Preference for participating in professional development activities	**Yes**	**No**
a) scheduled on a release-time basis	35.7	64.3
b) after regular hours	2.4	97.6
c) during school holidays	61.9	38.1
Type of follow-up activities	**Yes**	**No**
a) coaching	25.6	74.4
b) one-on-one session with the subject advisor	55.8	44.2
c) appraisal by the HOD	20.9	79.1
d) videos/DVDs	30.2	69.8
e) demo lessons	23.3	76.7
f) others	4.7	95.3

In Table 5.4, Professional training in the past three years expressed as percentage scores has been shown. The variables that were depicted by this table include, the provision of professional development training, the duration of training, preference for participating in professional development activities and the type of follow-up activities.

Out of 46 respondents, 93.5% attended the training organised by the Free State Department of Education and 6.5% of the respondents did not attend. At least this was a sizable amount of teachers who at least attend workshops organised by the Free State Department of education. Only 26.1% of the respondents attended programmes organised by the university staff and 73.9% of the respondents did not attend this training. Only 19.6% of them attended programmes organised by NGOs and 80.4% of them did not attend such training. This table also shows that 84.8% of the teachers did not attend the activities organised by the book authors and curriculum developers and only 15.2% of them attended such trainings. A high number (82.6%) of the respondents have attended the professional development on the new curriculum, whereas only 17.4% of the respondents did not attend this type of training.

Another high number (67.4%) of the respondents attended programmes on practical work in physical sciences and 32.6% of the respondents did not attend such training. A number of respondents who attended training on the general policy on the new curriculum have been shown. And out of 46 respondents, 87% of the respondents attended and 13% of the respondents did not attend. A high number (56.5%) of the respondents attended programmes on assessment and 43.5% of the respondents did not attend. Here there were 44 respondents who indicated their preferences and 31.8% of them preferred it once per term while 34.1% of them preferred it to take place twice a year. Only 2.3% of them preferred it to take place once every two weeks and 13.6% of them preferred it to take place once every school holiday.

In the table above (Table 4.4), different times at which respondents preferred to attend professional development activities has been illustrated. Most respondents felt the need to participate in these activities during school holidays (61.9%), and others preferred them on the scheduled release-time basis (35.7%). However, only 2.4% felt that they can attend these training after working hours and on a week night. Only 23.3% of the respondents participated in demo lessons as a follow-up activity and 76.7% of the respondents did not take part. Only 25.6% of the respondents took part in coaching as a follow-up activity, whereas 74.4% of them did. 55.8% of the respondents have participated in one-on-one session with the subject advisor and 44.2% of the respondents did not. A considerable number (79.1%) of these respondents have not participated in the appraisals with the Head of the Department and only 20.9% of the respondents have participated in this activity. Only 30.3% of these respondents have actually watched Videos/DVDs and 69.8% of them did not. Out of 43 respondents, only 4.7% of the respondents have participated in other follow-up activities, whereas 95.3% of them have not.

5.2.3 Professional Development Needs

The following tables illustrate the different professional development needs of physical sciences teachers in the Lejweleputswa district.

Table 5.5 Professional development needs expressed as percentage scores

Provision of professional development needs	**Yes**	**No**
a) seminars, classes and/or study groups	51.2	48.8
b) Guidance from a formally designated mentor or coach as a need in teaching of physical sciences.	48.8	51.2
c) A higher level of supervision than from other teachers is needed in teaching physical sciences	25.6	74.4

Table 5.5 shows the professional development needs of physical sciences teachers presented as percentage scores. A considerable number of the respondents felt that seminars/classes and/study groups are needed as part of support, and that is (51.2%) of them, whereas 48.8% of them felt that these were not needed. Out of the 43 who responded, 48.8% need the guidance from a designated mentor or coach, whereas 51.2% of them felt it is not needed. Only 25.6% of the respondents felt that a higher level of supervision from other teachers is needed in teaching physical sciences, whereas 74.4% of the respondents felt that is not necessary. This may be due to the fact that most of the teachers are members of unions, which are against observations of teachers of any kind.

5.2.4 Influences on Physical Sciences Instruction

The following section deals with the influences of different issues on physical sciences instruction.

Table 5.6 The quality of science instruction at schools expressed as percentage scores

Quality of science instruction	Inhibits effective instruction	Neutral	Promotes effective instruction	N/A or Don't know	Mean	SD
a) Influence of science policies and practices	4.3	26.1	67.4	2.2	2.67	0.598
b) Time provided for teachers' professional development in science	6.8	40.9	50	2.3	2.48	0.664
c) The influence of the science as placed by the school	8.7	34.8	52.2	4.3	2.52	0.722
d) Influences of public attitudes towards science instruction	16.7	42.8	31.0	9.5	2.33	0.874
e) influence of conflict between efforts to improve science instruction and other school and/or district/stakeholders' initiative:	8.9	44.4	31.1	15.6	2.53	0.869
f) influences on how science instructional resources are managed	8.9	33.3	53.4	4.4	2.53	0.726

Table 5.6 represents the number of respondents who responded on the influence of science policies on the quality of science instruction in schools and the way it affects effective learning. Out of 46 respondents, 67.4% of them felt that these promote effective instruction and 4.3% of them felt that these policies inhibit effective instruction of science in their schools. However, 26.1% of these teachers were neutral on the issue and only 2.2% of these teachers did not know whether this was of any significance or not.

In the above table (5.6), 50% of the respondents felt that time provided for teachers' professional development in science, promotes effective instruction, and 6.8% feel that it inhibits effective instruction. However, 40.9% still felt neutral and only 2.3% of the respondents did not know. Out of 46 respondents, 52.2% felt that science has a great influence in the school, hence it also promotes effective instruction. However, 34.4% of the respondents were neutral on this issue and 8.7% of them felt that this inhibits effective science instruction. Only 4.3% of the respondents did not have any response (did not know).

A certain percentage of the respondents felt that the public attitudes towards science instruction promote effective instruction (31%), whereas 16.7% of the respondents felt that these actually inhibit effective instruction of science in schools. Again, 42.8% of the respondents were neutral on this issue, and 9.5% of the respondents did not know.

Influences of conflict between efforts to improve science instruction and other schools and /or district's initiatives have been dealt with in this table and 44.4% of the respondents were neutral on this issue whereas 31.1% felt that it promotes effective instruction. Four respondents (8.9%) felt that it inhibits effective instruction and 15.6% of the respondents did not know whether this type of conflict inhibits or promotes effective instruction. Responses on the influences on how science instructional resources are managed in schools was also illustrated and 53.3% of the respondents felt that this issue promotes effective instruction, whereas only 8.9% of the respondents felt that it inhibits effective instruction. However, 33.3% of the respondents were neutral on the issue and only 4.4% of the respondents did not know whether that can inhibit or promote science instruction.

According to the mean analysis, teachers are influenced more by the science policies and practices, as shown by the highest mean of 2.76 and the standard deviation of 0.598. Teachers felt that they are influenced by CAPS policy to guide them into effective teaching of physical sciences, than any other issue. They are less influenced by the attitudes of the public and that is why the mean was 2.33. The standard deviation of 0.874 shows that teachers agree on the fact that this was not so influential on them.

Table 5.7 Factors that inhibits or promote science instruction expressed as percentage scores

Factors that inhibits or promote science instruction	Not significant problem	Somewhat of a problem	Serious problem	Mean	SD
a) Significance of lack of science facilities	19.6	30.4	50.0	2.30	0.785
b) A problem caused by inadequate funds for purchasing science equipment and supplies	6.7	31.1	62.2	2.56	0.624
c) A problem caused by inadequate supply of science textbooks/modules	26.7	28.9	44.4	2.18	0.834
d) A problem caused by low learner interest in science	19.6	37.0	43.4	2.24	0.766
e) A problem of inadequate science-related professional development opportunities	15.2	52.2	32.6	2.17	0.677
f) A problem caused by lack of opportunities for science teachers to share ideas	28.3	45.7	26.0	1.98	0.745
g) A problem caused by inadequate educator preparation to teach science	35.6	24.4	40.0	2.04	0.878
h) A problem caused by inadequate time to teach science	28.3	34.7	37.0	2.09	0.812

Table 5.7 deals with factors that inhibit or promote science instruction. One of the factors was a significance of lack of science facilities. Only 19.6% of the respondents felt that this issue is not significant in the teaching of science, whereas 50% of them felt it has a serious problem. Science is a practical subject and if there are not enough facilities, that may impact very negatively on the learners and the educator as well. However, 30.4% of the respondents felt that if facilities are not enough, there might be some problems. The other factor was a problem caused by inadequate funds for purchasing science equipment and supplies. Out of 45 respondents, 62.2% of them felt that this causes a serious problem, whereas 6.7% of the respondents felt that is not necessarily significant. However, 31.1% of these respondents felt that it may cause some problem.

The other factor was a problem caused by inadequate supply of science textbooks/modules. Out of the 45 respondents, 26.7% of them felt that this is not significant, whereas 44.4% felt that it causes a serious problem in science teaching. However, 28.9% of the respondents felt that this issue might cause some problems. Among other factors, a problem caused by low student/learner interest in science was looked into. It was illustrated in the same table that, 43.5% of the respondents felt that this is a serious problem indeed and only19.6% of the respondents felt that this is not significant, whereas 37% felt that it is a problem.

A problem of inadequate science-related professional development opportunities has also been illustrated. Out of 46 respondents, 32.6% of them felt that this issue poses a serious problem whereas 15.2% of them felt that it is not significant. Some respondents felt that it causes some problems (52.2%). A problem caused by lack of opportunities for science teachers to share ideas is illustrated in a form of responses. Out of 46 respondents, 45.7% of them felt that it is some problem but 26% of them felt that it causes a serious problem. However, 28.3% of them felt that this issue is not significant. Another factor was a problem caused by inadequate educator preparation to teach science. Out of 45 respondents, 35.6% of them felt it was not significant and 40% respondents felt it causes a serious problem, 24.4% of the respondents felt it causes some problems. Lastly, a problem caused by inadequate time to teach science was also illustrated and it was found out that out of 46 respondents, 37% of them felt it caused a serious problem and 34.7% of them felt it causes some problems. However, 28.3% of the respondents felt that is not significant.

Analysis of the mean shows that the problem of lack of funds to purchase science equipment and supplies is a very serious one that teachers are faced with in schools. This issue displays the highest mean of 2.56. The standard deviation of 0.624 is nearer to the mean, which shows they agreed on this. However, the mean analysis on problems caused by lack of opportunities for science teachers to share ideas is the lowest (1.98), which means, teachers do not regard this as a serious problem as such.

5.2.5 Professional Development Support Opportunities

In-service training workshops offered in the past three years, offered by the schools in collaboration with other organisations such as universities, professional associations etc., and the extent to which these were addressed deepened educator understanding on the following:

Table 5.8 In-service workshop on science content or teaching

In-service workshop on science content or teaching	**Yes**	**No**
Provision of in-service workshop on science content or teaching	92.9	7.1

Table 5.8 deals with the in-service workshops specifically focused on science content or science teaching (methodology). Out of 42 responses that were analysed, 92.9% of the respondents attended such workshops whereas 7.1% of the respondents did not attend.

Table 5.9 In-service workshops deepening teachers 'understanding expressed as percentage scores

In-service workshop content	Always	Often	Sometimes	Seldom	Never	Mean	SD
a) In-service training addressing science content	34.9	30.2	30.2	0	4.7	2.09	1.042
b) In-service training addressing National science standards	24.4	24.4	33.4	11.1	6.7	2.51	1.180
c) In-service training on how to use particular science instructional materials (e.g. modules or textbooks)	27.3	27.3	31.8	9.1	4.5	2.36	1.123
d) In-service training addressing how to monitor learner understanding during science instruction	26.7	22.2	33.3	15.6	2.2	2.44	1.119
e) In-service training addressing how to adapt science instruction to address learner perceptions.	17.4	43.5	19.6	13.0	6.5	2.48	1.130
f) In-service training workshops that	15.6	20.0	31.1	8.9	24.4	3.07	1.388

addressed how to provide alternative science learning experiences for learners with special needs							
g) the use of investigation-oriented science teaching strategies	13.3	28.9	31.1	20.0	6.7	2.78	1.126

Table 5.9 deals with the in-service workshops deepening educator understanding expressed as percentage scores. Here, the different in-service workshop content was dealt with. The responses about the in-service training which address the science content were illustrated.

Here there were 43 responses and 34.9% of the respondents agreed that it always addressed the science content, 30.2% of the respondents felt it often addresses science content and another 30.2% felt that sometimes it does address the science content. Only 4.7% of the respondents felt that the in-service training that they have attended never addressed the science content.

The in-service training that addresses National science standards was also illustrated, and 24.4% of the respondents agreed that the in-service training they attended in the past three years always addressed the National standards and another 24.4 % of the respondents felt that it often addressed the national standards, 33.4% felt that sometimes the training addressed the national standards. However, 11.1% felt that the training seldom addressed the national standards and 6.7% said it never did.

The responses on the in-service training that address how to use particular science instructional materials have been put forth. Out of the 44 respondents who answered this, 27.3% of the respondents said that it always did, another 27.3% of the respondents said it often did while 31.8% of the respondents said it sometimes does address that issue. However, 9.1% of the respondents said it seldom did and only

4.5% of the respondents totally disagreed, said it never addressed the issue of usage of particular science instructional materials.

The in-service training on how to monitor learner understanding during science instruction is also illustrated. Out of 45 respondents who answered this, 26.7% of the respondents said it always addressed that and 22.2% felt that it often addressed that, whereas 33.3% of the respondents felt that sometimes the in-service training does address that issue. However, 15.6% of the respondents said it seldom does that and 2.2 % of the respondents disagreed, saying that it never addresses such an issue.

The in-service training addressing how to adapt science instruction to address learners' perceptions has been illustrated with the responses. Out of the 46 responses that were analysed, 17.4% of the respondents said it always addressed that, and 6.5% of the respondents felt that it never did. However, 43.5% said it happens often, with 19.6% saying it sometimes addresses that. 13% of the respondents felt that it seldom addresses the issue. In the above table (Table 5.9), responses on the in-service training workshops that addressed how to provide science learning experiences for learners with special needs have been tabled. Only 15.6% of the respondents felt that they always did, whereas 24.4% of the respondents felt that they never did. However, 20% of the respondents felt that the workshops often did address that, and 31.1% of the respondents felt that they sometimes did, whereas 8.9% of the respondents said that it seldom happened.

Table 5.9 also illustrates responses on the question of in-service training that addressed how to use investigation-oriented science teaching strategies. Out of 45 responses, 13.3% of the respondents felt that the in-service workshops always did that, whereas 6.7% of the respondents felt that these workshops never addressed that. However, 31.1% of the respondents felt that the workshops sometimes addressed that issue and 20% of the respondents felt that it seldom happened. Only 28.9% of the respondents felt that it often did address that issue. According to the mean analysis, more teachers seem to agree that the in-service training workshops addressed how to provide science learning experiences for learners with special needs, but there seem to be a disagreement. It displays the highest mean of 3.07 and a standard deviation of 1.388. However, teachers seemed to agree on the issue of in-service training addressing science content, with a lowest mean of 2.09 and a standard deviation of 1.042.

Table 5.10 Provision of professional development support by the school expressed as percentage scores

Provision of professional development support by the school	Yes	No
Study groups of teachers	34.1	65.9
Schedule for study group meetings	51.7	48.3
Period of meeting times		
a) the entire school year	52.4	47.6
b) one semester	33.3	67.7
c) less than a semester	14.3	85.7
Duration of study group meetings		
a) less than a month	25.0	75
b) once a month	50.0	50
c) twice a month	20.0	80
d) more than once a month	5.0	95

Table 5.10 illustrates the provision of professional development support by the school expressed as percentage scores. It also shows the period of meeting times for these professional development meetings and the duration of such meetings. Out of the 44 responses, 34.1% of the respondents acknowledge the presence of these groups, whereas 65.9% of the respondents refuted their presence. It also illustrates the presence of specified schedule for the science-focused educator study groups. Here there were only 29 responses and 51, 7% of the respondents acknowledged the presence of such schedules, whereas 48.3% of the respondents refuted their presence in their schools.

Table 5.10 also illustrates the responses on the period of time where science-focused educator groups were expected to meet. Here there were 21 responses and 52.4% of the respondents said they met for the entire school year, 33.3% of the respondents said that they met in one semester, whereas 14.3% of the respondents said they met in less than a semester.

The time at which the science-focused educator study groups met is illustrated. Here, only 20 respondents answered, and 25% of the respondents said they met less than once a month, 50% of the respondents said they met once a month, 20% of the respondents said they met twice a month and only 5% of the respondents said they met more than twice a month.

Table 5.11 Composition of science-focused study groups expressed as percentage scores

Composition of science-focused study groups	Yes	No	MEAN	SD
Organised by teachers from same grade level	47.6	52.4	1.52	0.512
Organised by teachers from multiple grades	90.5	9.5	1.10	0.301
Organised by teachers from other schools in the district	66.7	33.3	1.33	0.483
Organised by teachers from other schools outside the district	28.6	71.4	1.71	0.463
Organised by parents/guardians and other community members	47.6	52.4	1.52	0.512
Include higher education faculty or other consultants	38.1	61.9	1.62	0.498

Table 5.11 illustrates the composition of science-focused study groups expressed as percentage scores. Responses on whether the science-focused study groups consisted of teachers from the same grade have been illustrated. Out of the 21 respondents, 47.6% of the respondents said the study groups consisted of teachers from the same grade, and 52.4% of the respondents said that they did not comprise of teachers from the same grade. 90.5% of the respondents agreed that the science-focused groups comprised of teachers from multiple grades, whereas 9.5% of the respondents disagreed. These are teachers who teach from Grade 10 to Grade 12.

In the table, the responses on the science-focused study groups that were formed by teachers from other schools were tabled. Out of the 21 respondents who gave out their responses, 66.7% of the respondents said there were teachers from other schools in the district, whereas 33.3% of the respondents said there were no teachers from other schools in the district. However, it seems like the science-focused groups are organised by teachers from outside the district, as depicted by the responses.

A percentage of responses (28.6%) alluded to this fact, whereas (71.4%) refuted that fact. It was also illustrated that science-focused study groups comprised of parents/guardians and other community members. There were 21 responses to this question, and 47.6% of the respondents agreed, whereas 52.4% of the respondents disagreed. The responses on whether the science-focused study groups comprised of higher education faculty and consultants were also put forth and out of the 21 teachers who responded, 38.1% of the respondents said there were higher education faculty members as well as consultants. However, 61.9% of the respondents said there were no such. The mean analysis of 1.71 shows that more teachers agree that science-focused study groups are not organised by teachers from other schools outside the Lejweleputswa district, but rather, by teachers from multiple grades, with the lowest mean of 1.10.

Table 5.12 Description of science-focused study groups expressed as percentage scores

Description of science-focused study groups	Yes	No	MEAN	SD
Teachers engage in science investigation	71.4	28.6	1.29	0.463
Teachers plan lessons together	90.5	9.5	1.10	0.301
Teachers analyse learners' science assessment results	90.5	9.5	1.10	0.301
Teachers analyse classroom artefacts	66.7	33.3	1.33	0.483
Teachers analyse science instructional materials	71.4	28.6	1.29	0.463

Table 5.12 illustrates the description of science-focused study groups. Out of the 21 teachers who responded, 71.4% of the respondents agreed that the teachers in these groups engaged in science investigations, whereas 28.6% of the respondents disagreed that teachers in these study groups did not engage in science investigations. According to the findings, it seemed like teachers plan activities together and help each other to analyse the learners' assessments. This is shown by the same percentage responses that was evident under these factors, which is 90.5% in both. However, 66.7% of the respondents said teachers in these groups do analyse

the classroom artefacts, whereas 33.3% disagreed. Table 5.12 also illustrates the responses on whether teachers in these science-focused study groups analyse science instructional materials such as textbooks or modules. Out of the 21 responses that were analysed 71.4% of the respondents agreed that teachers in the science-focused study groups analyse science instructional materials, whereas 28.6% of the respondents disagreed. According to the mean analysis of 1.33 and a standard deviation of 0.483, more teachers feel that these study groups help them to analyse classroom science artefacts but then they do not agree because of the size of deviation from the mean. Teachers agree that these study groups help them to plan lessons together. This is shown by the lowest mean of 1.10 and a standard deviation of 0.301**.**

Table 5.13 Extent to which science-focused study groups addressed teachers understanding on science content expressed as percentage scores

Content of science-focused study groups	Not at all	To some extent	To a great extent	MEAN	SD
Science content	8.7	43.5	47.8	2.39	0.656
National curriculum standards in science	4.4	47.8	47.8	2.39	0.590
How to monitor learner understanding during science instruction	4.3	43.5	52.2	2.48	0.593
How to think about various science ideas	4.3	56.5	39.1	2.35	0.573
How to adapt science instruction to address learner misconceptions	17.4	47.8	34.8	2.17	0.717
How to use technology in science instruction	13.0	52.2	34.8	2.22	0.671
How to provide alternative science learning experiences for learners with special needs	8.7	56.5	34.8	2.26	0.619
How to conduct practical in new curriculum	27.3	36.3	36.4	2.09	0.811

Table 5.13 illustrates the extent to which science-focused study groups addressed teachers understanding on science content expressed as percentage scores. Here content of science-focused study groups was described. Out of 23 responses, 8.7% of the respondents said it did not address deep understanding of the science content,

43.5% of the respondents said it did, but to some extent, 47.8% of the respondents said it did to a great extent.

Responses on the extent to which science-focused study groups addressed deep understanding on national curriculum in science have also been illustrated. There were 23 responses to this question and 4.4% of the respondents said it did not at all address that, 47.8% of the respondents said it did but to some extent and another 47.8% of the respondents said it did, to a great extent. In addition, responses on the extent that the science-focused study groups addressed the teachers' understanding on how to monitor learner understanding during science instruction have been illustrated and 4.3% of the respondents said it did not at all, 43.5% said it did, but to some extent and 52.2% of the respondents said it did, to a great extent.

Responses on the extent to which science-focused study groups have addressed deep understanding on how learners think about various science ideas, have been illustrated. Out of the 23 responses, 4.3% of the respondents said it did not at all address this, 56.5% of the respondents said it did but to some extent, whereas 39.1% of the respondents said it did, to a great extent. In addition, responses on the extent to which science-focused study groups having addressed understanding on how to adapt science instruction to address learners' misconceptions, have been illustrated. There were 23 responses to this question and 17.4% of the respondents said it did not at all, 47.8% of the respondents said it did but, to some extent and 34.8% of the respondents said it did, to a great extent.

The responses on the extent to which science-focused study groups have addressed understanding on how to use technology in science instruction have been illustrated. Out of 23 responses, 13% of the respondents said it did not at all address the understanding on the use of technology, 52.2% of the respondents said it did but, to some extent and 34.8% of the respondents said it did, to a great extent.

The responses on the extent to which science-focused study groups have addressed understanding on how to provide alternative science learning experiences for learners with special needs have been illustrated. Out of 23 responses, 8.7% of the respondents said it did not at all, 56.5% said it did but, to some extent and 34.8% of the respondents said the study groups addressed that issue to a great extent.

The responses on the extent to which science-focused study groups addressed the understanding on how to conduct practical in CAPS came out as follows: Out of 22 responses, 27.3% of the respondents said it did not at all, 36.4% of the respondents said it did but, to some extent and another 36.4% of the respondents said these science-focused study groups addressed this issue to a great extent. The mean analysis of 2.48 and a standard deviation of 0.593 shows that teachers agree that science-focused study groups addressed their understanding on how to monitor learner understanding during science instruction, however, they seem not to agree on these study groups having addressed the understanding on how to conduct practical in CAPS. This is shown by the lowest mean of 2.09 and a standard deviation of 0.811. This means that teachers still do not have a clear understanding on how to conduct practical work in CAPS, maybe that is why most of them neglect the practical work.

Table 5.14 Availability of designated leader for educator study group expressed as percentage scores

Designated leader for educator study group	**Yes**	**No**	**MEAN**	**SD**
Availability of designated leader	50.0	50.0	1.50	0.512
This school	28.6	71.4	1.71	0.483
Place from which the designated leader came (from other school)	66.7	33.3	1.33	0.483
From college/university	14.3	85.7	1.86	0.359
From external consultants	4.8	95.2	1.95	0.218
Other	14.3	85.7	1.86	0.359

Table 5.14 illustrates availability of designated leader for educator study group which is expressed as percentage scores. Here the question was whether there is a designated leader for educator study groups, and where they came from.

Out of 22 responses, 50% of the respondents said yes, while another 50% of the respondents said these groups did not have any designated leader. Out of 21 responses, 28.6% of the respondents said yes the designated leader was someone from the school of the respondents, while 71.4% of the respondents responded differently, that the leader was not always from the respondents' school. However, 66.7% of the respondents indicated that the leader came from elsewhere in the district and 33.3% of the respondents refuted that.

Responses on whether the designated leader for science-focused study groups came from a college or university are illustrated and out of 21 responses, 14.3% of the respondents said yes and 85.7% of the respondents responded by indicating that the leader was not always from the university. Responses on whether the science-focused study groups' leaders came from external consultants have been illustrated. Out of 21 responses, 4.8% of the respondents agreed and 95.2% of the respondents indicated that the leader was not anyone from the external consultants.

The table also illustrates responses on whether the designated leaders for science-focused study groups came from any other places. Out of 21 responses, 14.3% of the respondents indicated that the leader for these science-focused groups came from elsewhere except their school and 85.7% of the respondents refuted that. According to the highest mean analysis of 1.95 and a standard deviation of 0.218, teachers agree that a leader for these science-focused groups always came from external consultants. However, the lowest mean of 1.33 and a standard deviation of 0.483 means that they do not agree that the leader came from other schools (0.483 is far from 0.218).

Table 5.15 Time allocated for in-service workshops/educator study groups

Availability of time allocated for workshops	**Yes**	**No**	**MEAN**	**SD**
Early dismissal and/or late start for learners	24.2	75.8	1.76	0.435
Educator normal working days during the year	51.5	48.5	1.48	0.508
Educator normal working days before/after school year	33.3	66.7	1.67	0.479
Common planning time provided for teachers	54.5	45.5	1.45	0.506
Substitute teachers to cover classes while other teachers attend professional development	18.2	81.8	1.82	0.392

Table 5.15 illustrates the time allocated for in-service workshops/educator study groups. Responses on whether early dismissal and/or late start for learners were done

to provide time for teachers for in-service workshops/educator study groups have been illustrated. Out of 33 responses, 24.2% of the respondents said yes and 75.8% of the respondents said no, that was not used to provide time for teachers to engage in in-service workshops. Fifty-one percent (51.5%) of the respondents said professional/educator work days during the learners' school year was used to provide teachers with time for in-service workshops/study groups and 48.5% of the respondents said no, that was not utilised in that way. Responses on common planning time for teachers as one of the things used to create time for the educator workshops (in-service training) or any professional development activities have been illustrated. Out of 33 responses, 54.5% of the respondents said yes and 45.5% of the respondents said that never happened.

Responses on whether there were substitute teachers that were hired to cover in classes while other teachers attend professional development activities. Out of 33 responses, 18.2% of the respondents said there were such substitute teachers but 81.8% said there were no substitute teachers that were hired to cover up the classes of teachers who go for professional development workshops. The mean analysis of 1.82(highest in this case) and a standard deviation of 0.392 shows that teachers agree that substitute teachers are used to cover classes while they attend professional development. A lowest mean of 1.48 and a standard deviation of 0.508 shows that they do not agree for professional development activities to take place on a normal working days, because the standard deviation of 0.508 is a bit far than 0.392

Table 5.16 Availability of one-on-one "coaching" focused on improving science instruction expressed as percentage scores

One-on-one "coaching"	Yes	No
Availability of one-on-one "coaching" focused on improving science instruction	43.9	56.1

Table 5.16 illustrates the availability of one-on-one "coaching" focused on science instruction. Out of a total of 41 responses, 43.9% of the respondents agreed to this

fact, whereas 56.1% of the respondents said that teachers have no access to a one-on-one coaching focused on improving their science instruction.

Table 5.17 The extent at which science-focused one-on-one coaching is provided expressed as percentage scores

Provision of science-focused one-on-one coaching at school	Always	Often	Sometimes	Seldom	Never	MEAN	SD
The principal of the school	8.0	28.0	20.0	20.0	24.0	3.24	1.332
The Head of science department in a school	20.0	36.0	24.0	4.0	16.0	2.60	1.323
District administrators including subject advisors	24.0	32.0	36.0	4.0	4.0	2.32	1.030
Teachers/coaches who do not have classroom teaching responsibilities	12.0	16.0	32.0	4.0	36.0	3.36	1.440
Teachers /coaches who have part-time classroom teaching responsibilities	8.0	8.0	40	44	0	3.64	1.350
Teachers /coaches who have full-time classroom teaching responsibilities	12.5	12.5	45.8	29.2	0	3.21	1.211

Table 5.17 illustrates the extent at which science-focused one-on-one coaching provided expressed as percentage scores. Here the provision of science- focused one-on-one coaching has been tabled and the extent to which science-focused one-on-one coaching is being provided by the school principal of the school have been presented. Out of 25 responses, 8% of the respondents said the principal is always

providing this service, whereas 28% of the respondents said it often happens and 20% of the respondents said sometimes it happens. However, 24% of the respondents said it never happens and another 20% of the respondents said it seldom happens.

Responses on the extent to which science-focused one-on-one coaching is provided by the head of science department in a school have been presented. Out of 25 responses, 20% of the respondents said always, 36% of the respondents said often, 24% of the respondents said sometimes, 4% of the respondents said seldom and 16% of the respondents said it never happens.

In this table, responses on the extent to which science-focused one-on-one coaching is provided by district administrators including subject advisors, have been presented. Out of 25 responses, 24% of the respondents said always, 32% of the respondents said often, 36% of the respondents said sometimes, 4% of the respondents said seldom and another 4% of the respondents said it never happened that district administrators provided one-on-one coaching sessions to teachers.

Teaching responsibilities have been presented. Out of 24 responses, 12.5% of the responses on the extent to which science-focused one-on-one coaching is provided by teachers/coaches who do not have classroom teaching responsibilities have been presented. Out of 25 responses, 12% of the respondents agreed that it always happens, 16% of the respondents said it happens often, whereas 32% of the respondents said it sometimes happens, 4% of the respondents said it seldom happens and 36% of the respondents said it never happens. Responses on the extent to which science-focused one-on-one coaching is provided by teachers/coaches who have part-time classroom teaching responsibilities have been illustrated.

Out of 25 responses, only 8% of the respondents indicated that it always happens, another 8% of the respondents said it often happens and 40% of the respondents indicated that it sometimes happens, whereas 44% of the respondents indicated that it never happens.

In addition, responses on the extent to which science-focused one-on-one coaching is provided by teachers/coaches who have full-time classroom respondents said always, another 12.5% of the respondents said often, 45.8% of the respondents said sometimes and 29.2% of the respondents said it never happens.

According to the mean analysis, science-focused one-on-one coaching is provided by teachers/coaches who have part-time classroom teaching responsibilities, with the highest mean of 3.64 and a standard deviation of 1.350, which indicate some disagreements between teachers. These teachers who have part-time classroom responsibilities may be HODs, and the reason for the disagreement may be because HODs deal with a lot of administrative work and may not necessarily have the expertise to substitute teachers in their classrooms. However, teachers seem to agree that one-on-one coaching is provided by district administrators such as subject advisors. This is shown by the lowest mean and deviation of 2.32 and 1.030 respectively.

5.2.6 General Feeling about Curriculum and Assessment Policy Statement in Physical Sciences

The table below shows the responses of teachers on the introduction of CAPS for physical sciences and how this introduction of the curriculum is perceived by teachers as well as learners.

Table 5.18 General feeling about CAPS physical sciences

Feelings about CAPS physical sciences	Strongly Agree	Agree	Not sure response	Disagree	Strongly disagree	MEAN	SD
It was a mistake to have introduced the new topics	4.4	17.8	17.8	31.1	28.9	3.62	1.211
The new topics help to make science more relevant to learners	34.8	41.3	10.9	13.0	0	2.02	1.000
The new topics are an extra burden on physical	15.2	26.1	19.6	21.7	17.4	3.00	1.350

sciences teachers							
There is no reason to teach a new topic if it is not going to be examined in the National Senior Certificate examinations	15.2	23.9	10.9	28.3	21.7	3.17	1.419
The new topics have concepts which are difficult for teachers to understand	8.7	15.2	26.1	26.1	23.9	3.41	1.257
Teachers struggle to make new topics understandable to learners	4.3	13.0	17.4	45.7	19.6	3.22	1.082
It is more demanding to find ways to teach the new topics compared to the old topics	6.5	28.3	13.0	41.3	10.9	3.22	1.172
More time is spent in planning lessons to teach the new topics compared to the old syllabus	6.5	34.8	17.4	32.6	8.7	3.02	1.145
My learners find the new topics interesting	19.5	37.0	32.6	8.7	2.2	2.37	0.974

Table 5.18 shows teachers' responses on their general feelings on CAPS physical sciences. Out of 45 responses, 4.4% of the respondents strongly agreed that it was a mistake to have introduced the new topics, 17.8% of the respondents agreed, another 17.8% of the respondents were not sure, 31.1% of the respondents disagreed, and 28.9% of the respondents strongly disagreed. This factor displayed the highest mean of 3.62.

Out of 46 responses, 34.8% of the respondents strongly agreed that the new topics help to make science more relevant to learners, 41.8% of the respondents agreed, and 10.9% of the respondents were not sure and 13% of the respondents disagreed. Out of 46 responses, 15.2% of the respondents strongly agreed that the new topics are an extra burden on physical sciences teachers, 26.1% of the respondents agreed, 19.6% of the respondents were not sure, 21.7% of the respondents disagreed and 17.4% of the respondents totally disagreed.

Out of 46 responses, 15.2% of the respondents strongly agreed that there is no reason to teach a new topic if it is not going to be examined in the National Senior Certificate examinations, 23.9% of the respondents agreed, 10.9% of the respondents were not sure, 28.3% of the respondents disagreed and 21.7% of the respondents strongly disagreed. Out of 46 responses, 8.7% of the respondents strongly agreed that the new topics have concepts which are difficult for teachers to understand, 15.2% of the respondents agreed, 26.1% of the respondents were not sure, another 26.1% of the respondents disagreed and 23.9% of the respondents strongly disagreed.

Out of 46 responses, 4.3% of the respondents strongly agreed that teachers struggle to make new topics understandable to learners, 13% of the respondents agreed, 45.7% of the respondents disagreed and 19.6% of the respondents strongly disagreed. However, 17.4% of the respondents were not sure. Responses on whether it is more demanding to find ways to teach the new topics compared to the old topics have been presented. Out of 46 responses, 6.5% of the respondents strongly agreed, 28.3% of the respondents agreed, 41.3% of the respondents disagreed and 10.9% of the respondents strongly disagreed. However, 13% of the respondents were not sure. Out of 46 respondents, 6.5% of the respondents strongly agreed that more time is spent in planning lessons to teach the new topics compared to the old syllabus, 34.8% of the respondents agreed, 32.6% of the respondents disagreed and 8.7% strongly disagreed. However, 17.4% of the respondents were not sure.

In addition, responses on whether the learners find the new topic interesting have been illustrated. Out of 46 responses, 19.6% of the respondents strongly agreed, 37% of the respondents agreed, 8.7% of the respondents disagreed and 2.2% of the respondents strongly disagreed. However, 32.6% of the respondents were not sure.

The mean analysis in this case indicates that most teachers feel strongly that it was a mistake to have introduced the new topics in CAPS, even though there is some sort of disagreement. This factor shows the highest mean of 3.62 and a standard deviation of 1.211. However, teachers seem to agree that the new topics help to make science relevant to learners. This fact is shown by the lowest mean of 2.02 and a standard deviation of 1.000.

Table 5.19 Benefits from additional content-specific professional development in physical sciences

Additional content-specific professional development in physical sciences	Yes	No	MEAN	SD
CAPS for physical sciences	79.5	20.5	1.20	0.408
Inquiry-based reading strategies	34.1	65.9	1.66	0.479
Using standards-based assessment	38.6	61.4	1.61	0.493
In - progress monitoring tools to inform instruction	53.5	46.5	1.47	0.505
Effective use of curriculum tools/technology tools	50.0	50.0	1.50	0.506
In science curriculum resources (such as new science textbooks)	68.2	31.8	1.32	0.471
In unpacking standards/writing learning goals and scales	36.4	63.6	1.64	0.487

Table 5.19 illustrates benefits from additional content-specific professional development in physical sciences. Out of 44 responses, 79.5% of the respondents agreed that there is more benefit for additional content-specific professional development in CAPS for physical sciences, and 20.5% of the respondents felt that there is no benefit. Out of 44 responses, 34.1% of the respondents agreed that they

can benefit from additional content-specific professional development in physical sciences that addresses the Inquiry-based reading strategies, whereas 65.9% of the respondents disagreed.

Responses on using standards-based assessment and grading as one form of additional content-based professional development in physical sciences have been illustrated. Out of 44 responses, 38.6% of the respondents agreed that they can benefit from using standards-based assessment, and 61.4% of the respondents disagreed. Responses on the need for teachers to have additional content-specific professional development for physical sciences (in effective use of curriculum tools such as maps and technology tools) have been illustrated. Out of 44 responses, 50% of the respondents agreed that they can benefit from that, and 50% of the respondents disagreed. Responses on whether teachers can benefit for additional content-specific professional development for physical sciences (in-science curriculum resources/new textbooks) have been presented, and 68.2% of the respondents agreed that they can benefit from that, whereas 31.8% of the respondents disagreed.

Responses on whether teachers can benefit from additional content-based professional development for physical sciences in (unpacking standards/writing learning goals and scales) have been presented. Out of 44 responses, 36.4% of the respondents agreed that they can benefit from that, and 63.6% of the respondents disagreed. According to the means analysis, teachers feel they can benefit from additional content-specific professional development in physical sciences that addresses the Inquiry-based reading strategies, because it indicates the highest mean of 1.66. However, there is some sort of disagreement as the standard deviation is 0.479. Teachers seem to agree that they can benefit from additional content-specific professional development in CAPS for physical sciences, as there is a lowest mean of 1.20 and a standard deviation of 0.408.

The following section presents the qualitative data as gathered from the focus group interviews and from the physical sciences subject advisor.

5.3 PRESENTATION OF QUALITATIVE DATA AND ANALYSIS

As the participants were divided into two categories, namely, physical sciences teachers and one physical sciences subject advisor, the responses of the groups are presented separately. Prior to the interviews, the researcher visited each of the selected schools that would form meeting areas and sought permission for appointments to interview participants. The purpose of the interviews was explained and identification of groups needed for the study done. The confidentiality of information and anonymity of interviews as well as their right to withdraw their involvement if needs be, were also mentioned in order for participants to feel at ease during interviews.

The main aim of the study was to evaluate different in-service programmes that are conducted in schools and to develop a model for quality external support framework for the phase physical sciences teachers in the Lejweleputswa district. Apart from distribution, collection and analysis of questionnaires, teachers were also interviewed. In order to present a holistic picture, the presentation of data pertains to the teachers from the three clusters. The teachers were between 35 and 60 years old, fully qualified (with teaching diplomas or degrees) and have been teaching for more than 10 years.

The teachers were asked questions which related to the type of problems that they encounter in implementing and/or teaching CAPS in physical sciences, as well as the type of professional development programmes that they have been involved in. The responses in all of the cases reflect the recurring themes (cf. 1.4). Where, necessary, verbatim quotes have been included in order to present teachers’ responses.

The second section of this chapter presents the data generated through individual and focus group interviews, while the third section presents an analysis of the data. The collected data were grouped into themes. In this data presentation and analysis, some of the comments and statements by participants are quoted verbatim to illustrate and emphasise the themes. The following steps as outlined by Leedy and Ormrod (2013:146) were followed to analyse the recorded interviews:

- *Identify statements that relate to the topic.*
- *Group statements into "meaning units".*
- *Seek divergent perspectives.*
- *Construct a composite*.

As the main aim of the study is to evaluate different in-service programmes that are conducted in schools and to develop a model for quality external support for the FET phase physical sciences teachers (cf. 1.5), this can be achieved through research questions one, two and three that were used (see 1.3.1, 1.3.2, 1.3.3).

- What problems are encountered by physical science teachers when implementing CAPS?
- What type of support programmes are provided to physical sciences teachers?
- How best could teachers be supported to improve physical sciences teaching in schools?

Against this backdrop, the researcher designed an open-ended interview schedule through which she solicited for the views and opinions of the participants in an attempt to answer research questions 1 to 3. The selected purposeful sample for qualitative purposes consisted of twenty-one (21) physical sciences teachers.

5.3.1 Data Processing

In order to process qualitative data, the process of thematic analysis or text analysis, as well as interpretation of data into identified themes and categories is essential.

Familiarity with the written responses was gained through repeatedly reading those responses. Creswell (2012) suggests that, in order for a researcher to be familiar with the data, one needs to continuously read through it until one is familiar with the regularities, patterns and topics as well as words and phrases that represent those patterns. In this study, the researcher searched through data for such regularities and patterns and then wrote such, to divide data into manageable themes which were then coded. The researcher preferred to use emic categories in collecting and analysing data. McMillan (2012) describes emic categories as explanations of the phenomenon by the participants in their own words.

5.3.2 Identification of Themes

A qualitative data analysis process was followed in order to analyse and interpret large volumes of raw data collected through the process of consulting written records derived from interviews. The researcher applied Creswell's Data Analysis Spiral as suggested by Leedy and Ormrod (2015:315) by:

- *Organising the data*
- *Perusing through the data several times to get a sense of what it contains*
- *Identifying general categories or themes*
- *Integrate and summarize the data* (Creswell, 2013 in Leedy & Ormrod, 2015:315).

In the second stage the data was coded and categorised to generate themes as per the Data Analysis Spiral. This process of categorizing the information into themes assisted the researcher in data analysis and interpretation (Wiesrma & Jurs, 2009).

The main themes identified during the text analysis were as follows:

- Theme 1: Problems encountered in implementing CAPS
- Theme 2: support structures provided
- Theme 3: Envisaged support to help the physical sciences teachers

5.3.2.1 Thematic Analysis for Qualitative Data: Focus Groups

Section 5.3.2 highlighted three main themes, each main theme consisting of various sub-themes. These themes and sub-themes are discussed in detail to present the major findings of this research based on the focus group interviews. In addition, verbatim quotes obtained from raw data are used to confirm and justify important findings.

- **Theme 1: Problems Encountered in Implementing Curriculum and Assessment Policy Statement**

  - **Sub-theme 1.1: Insufficient Training and Support for Physical Sciences Curriculum and Assessment Policy Statement**

The teachers were asked questions which related to the type of problems that they encounter in implementing and teaching CAPS in physical sciences. Where, necessary, verbatim reports have been included in order to present how teachers responded. The researcher asked questions and in some cases discussions were afforded and the participants responded voluntarily. Even though the interviews were done in a form of focus group interviews, participants were afforded chance to discuss matters and at the end of the discussion, there would be an agreement as to whether participants agree or not, and then the results would then be tallied.

There were 7 teachers per cluster who participated in this study, making a total of 21 teachers. Out of this number, 15 teachers said the physical sciences content is just too much and the time is limited and the training for CAPS was not properly done, 3 teachers added on the lack of support from stakeholders such as their colleagues, their principals and the subject advisors themselves. Others pointed out the problem of lack of funds to buy science equipment and lack of interest in learners.

The following is a report of what participants discussed in responding to the question regarding problems they encounter in implementing CAPS.

Teachers from the three clusters shared the same sentiments in most of the problems encountered. Teachers felt there was not enough training in terms of the implementation of CAPS. For any new curriculum to succeed, the custodians of that system should be trained properly so that the implementation can go smoothly. This was intensely depicted by some of the teachers in the following statements: Educator A: ***"****We were not thoroughly trained for CAPS, there are certain topics that used to be part of Grade 11 content, but are now supposed to be treated in Grade 10. This becomes a problem to learners who have just come out of Grade 9, with only natural sciences background, which in itself is some bits and pieces of information. These kids lack a lot of foundation".*

Some teachers added on the insufficient training for CAPS as part of the problem, but that it was also rushed, and that there was no in-classroom support, either by their HODs or the physical sciences subject advisor. Educator B added: *"There is no classroom support that we get. We only rely on what we were trained for CAPS, which is still not enough, considering the fact that we were struggling to implement NCS as it is, and so suddenly we just dropped it and transitioned into CAPS".* When analysing in-classroom support from the Free State Department of Education, teachers felt that this was not enough, that it is regarded as a serious problem that needs to be attended to for effective implementation of CAPS.to this effect, Educator C had this to say: *"Our subject advisor seem to be overloaded because he seldom visits us at school, even when he does, he does not have time to visit us in our classes, but he tries to encourage us to contact him whenever we experience any problems whatsoever regarding the content".*

The problem of lack of support by parents and other teachers also came up during our discussions. Some teachers from two clusters supported this by the following statements: Educator D: *"…parents of my learners are not so supportive, always complaining about the amount of work learners bring home, that they are not able to help them because of the complexity of the subject. If parents are not supporting science teachers, who will?"* Lack of support by other teachers who are not involved with physical sciences was also indicated. In support, Educator E had this to say: *"Other teachers are not supporting us. If teachers are not encouraging learners to try* *harder in science, then it becomes difficult for us as science teachers to do this alone-this is supposed to be a mutual effort. Others can even go to an extent of not releasing learners in time from their classes, then it results in some work not done".*

It was also evident that physical sciences teachers are struggling to keep the ship afloat in other schools. These teachers claimed to have no necessary support from their SGBs, in terms of funding some equipment/materials not supplied by the Department of Basic education. Educator F from Cluster A supported this statement by saying: *"In my school, I am faced with the problem of funds. There are no budgeted funds for purchasing science equipment, we do not have enough physical sciences textbooks. There is always an issue with the SGB".* On the same note, Educator G shared the same sentiments: *"I am always encountering problems with my SGB. They complain that most of what we require is expensive. I sometimes improvise with whatever I can use, but as you all know, not all the experiments can be done using domestic staff. However, sometimes learners donate some money and we buy some material, even though is not much. Funding is a problem".*

- **Sub theme 1.2: The structure of the physical sciences content**

The other problem that seemed to feature throughout the three focus group sessions was the structure of physical sciences content. A number of teachers felt that the content of physical sciences is too compressed and the time to cover up the required content is very limited. Educator H supported this by stating: *"There is a lot of theory to cover and there is not enough time".*

This was supported by Educator I: *"I find the content to be very compressed. There is a lot to do in a very short period of time. Everything seem to have shifted, what used to be in Grade 11 content has now been shifted into Grade 10 work. It is really a struggle on my side".* In physical sciences, there is a lot of practical work that needs to corroborate what has been covered in the theory. Some teachers admitted to the fact that the practical work does not receive the necessary attention as it should. This was supported by Educator J by saying: "The curriculum requires a lot of practical work and there is shortage of material in our laboratories, so most of the time I rely on the theory, which is not enough for learners". On the same issue, the statement was supported by Educator K who said*: "…most of the required practical become difficult for me as an educator, so you can just imagine how it is for learners".*

The issue of unequipped physical sciences also came up as one factor that hampers the practical aspect of this subject. This was emphasised by several teachers, who shared the same sentiments. Educator L said: *"Our science laboratories are full of old, disused chemicals, some of which are already expired. This is a real challenge to me as I have to rely on either the textbook or organise some extra lessons at neighbouring schools. Sometimes this is not ideal as it often affect the working relations of the physical sciences teachers in those particular schools, with their SMTs".* This was also supported by Educator M from Cluster B, who indicated that: *"There is a lot of work to be covered with limited resources. There is shortage of material, especially for practical work. Most of the materials in our laboratories are old and the chemicals have expired. One cannot always rely on the mini-science equipment/kits that is supplied by the education department".*

- **Sub-theme 1.3: Lack of interest in learners and poor science/maths foundation**

There seem to be a problem of lack of interest in the subject by the learners. This, as the researcher gathered, was due to the poor foundation that learners have in the preceding levels (Grade 8 and 9). As a result, this also affects the way they perceive science in FET. The statement was corroborated by Educator A, who alluded to the following: "There is a lack of interest on the learners, especially in Grade 10, who will tell you that they were not exposed to practical work in Grade 8 and 9 natural sciences. Whenever you assign some work, they just play around or mess things up. I really have to be vigilant when I am in that class because they can burn down the school if not properly supervised". This was supported by Educator N who said: ***"****A lot of problems that we deal with in Grade 10 physical sciences require a lot of mathematics background, and it is a real problem. Most of our learners perform poorly in mathematics, it is a national issue****".***

- **Sub-theme 1.4: Lack of Electricity**

The other logistical problem is that of electricity. Physical sciences teachers who had this problem felt that their everyday classroom experiences were not so successful because of lack of electricity in their respective schools. That, as a matter of fact hamper their implementation of CAPS and their professional spirits. The statement was stressed by Educator O from Cluster C said: *"Electricity is also a big problem especially in winter months if schools did not pay their municipal dues, or when electric cables have been stolen or tampered with because of illegal reconnections. My school is situated right in the middle of a township, surrounded by informal settlements. Due to high rate of unemployment, thugs regularly tamper with the schools' electric connection, by gaining access to the cable system, and steal them".*

- **Sub-theme 1.5: Improper induction on beginner teachers**

With the high levels of newly graduated teachers, induction seems to be a problem in schools, either by the subject advisors or the schools' HODs. This problem also came out in the discussions, as one of the problems that hamper the implementation of CAPS in schools. This came as a concern from Educator G from Cluster B who said: *"As a new educator, I have many problems in terms of support. Transitioning from university is not so smooth. One still needs the support of experienced teachers as well as a subject advisor, as there is a vast difference between theory that I gained from university and the real teaching. The support is really limited. I have only met the subject advisor during workshops, which are not held regularly by the way".* This was also seconded by other teachers, who have undergone the same problem in their beginner years and had to struggle before they could find their feet in teaching of physical sciences.

- **Theme 2: Support Structures Provided**

    - **Sub-theme 2.1: Workshops Attendance**

The common themes in the teachers' responses indicated that 18 teachers stated the attendance of workshops as their main support programmes that they have, whereas, three teachers added that they also have common papers as a way of support. But then, these common papers seem to be a problem to some teachers as they put unnecessary pressure onto them as they have to rush through the content that is so congested.
Educator A said: *"We attend workshops from time to time, organised by our subject advisors. Even though these workshops are not always content- related, we try during those workshops to go over the content-related problems with colleagues from other schools".* This statement was supported by another Educator M by saying: *"Workshops are organised by the subject advisors and we are required to attend. Sometimes these are just administrative whereby we are shown how to fill in different assessment forms, and the amount of work which is expected to be covered at the end of each term. During this time, that is where we manage to consult our subject advisors on the different problems we encounter in dealing with different areas of the content".*

Even though workshops seem to be the most important support program, their timing sometimes seems to create problems to teachers, such that they are not always well attended. This was the sentiments of another Educator P, who stated: *"We attend workshops which are held either during the week, in one afternoon or during the holidays. But then the ones organised during the holidays are not so ideal because people do not attend****".*** Teachers seemed to support the use of external subjects' experts that have been sought by the Free State Department of Education to address their training needs as well as offering mentoring skills. This was supported by Educator R who said, *"…... there is a certain Doctor who specialises in educator* *development, who has held several trainings for physical sciences teachers. She actually helps and she seem to be relevant to what we do****".***

However, the workshops as one type of support programmes have not always served the purpose. It would seem like some of these workshops did not bear fruits for some physical sciences teachers, as Educator P had this to say: *"Sometimes there are workshops where some lecturers from the university come to try to tackle relevant content of Physical sciences, but sometimes the exercise becomes futile if they are just going to deal with content that is not even in our syllabus, because they are not directly involved in teaching high school material****".***

- **Sub-theme 2.2: Assessment**

Most of the physical sciences teachers commended the Free State Department of Basic Education for relieving them from setting question papers. As has been mentioned earlier that the content seems to be congested and there is limited time, teachers seem to be in favour of this gesture.

Educator B had this to say: *"… we get pre-set question papers every term from the department and we use these tests for the end of term assessment".* This was supported by Educator C*: "Some teachers are also involved in setting of question papers that are submitted to the department to be written by the whole district at the same time. Sometimes the question papers are pre-set by the people in the curriculum development. This really save us tuition time".*

The pre-set question papers seem to be saving their time and their standard would be the same for their learners. In order to ensure the credibility of the question papers, the Free State Department of Basic Education has some measures in place. Educator D had this in support of this exercise: *"we also attend memo discussions after every assessment. These memo discussions are very useful because we mark learners in the same way".* Educator E also supported the statement by saying*:" we used to attend* *memo discussions after every examination is written. This is where we discuss how different questions have to be marked. We also agree on the alternative answers as well as the marks that have to be allocated to different questions/answers"****.*** Another educator added: *"We also get involved in the marking of our learners at the district level, more especially if one is teaching Grade 12****.****"*

However there seems to be a new way of communicating this standard marking, that was not known to the researcher, and this seems to be happily accepted by physical sciences teachers as it saves their time. This sentiment was shared by Educator F: *"Nowadays what we do is even better. On the day of memo discussion, teachers assemble in one school and they get in contact over a video call, with somebody from Bloemfontein. This person then discusses the memo with all the teachers who are present at that venue. They call that IBP****".***

However, the noble exercise engineered by the Free State Department of Basic Education was not accepted by all the teachers. Those who were not satisfied, stated that the pressure placed on them as teachers and learners is not necessary. This is what transpired from Educator R: *"… I have a different feeling altogether, this system of subjecting our learners to common papers really put us under unnecessary pressure. Time is not on our side as it is, there is a lot to be covered, both theory and practical, then there is an issue of finishing the prescribed work within time so that learners will be able to write the common paper- sometimes you just pass through concepts because you want your learners to be able to write a common paper. So in a way the Department of Basic education is just interested in the syllabus and not*

considering whether learners understand or what, or whatever has prevented me as an educator to finish the prescribed work. I really think they should also consider what is happening in the classroom". The statement was supported by another educator, who mentioned: *"Most of these examiners are people who are not even teaching at the moment, how would they know our problems?"*

- **Sub-theme 2.3: Developmental assessment system and the bursary schemes**

One of the systems that was put in place for the development of teachers in South Africa was through the Integrated Quality Management System (IQMS). This also came out during the discussions, as one of the support structures that teachers are continuously exposed to. Educator C had this to say about their involvement: *"We are also involved in DAS, which is Developmental Assessment System whereby we are assessed through class observations by our Head of Departments. DAS has been in place for years in schools, but it is not helping at all in terms of the CAPS. It is only done for salary increment purposes and have nothing to do with the day-to-day problems that teachers of science are faced with in the classroom. But I strongly believe if this system was used properly by our subject advisors, it would be more beneficial than it is now because as of now, it is just done as a routine for more pay****".***

In recent years, the Free State Department of Basic Education committed itself in developing teachers through improvement of their qualifications. This came about after the closure and merging of colleges of education. Some teachers were underqualified to teach physical sciences, and during the discussions, there seemed to be some teachers who were recipients of this noble initiative. One Educator O mentioned: *"We also get some bursaries to further our studies, even though I am not so sure whether these come from our district or not. I am one of those who got a bursary to do a teaching course as I only had an undergraduate qualification, so I had to do PGCE, majoring in physical sciences and mathematics".*

- **Sub-theme 2.4: Collaboration with other teachers**

From the interviews, it became evident that teachers try by all means to join forces in combating their problems. This exercise also serves as a support mechanism, where teachers support each other through shared experiences. Educator R had this to say in support of the initiative: *"We meet with other colleagues from other neighbouring schools where we share ideas and sometimes plan different activities together, but this practice does not happen all the time, due to time constraints".* However, teachers agreed that even though they try to share activities, they do not meet as often as they would like to, and that creates problems, especially to beginner teachers who still need a lot of guidance in implementing CAPS.

- **Theme 3: Envisaged Support to Help the Physical Sciences Teachers**

  - **Sub-Theme 3.1: More Workshops and Relevant Training Needed: Follow-Up Classroom Visits by The Subject Advisors**

Teachers across the three clusters seem to be in unison on the issue of more training. According to the physical sciences teachers, they feel that if they can be exposed to on-going training, on a continuous basis, the implementation would not be so difficult. A supporting statement from Educator A: is: ***"**More training is needed, not only workshops, but thorough training because we are joined by new teachers who have just graduated every year and I am sure these teachers can benefit in the training for CAPS"**.*** Other teachers felt the need for continued support through relevant training and visits, so that they can easily apply information while it is still fresh, that the subject advisor organise his schedule so that he can visit them even in their respective classes.

This was supported by the following statements from Educator D: *"There should be more workshops, preferably during the week when matters are still relevant and fresh in our minds. This will enable us to deal with different problems as they occur".* Educator G: said*: "there should be enough classroom visits or observations by the subject advisors. I know it is not so feasible but it can be done, with proper planning on the side of the department of education".* This was also supported by the following statement by Educator H***: "I share the same sentiments with my colleagues. We need follow-up classroom visits from the subject advisors. They should be able to relate to our everyday struggles, not just on occasions where they come and pay us a visit at*** *school, but they should just organise themselves and make appointments to visit us in classes".*

Another Educator F: also added onto the involvement of curriculum developers, by stating*: "We need more workshops. Actually we need people from the curriculum development to come and guide us on how to assess for instance. These are the people who have to elaborate on why the content was shifted like it has been, so that we can be able to see the progression and cohesion of the topics-why they had to be reshuffled and others had to be eliminated".*

The problem of subject advisors is not a personal issue but it relies on the government procurement. Educator J: suggested the following: *"our government need to hire more subject advisors so that they can be able to visit us all in the schools. The rate at which our subject advisors are in contact with us is very limited. We rely on books and sometimes one needs a second opinion of a knowledgeable person when tackling problems".* The statement was supported by Educator K: who added**:** *"there should be follow-up classroom support by the subject advisors. They come to us after a long time when we are already frustrated".* Teachers also felt they have always been excluded during curriculum planning. They brought out their frustrations on the fact that they are expected to implement policies that are new to them, and they are expected to produce good results.

This was elaborated upon by Educator L: who said: *"I think consultation was not done properly with all the stakeholders when introducing CAPS. The government need to consult the teachers because they are the ones who are expected to implement the syllabus. This curriculum seems to have been imposed on teachers, just like OBE and NCS, which is why we are still struggling even to cover up the required syllabus".* This was however refuted by some teachers, who felt that the continuous change of curriculum leads to instability of South African education system, affecting both learners and teachers negatively.

This is what was said by Educator M: *"I think it is high time that our government just stick to one curriculum. This constantly changing of the curriculum is not fair on the teachers, because every time a new curriculum emerges, it comes with different methodologies totally different from the ones we were trained upon. Not only that, but the content changes as well. This is just too much on us".*

- **Sub-theme 3.2: Setting of Question Papers and Impact: Teachers' Clustering and Study Group Formation**

Teachers felt that they would feel supported if they can be allowed to set their own question papers, to avoid rote-learning. The following statement was the sentiments shared on the issue which was stated by Educator H: *"I think the department has to do away with this common-paper style. It really puts us and the learners under unnecessary pressure. As an educator, I have to rush over things because I want to cover the syllabus, and the poor learners have to work under pressure, even those slow ones, just because they know they are going to write a common paper. I personally do not support it. The other thing, it does not even consider some factors that might cause a delay in finishing the syllabus, like sports, holidays etc.…"*

However, other teachers had a different approach to the issue of setting common papers. This was summarised by Educator K: who said: "*if we can go back to the basics, where we would form clusters, then planning of activities would not be a problem. If teachers belonging to the same cluster can come together, to form study groups, and then we share ideas, we plan activities together, set informal assessments together, then the issue of a common paper at the end of a term would not be a problem because learners would have been used to the idea of writing common type of work on a regular basis. But this can be possible if it is done by teachers from neighbouring schools".*

- **Sub-theme 3.3: Involvement of external stakeholders in training and developing apparatus**

Teachers had a strong feeling that their problems of lack of science equipment could easily be solved if there is continuous partnership between the government and some external structures.

The statement was emphasised by Educator O: who said*: "the other important thing is to partner with other stakeholders like Eskom, whereby they can help with practical work in those schools which do not have enough material in their laboratories, or even those who do not have laboratories at all. I heard they are already doing it in other provinces but we don't know how to contact such stakeholders. The other option can be finding relevant people such as that lady my colleague was referring to earlier".* This sentiment was shared by another educator from Cluster C, Educator Q: who said: *"I personally think the department is not doing enough to make sure that we get the relevant material. We can partner with the former Technical schools and start manufacturing some materials, more especially some simple staff that can be easily used in Physics. I am sure that is feasible because those schools have the relevant engineering material. Things like Ticker-timers and small carts that can be used in velocity and motion experiments".*

The involvement of external service providers was perceived to be a suitable one, for effective development, so that CAPS could be implemented properly. Most of the teachers seemed to be happy with what the Free State Department of Education is doing for them, by hiring an external moderator to train them. Most of them felt comfortable and happy with what the said lady is doing so far. This is stated as follows: Educator R: *"I think if the Department of Basic education can bring us people such as Dr. Y, who has already held some workshops for some of us, there might be progress in terms of what we are supposed to be doing in classes. That lady is so relevant because she even shows us how to develop some simple apparatus".*

Teachers also felt over-loaded by the compressed physical sciences content, that it could be advantageous if it could be shifted a little bit more on Grade 10 and 11, to allow Grade12 more time to prepare for examinations. This is what transpired from Educator D*: "...also the syllabus should be a little bit compressed into Grade 10 and 11 so that in Grade 12, there shouldn't be a lot to cover".* This was supported by another Educator K: from a different cluster, who said: *"more time is needed for physical sciences on the school time-table. If more time is allocated, then it becomes easy for the amount of work that has to be covered, to be finished in the required time".*

- **Sub-theme 3.4: School administration and the involvement of SGBs: science material and equipment should be bought in time**

Teachers felt that school administrations should also be liable on the support and development of physical sciences teachers. The SGBs should take responsibility of purchasing the required material timeously to avoid using expired chemicals. This was supported by this statement by Educator M: *"our management and the SGBs should be brought on board, in terms of buying enough material for physical sciences".*
Another Educator N: supported this statement by stating: *"Our laboratories are very empty; we are struggling to get funding from our SGBs to get science material. If we use the right material, which is new and relevant to the required practical work for physical sciences, then the poor results in physical sciences will be improved. Textbooks should also be delivered in time in those schools where they are needed. This will allow learners to push themselves"*

More teachers also felt the need for school administration to allocate physical sciences teachers properly and advise learners properly when selecting subjects at FET. This, as they deliberated, can alleviate the problem of poor results in physical sciences. The following statements by Educator F: alluded to that effect: *"the administration of schools also is very important. I think if I am a physical sciences teacher, I do not have to be teaching other subjects that are not so related to physical sciences. There should be proper allocation so that we can put more time and effort on physical sciences. It is a very demanding subject as it is".* In support of the statements, Educator J: from

Cluster B elaborated on the following: *"…. the other important matter is the criteria in which learners are chosen from Grade 9. Presently, if a learner has just passed Grade 9 mathematics and natural sciences, he is legible to do physical sciences in Grade 10. This may not necessarily mean that learner is capable of doing physical sciences. Thorough selection of learners should be done in the preceding grades with proper guidance**".***

5.3.2.2: Thematic Analysis from the Physical Sciences Subject Advisor

One subject advisor for physical sciences was interviewed to find out from him, the type of professional development programmes organised by the Free State Department of Education. The main reason of interviewing this specific departmental official was the fact that he has been in his post from as far as OBE and NCS, whereas the other one was new in his position. The other experienced subject advisor had just been deployed to the provincial education department. The interview was conducted in his office and it lasted for one and half hours. It comprised of unstructured questions as the researcher wanted to corroborate the concerns brought forward by the physical sciences teachers under his jurisdiction, and to get clarity of his involvement in educator support. Where, necessary, verbatim reports have been included in order to present how he responded. The following theme emerged from the content of his interview:

Theme 1: The type of support programmes provided to physical sciences teachers by the Free State Department of Education

Below is a detailed account of this theme.

Theme 1: The Type of Support Programmes Provided to Physical Sciences Teachers by the Free State Department of Basic Education

- **Sub-Theme 1.1: Educator Support Is in The Form of Workshops/Training**

The researcher sought appointment with the physical sciences subject advisor, who agreed for it to be conducted in his office, the researcher assured the respondent of the anonymity, hereafter referred to as Mr X.

Among others, the participant mentioned his duties as: guiding teachers, help them with content issues through workshops, motivate them, moderation of question papers and they do a lot of administration. Mr X summarised his job description as follows: *"We are supposed to guide teachers in their everyday class, you know, on content maybe. I must take aspects of work because practice sometimes seldom turns out like that, with the amount of administration we do and staff like that, but in terms of educator support, we help them with content issues, either through workshops and meetings in school for a week or longer - like last year in September holidays we had more teachers in Bloemfontein for a week, where we trained them. We motivate teachers, you know sometimes they can be terribly demotivated. I don't know, maybe it is in my nature, I just feel that if people are just being pushed obviously they don't behave spontaneously. Motivation and pulling people work much better.*
So, it is content support, either training and so on. Nowadays with e-mails it is very nice. I can just WhatsApp them with pictures on how to solve problems. In a nutshell, we try to give them ideas about methodology, more especially on practical, and in my case, because I like practical so much, I try to motivate them to do more practical. I don't know whether there is any reference in your study on practical work because that is one of the most neglected areas of physical sciences".

In his account, there was a mention that practical work, which is the most important component of physical sciences, seems to be neglected. This is due to the fact that teachers are pressurised to finish the syllabus for examination purposes, and as a result, teachers miss the development of skills associated with practical work. The participant mentioned again some initiative by the Lejweleputswa district which adds to the support of teachers. This is what he said: *"In 2011, the Director gave us permission to take teachers out of school on afternoons for training. These trainings were not effective because you cannot do much in one afternoon, it frustrates them more, rather, take them on a full day where you can deal with a topic extensively".*

The participant mentioned some initiatives that he took upon himself to address the issue of the relevance of workshops and training. This is what he stated to that effect, *"….so I suggested to the District Director, that we release teachers for a day to train them on a specific topic. I knew it would be inconvenient as they might miss one or two periods of physical sciences but that was a suitable solution. We said in our letter that we wanted them to come in their clusters, and we would treat a specific topic, let's say, Acids and bases. There will be no catering, teachers would just have to bring their own lunch. I would go in my car and my colleague would meet other teachers as well. That means in a month, all teachers would have been trained in all the prescribed work. This was a cheap model and this "money- eating" business of accommodation and catering would not be a problem. That was in 2010 and during the first term of 2011, and it was successful. Then in 2011, the National Department of Education came up with another model called 'Residence- teacher Development', where they trained teachers over weekends….*
They were using Welkom Inn and it was going to be expensive because of accommodation and paying the presenters. This continued for about a year or so and it soon lost momentum and it is no more happening". The reason for such good initiative to have been stopped, according to him was, that it became expensive to train teachers on an extended time.

The participant also mentioned the use of technology in reaching teachers, as it is not always possible for him to visit them in their respective schools. The following was the response that supported the statement: *"We have a lot of communication with teachers, in terms of things we need from them, things we need to tell them. I use*

Twitter I have a website for that as well as Google Drive. I have a website where they can download question papers, memoranda and some important documents".

The other support system that is in place for the physical sciences teachers, is the issue of pre-set question papers. The respondent stressed the importance of having a common paper, that, besides having the same standard, it also prepares the learners for final examination. It also paces teachers to cover more work. This was supported by the following statement: ***"****Remember maths, science and technology are supposed to be special subjects which need special focus. There is an advantage to that as I mentioned earlier-the issue of common question papers. We see that as an advantage because when you set up your own question paper at the end of June for Grade 12, you can set it up to where you have covered, but if the question paper is set by us, it will be set up to the questions where the work has been demarcated. This is to ensure consistency. Questions are the same and the instrument is the same, and there is some push on teachers to finish on time****"****.*

The participant also mentioned another support mechanism that is an initiative by the Free State Department of education, that one of moderation. This is what he said: *"We also do moderation of question papers for them. Moderation is sometimes done in groups and at the end of the year, we do individual moderation. We do individual school moderation depending on logistical facilities that sometimes determine where one has to be at a specific time and date, like last year, I did not do individual school moderation because there wasn't enough time and it was cheaper to go for cluster moderation".*

The participant mentioned a new strategy that is used by the Free State Department of education to address the issue of time and costs for individual moderation of papers. The following statement describes the process*: "We have IBP lessons. This is Internet Broadcast Project which is hosted at the University of Free State. There is a studio at the West campus of UFS, and as far as I know, Vodacom takes costs for data charges. There are centres in different places in Lejweleputswa, and this place (Resource centre) is also one centre. These are places where we come together with teachers to* *discuss the memoranda. The examiner sits in the studio in Bloemfontein, in front of the camera and he discusses the memo. Teachers are supposed to be in the different centres, taking notes and then deciding on what they want in terms of the questions and things like that. In doing that, we try to make things consistent. Afterwards, we follow it up".*

The participant was aware that teachers are not supported fully in setting their own question papers, however, as he clearly stressed in the following statement, IBP addresses that problem and some identified teachers whom he wants to help prepare papers in future. This is what he said: *"Even though teachers do not get enough support on developing question papers because of the common papers set by the Department, they get a lot of experience in marking questions due to IBP. Before then, I used to conduct training on marking and discussion of the memorandum. In order to combat that problem, I have already identified two lady teachers who showed a lot of potential, to form some sort of partnership, where they will set some specific questions, and then I will help with moderation of their question papers so that they could be included in the June examinations".*

- **Sub-theme 1.2: External Support Structures**

Apart from the above-mentioned support structures, Mr X (the physical sciences subject advisor interviewed) mentioned the use of external moderators. This matter also came up during the interviews with teachers. He mentioned that the Free State Department of Education makes use of the services of an expert, who specialises in methodologies and mentoring. This was supported by the following statement: *"There is a certain Dr Y, who has been hired by the department on several occasions. She is fantastic***!** *She can work on specific topic and develops apparatus and she knows methodology. Now that she is based in Bloemfontein, she is closely working with the IBP and she is a mentor. She actually stays for the whole day in a school, for four days, to support teachers and give them mentorship skills as well as skills on practical work. Last year (2015) we hired her twice- in September for 30 teachers and in November for 20 teachers. This year we have hired her again maybe at the end of*

May. We want to expose all teachers to those kinds of workshops. We also bought some study guides and those will go to those teachers who will attend in May. That is a fantastic idea that Free State has".

However, as the researcher discovered, not all the external experts were good. The experience they had with university personnel was not so good, due to them not being able to relate to the required syllabus. Mr X stated: ***"****We have had very bad experience with the outside service providers. The department sought some university lecturers to train teachers. Accommodation and catering was prepared and teachers gathered at the venue. At some stage we had to stop them because they were talking about staff that was not even in the curriculum, and teachers were just frustrated, but I am sure they made a lot of money out of that, I guess".*

- **Sub-theme 1.3: Teachers Not Being Visited in Their Respective Classrooms**

The issue of support is supposed to be coupled with the school/classroom visits. This however, was not done as it should, due to different logistical issues, such as: no money for transport by the Free State Department of Education, administration commitments and the hectic work schedule that the subject advisors function under. The issue was raised as a problem by the teachers and it seemed to bother the subject advisor as well. These sentiments were shared by the subject advisor in the following account: ***"****there is a lot of administration that we do here. There is a plethora of reports to write on this and that….at the end of the term/period you report on, at school, during school visits, because the national comes up with ideas for schools and they want us to write reports on different activities, what we are responsible for, to make sure that schools have resources. For these reasons, I do not always have time to visit them in schools, the many reports and administration logistics cause us to get into contact with teachers less than we would like to have. That is unfortunately the scenario".*

The participant was also aware that he is not supporting newly appointed teachers as he should. This is mainly due to logistical challenges that he is constantly operating under. He supported this by saying*, "I have a new teacher in school A, a new educator* *in school B, and none of those schools are in this area. I can't see these teachers because there is no money in the department to allow me to see them, but those young teachers seriously need support. The management decides, say on Monday, for me to go to school C (which is in Welkom), where there are two experienced teachers, but I must go there because management has decided for me to go there. Even if I feel I need to go to school A, where there is a new educator, I can't because of the logistical issues such as petrol and/or because the management has decided. So the whole thing with not having enough money ……where all the money is, because there is supposed to be money in the province, it's a mystery**!** This affects your professional judgement, because somebody just decides that you go to school C where they already have experienced teachers**,** so**,** management logistics and administration basically get in the way".*

The participant was also concerned about the Department of Free State's lack of concern on in-school visits, and was only concerned with administrative school visits. This, according to him does not help teachers if they are not going to be visited in their classes for support. The following statement supports his concern ***"….*** *Instead they ask you how many school visits you had, as if school-visits is the only important thing. Obviously school visits are important, and we should be in classes, listening to teachers, and to support them by motivating them"****.***

- **Sub-theme 1.4: Teachers Responsible for Their Own Support**

Even though the respondent felt that he does not visit teachers as he should, he always encourages them to contact him whenever they have problems. This was supported by his statement: ***"****I always tell them that they should feel free to contact me because they might not see me for a long time. For this we use emails and staff like that. If they struggle with calculations, they should not feel restricted, but rather send me a picture of that problem and I will provide notes so that they know what to do. We live in a 21st century and there is no need for face-to-face discussions with teachers just for problems alone when there is so much that the social media can offer.*

They should also take the responsibility of buying data for themselves and not rely on the schools for their own development".

- **Sub-theme 1.5: Teachers Not Supplied with Science Equipment To Do Practical Work**

Policies of the government are very strict, and one of the policies in the Department of Basic Education is that schools are not supposed to be supplied with practical equipment or materials, except if such schools fall under special quintiles. However, there are mini-science kits that are supplied to the schools to at least augment for practical work. Schools have to buy their own staff through their SGBs. This was again supported by Mr X: **"***We don't supply schools with apparatus or materials, what you see is not (he showed me a box full of about a hundred small carts made of steel) ……but we make a few exceptions. We asked the Technical school to make us these little things. During the evening I am going to weigh each of these to get their masses and specifications.*

As a rule, we don't supply schools with apparatus but CAPS prescribes the specific practical, for example, Titration, Collision experiments, so as a result, in Free State, we went on to say, we want learners to be in contact with at least four formal assessment of those prescribed practical, and in order to achieve that, from the provincial government, we got money and we provided each school with one kit for electricity, one kit for collision, and each school in the Free State has one of each. It will then depend on how teachers use them. And doing that we are supplying teachers with apparatus, which is not our primary function to do that".

- **Sub-theme 1.6: Teachers' response on professional support**

The researcher further wanted to know the response that the subject advisor gets from the physical sciences teachers, on the type of support that he is providing. However, the researcher felt that this question was a bit ambiguous to the subject advisor due to the way he answered. The researcher wanted to know whether teachers feel supported and empowered by all the efforts that the subject advisor is doing.

The following is the verbatim response that he gave: ***"**unfortunately we don't always get a good response due to different reasons like not having data but generally, we communicate well with the teachers in our district, ……it is difficult to say they feel supported enough or not because we have results. I keep record of results from 2001 and I have been moderating from 2003 and so far the results have improved. We do reports and results, however, we cannot measure education in the same way as in business. In business world, we measure profit but one cannot use the same model in education as we do in business, because here we measure results and so far the results in our district have improved".*

- **Sub-theme 1.7: No follow-up after training**

Even though physical sciences teachers do undergo training in the form of workshops from time to time, however, the subject advisor admitted that due to administration and other logistics, he does not make follow-ups like he should. This sentiment was supported by saying: ***"**it happens but unfortunately it doesn't happen effectively. There is always not enough time to do timeous follow-up on a specific topic. Follow-up should happen on my judgement, not on management judgement, be done properly. I can give myself 3 out of 10, in terms of follow-up on the activities mentioned.*

If say during training, a topic on acids and bases was done, by the time you visit such an educator, he is already doing something else, then it becomes difficult to see any improvement on the topic per say, but you can see the methodology and how problem-solving skills have improved. We seldom reached all teachers but we always asked them to follow it up themselves. If they want support, they should tell me".

- **Sub-theme 1.8: No involvement of teachers in planning and implementing CAPS**

Focus group discussions with the teachers revealed that teachers are never consulted during the planning of the curriculum, yet they are expected to implement it. The researcher probed into this issue and this is how Mr X responded: ***"****in 2005, during the time of NCS, we went for a workshop in Durban and because there were not enough subject advisors, we had to identify one educator to accompany us so that he could be part of the training team. For CAPS, we did not invite teachers because it was the same thing except for methodology here and there. OBE and NCS were not designed and implemented properly, such that my stress levels were so high that I even wanted to leave the profession. In 2001, we had a meeting in Bethlehem, we took the old General science syllabus and went through it to say, in order to satisfy a certain outcome, one had to do a specific piece of content, just to give teachers something to work on since it seemed no-one was really sure of what would be expected of teachers at the end of Grade 9".*

- **Sub-theme 1.9: General feeling about CAPS for physical sciences**

After much deliberation on the support structures that were put in place by the Free Department of Education through him as an official of the same department, the researcher wanted him to share his feelings on CAPS. The following is an account of his response: *"after the disaster of NCS, this is much better and well organised, in contrast to NCS, where we received a layout of content without saying how far or how deep one should go with any topic. There is now a revised version of guidelines".*

The participant also expressed his concern with the amount of work that teachers have to put in physical sciences teaching, in preparation for final examinations, that the content is too congested. He said ***"****I am very happy with the curriculum except that with physical sciences, it is too overloaded, that is why teachers don't do practical work because they have to rush over content and theory. Our CAPS is well written with inputs from people from the Free State by the way. In as much as it is a very good* *curriculum, like I already said, physical sciences content is overloaded. If it was according to me, they should just tone a little bit on the content. Majority feel that Grade 11 and 10 need more time. There is a lot to be covered in Grade 10 and remember, what is covered in Grade 10 and 11 prepares for examination in Grade 12, but it is just too much".*

The participant also noted with caution that the issuing of textbooks is still not taken as a priority by the Department of Basic education; that these are sent late to schools. This is what he alluded to by saying *"Schools are still starting at the beginning of the year without textbooks, yet the National department sent us some electronic textbooks, very nicely illustrated with colourful covers, but they should have sent them to schools".*

The participant also noted with concern, the unprofessional conduct that is displayed by some teachers. He stressed the importance of teachers being professional in whatever they decide. This is what he said ***"**I would also like to see professionalism of teachers being restored. I do not have a problem with the unions, but if one is going to neglect his duties like when our colleagues were looking for term marks and they did not get them because there was a time-off for some union members, then it becomes a problem. Teachers should have self-confidence to teach and not to rely on outside support, teachers should have good control and discipline in their classes, and language proficiency should also play a role despite all different accents that we have".*

5.4 DISCUSSION OF THE INTERVIEW RESPONSES

The following section deals with the analysis of interviews that took place between the researcher and the focus groups of physical sciences teachers, as well as the subject advisor for physical sciences in the Lejweleputswa district.

5.4.1 Discussion of Responses from Teachers on theme one: The type of support programmes provided to physical sciences teachers by the Free State Department of Education

Teachers from the three clusters shared the same sentiments in most of the problems encountered. Teachers felt there was not enough training in terms of the implementation of CAPS. They also felt that teachers on the ground were not fully consulted or at least had the representation when NCS and CAPS was planned. For any new curriculum to succeed, the custodians of that system should be trained properly so that the implementation can go smoothly.

There was also a concern for new physical sciences teachers, who have just graduated and who are full of information and theory, but with less methodologies, as required by CAPS. These teachers require thorough mentoring and support from the Department of Basic Education as well as the experienced teachers in their schools. They were also concerned with the amount of work that has to be covered in a short period of time (cf. 2.2.4). This is a known fact that South African schools' calendar is full of public holidays. In as much as this is taken into consideration when drawing the school calendar, the nature and scope of the physical sciences still prevents teachers to finish in time. The large amount of practical work that has to be done was also a major concern because they claimed, there is not enough equipment and apparatus to do the practical work. They feel there is not enough support from other teachers and parents, which really prevent them to perform as they should (cf. 2.3.3). If parents are not involved in their children's work, then learners will display a negative attitude towards physical sciences. They also felt that the support they get from their subject advisors is not enough due to their demanding work schedules (cf. 2.7). They do not visit them in their classrooms as often as they should.

5.4.2 Discussion of the Interview Responses of Teachers on theme two: Support Structures Provided

Physical sciences teachers attend several workshops, which seem to be helping them to cope with the implementation and teaching of CAPS. They also put forward their concern of the type of stakeholders that sometimes run these workshops that sometimes they treat irrelevant materials that are not even in the syllabus because they are not directly involved with the CAPS syllabus. However, they do acknowledge the presence of Dr Y, who specialises in their syllabus. Most of the teachers from different clusters seemed to be satisfied with the workshops that they have attended, even though not all the workshops addressed physical sciences content. However, they were also a bit worried about the pre-set question papers by the officials of the provincial Department of Education which put unnecessary pressure on them as they have to rush through the demanding syllabus because they have to prepare learners for the examinations. This concern is somehow alleviated by their involvement in the memo discussions. Some teachers have also been custodians of the Free State Department of Education bursary schemes, where they managed to obtain additional qualifications.

5.4.3 Discussion of the Interview Responses of Teachers on theme three: Envisaged Support to Help the Physical Sciences Teachers

Teachers feel there was not enough consultation before CAPS was implemented. This was also shared under research question one. The changing curriculum becomes a problem if teachers' concerns are not addressed by the government, as they are the ones who will be working on it. The involvement of different stakeholders such as Eskom and former technical schools was deemed to be a very good move as teachers feel these stakeholders have direct impact on the problem of equipment and the expertise in some of the practical work required by the physical sciences curriculum. Collaboration with other teachers also was brought about as one factor which can benefit them in future. However, the issue of collaborations and study groups was negated during the quantitative analysis (cf. Table 4.10). this might be due to the fact that these activities are not school-based, instead, teachers are only exposed to them during their cluster meetings, which might be rushed and dominated by other teachers from other schools. Teachers feel the trainings and workshops should be strengthened and the follow-up classroom visits could also help them a lot because as it stands now, the subject advisors do not get enough chance to visit them in their classrooms, where most of their frustrations lie.

Even though subject advisors are trying to support teachers, they feel that too much emphasis is placed on paperwork rather than on what is happening in the science classroom. Teachers also feel that more training is needed, especially on the new content and practical work, five-days training is not enough, time should be allocated for the training and it should be continuous, it should happen at least once a year in advance before the curriculum is implemented.

5.4.4 Discussion of the Interview Responses of the Subject Advisor

Form the responses of the subject advisor, it was clear that the respondent was confident about the type of support that physical sciences teachers receive. This was in a form of workshops and training that he conducted himself, either face-to face or through the social media contact that he has with teachers under his jurisdiction but, he also felt that the support is not enough. This is due to the management logistics and administrative duties that he is subjected to. Newly graduated teachers need a lot of support but it is not always possible for the subject advisor to visit them in schools. After training, there is a need to follow-up teachers in their classrooms, but due to the administration and report writing, it takes time to go to schools, such that it becomes irrelevant to visit teachers long after they dealt with topics that they were trained on.

The researcher feels that the Free State Department of Education should hire more subject advisors so that physical sciences teachers can be supported fully. Having worked with graduate physical sciences teachers for almost four years, the researcher feels that these beginner teachers need more training on CAPS, since there is so much to cover in terms of methodology that is not covered at universities. They can only get that from the subject advisors and other experienced teachers, if they themselves are supported.

The Free State Department of Education should also ease on the administrative work of the subject advisors, so that they can perform their duties properly. The respondent was also concerned with the content of physical sciences that it seems to be overloaded with a lot of work, such that it compromises the practical work, which in his opinion, plays a very important part in physical sciences teaching. This was also evident from the teachers' responses, that CAPS seem to have congested the physical sciences content, and this puts more pressure on teachers such that they neglect the important practical work (cf. 2.2.4).

As an official of the Free State Department of Education, the respondent felt that the use of external support was not done properly in previous years, but the respondent applauded the Free State Department of Education on finding a very reliable expert who has been conducting training and offering mentoring skills to physical sciences teachers recently, as a way of external support structure, in order to corroborate the training and workshops that he organises for the physical sciences teachers under his jurisdiction. He was also satisfied with the way the memoranda are being handled, by incorporating the use of media (IBP), an initiative of the Free State Department of Education in collaboration with Vodacom.

Even though the respondent seemed to be satisfied with the common papers that are set by the Free State Department of Education for physical sciences, the respondent still feels that physical sciences teachers need to be developed in setting the question papers themselves, as this might be beneficial for them in future, when there are no personnel from the curriculum development to set papers, and also for the coming generation of physical sciences teachers. The other reason being the private time for setting and moderation of papers it takes from the departmental officials.

The respondent showed lack of trust and confidence on the curriculum developers who designed NCS and OBE, as these two curricula had many flaws, such that it added to the stress levels of physical sciences teachers. The respondent also seemed to agree that no proper consultation was done with teachers before the implementation of the curriculum (both NCS and CAPS), and this probably added to their frustrations on what and how to teach the newly incorporated topics. As a result, this led to low performance of physical sciences teachers in teaching the subject. The respondent also alluded to the fact that physical sciences teachers need to take responsibility of their own development, they should honour their profession and not wait for somebody like him for support. They should make use of the social media to get relevant information.

5.5 SUMMARY

This chapter has presented the responses of the participants as collected by the researcher during her fieldwork. Of particular significance to this study, this chapter presented the data from teachers, as well as the physical sciences subject advisor. Data generated from focus group interviews included educator's views on issues such as support of teachers, professional development programmes, CAPS training, role of external support services and the role of the subject advisor. Teachers' views on CAPS were also presented. Data generated from the interview with the subject advisor included his views on the type of support that they provide to physical sciences teachers, workshops they organise, as well as availability of resources. Data emanating from questionnaires, and interviews, were further discussed to help answer the research questions to this study. This chapter also made some efforts to answer three of the research questions in this study by linking the relevant data to each of the research questions for meaningful interpretation. The ensuing chapter presents the summary, concluding remarks based on the research study questions and recommendations based on the type of professional development programmes that would be suitable for physical sciences teachers in the Lejweleputswa district, which would provide the necessary support.

CHAPTER 6

RESEARCH OVERVIEW, RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

The main aim of the study was to develop a framework for quality external support for the FET phase physical sciences teachers (cf. 1.8). In chapter 5, the research findings from questionnaires (cf. 5.2) as well as from interviews (cf. 5.3 & 5.4) were presented. In order to do this effectively, the objectives and the main research questions were re-stated as a background to the presentation of the findings (cf. 1.8, & 4.1). The conclusions and recommendations that are reflected on this chapter stem from the preceding chapters.

The findings from all the participants are systematized in order to make recommendations of this study. In addition, conclusions are formulated based on the findings related to the research questions and limitations of the study. In the light of the conclusions made, pertinent recommendations and areas of further research regarding a suitable support framework for physical sciences teachers are suggested. This is done relative to the objectives of the study.

6.2 SUMMARY OF THE LITERATURE REVIEW

The different curricula reforms that have happened in South Africa since 1994 have been deliberated (cf. 2.2.1 - 2.2.5). Curriculum change and implementation as well as factors that have to be considered during curriculum change and some literature of some suggested models of curriculum change have been discussed (cf. 2.3 & 2.4).

The process of professional development of teachers, as a mechanism of support to conform to changing curriculum has also been extensively elaborated (cf. 2.6). Then the issue of how change in curriculum could affect teachers as well as how teachers respond to any change were discussed (cf. 2.5). Chapter three discussed Kirkpatrick's model of professional development evaluation as developed by Guskey. This was used as a theoretical lens through which effective professional development for teachers' support can be provided.

6.3 EMPIRICAL FINDINGS

The findings from empirical data have indicated a mixed reaction with regard to the perception of teachers towards the professional development support that they get from the Free State Department of Education, regarding the implementation of physical sciences CAPS (cf. 5.3.2.1). Several positive results (cf. 5.4.2) and negative ones (cf. 5.4.1) relating to all issues that relate to curriculum management, implementation and support have emerged through interviews and questionnaires.

Several positive results (cf. Table 5.3 & Table 5.4) and negative ones (cf. 5.3.2.1) pertaining to all issues related to the support that is provided to physical sciences teachers in the Lejweleputswa district as well as the problems they encounter in implementing CAPS have emerged through interviews and questionnaires (cf. Table 5.7 & 5.3.2.1). From the empirical evidence gathered in this area, the perception of teachers on the implementation of physical sciences CAPS and the professional support is just in between, a fifty-fifty situation, where half of the teachers are positive about the professional support they get from the Free State department of Education, and the other half is still negative or not in agreement (cf. 5.2.2-5.2.7).

Empirically gathered data also revealed quite some uncountable challenges in schools which are impacting negatively on the teaching practice of teachers. One of the negative revelations was the confession made by teachers about the overloaded content of physical sciences that makes it difficult for them to finish the work in time (cf. 5.3.2.1), such that they continuously rush over topics in preparation for examinations and neglect the practical work in physical sciences.

The study was prompted by objectives which were illuminated in the empirical findings. In addition, information about the views of teachers and their experiences during the implementation of CAPS was gathered from the research findings (cf. 5.3.2.1 & 5.4.1). The role of the Free State Department of Education through their subject advisors in providing support to teachers was also brought to light through the interviews. The subject advisor mentioned that they support teachers through training and workshops, helping them with content issues. They also offer guidance and motivate teachers where they feel confused as well as helping them to moderate their question papers (cf. 5.3.2.2 & 5.4.4).

The second and third objectives of the study which were to evaluate the type of support programmes that were provided to physical sciences teachers and to ascertain how best these teachers could be supported to improve physical sciences teaching in schools have been achieved through the findings (cf. 5.2.2 - 5.2.7 & 5.3.2.1). The fifth and the final objective was to devise a model which could be used as a support framework for physical sciences teachers for improving their teaching of CAPS. This model (cf. Figure 5.1) was developed using some information from the findings from objective three and the theoretical framework as described in the literature (cf. Chapter 3).

Triangulation has also assisted in validating the findings. Two types of research methods were involved in this research to foster validity and reliability of findings. The questionnaires have revealed different views and concerns regarding the implementation of physical sciences CAPS, the type of professional development of physical sciences teachers have been provided and the impact of such programmes, including the role played by the subject advisors in implementing CAPS.

The researcher scrutinised the questionnaire findings and searched for all the highly positive points and negative attributes of professional development programmes and their impact on teachers' teaching practices, that is, those points affirmed or negated by the majority of teachers. In the case of interviews, the general views of participants were considered in order to highlight the most significant parts of the findings. In some cases, the researcher picked up the lowest scores of respondents to highlight the good and bad aspects of professional development programmes. Important findings are discussed next.

6.3.1 Positive Aspects of Professional Development Programmes Provided to FET Physical Sciences Teachers

In as much as teachers perceive the professional support they receive from the Department of Basic education negatively, there are several positive aspects that were discovered by this study. Physical sciences teachers really acknowledge the support that they receive from their subject advisor and they are committed to making success of CAPS.

6.3.1.1 Physical sciences teachers attend workshops and other professional development programmes and these have a positive impact on their teaching practice

A comparatively high percentage of teachers seem to attend workshops and courses in physical sciences. When collecting data and synthesizing it, the researcher gathered a positive mood regarding the commitment of teachers in attending some professional development activities, even though it seems mostly it is in one form-workshops (cf. Table 5.3 & 5.3.2.1). These workshops have a large impact on their teaching of physical sciences, in that they gain knowledge on what to teach as well as which practical work have to be done with learners. However, some teachers feel that the content and the timing of the workshops is not sometimes ideal to teachers as these are normally held after school when people are already tired. The workshops that are held over the weekends and holidays are not well attended as these are bad times for most people who prefer to go on holidays with families (cf. Table 5.4).

6.3.1.2 Teachers prefer to improve their qualifications in physical sciences

The empirical data analysed show that most teachers have attended professional development activities such as workshops, conferences, observation visits, mentoring, peer observations, coaching, networking with other teachers and improved qualifications (cf. Table 5.3). However, they feel they prefer to improve their qualifications in physical sciences than to attend conferences and other professional development activities (cf. Table 5.3). This is so that they can improve their pedagogical content knowledge and practical skills in this demanding subject. This was elaborated on by teachers during the interviews who alluded to the fact that some of them are even recipients of the Free State Department of Education Bursary scheme (cf. 5.3.2.1). The researcher assumes that teachers would like to obtain higher degrees such as specialised Honours degree in physical sciences education as most of them are still holding the diplomas and general degrees, whereas most of the newly graduated teachers hold degrees in FET physical sciences education. The other reason may be for monetary gain, which they get from the Department of Basic Education, in a form of a cheque, after the submission of their newly obtained qualification.

6.3.1.3 Teachers attend workshops specifically focused on science content or science teaching

Data that has been gathered and analysed show that the majority of physical sciences have attended workshops that are specifically focused on deepening the science content and methodology (cf. Table 5.3), however because of the duration of these workshops, teachers feel they need a lot of training as there are new topics that have been added onto the curriculum. Most of these new topics are regarded as difficult by them that is why more time is needed (cf. 2.2.4). The other reason may be that most of physical sciences teachers are still not fully equipped to teach physical sciences as Kriek and Basson (2014) have alluded to this fact.

6.3.1.4 Teachers are satisfied with the setting of question papers and the impact it has on their teaching

According to the data collected and analysed during the interviews, some of the physical sciences teachers seem to like the idea of the provincial question papers provided by the Free State Department of Education (cf. 5.3.2.1).

This exercise seems to help as they are assured of the standardized assessment as they use the same instrument to assess their learners, and it also helps to prepare the learners for the final examination at the end of grade 12. However, there were those teachers who felt that this places unnecessary pressure on their learners as they have to rush over congested content and neglect other important tasks such as the practical work. This may also disadvantage those learners who are slow (cf. 5.3.2.1 & 5.4.1).

The researcher feels that this exercise is not developmental, as the next generation of teachers would not be able to set question papers if the Department of Basic Education provides pre-set question papers. It would be highly advantageous if teachers could be given a chance to set their own papers during the year, and only be subjected to the common papers in June, September and November examinations, as it has always been the case.

6.3.1.5 Teachers are influenced by the policies and practices that govern physical sciences

The empirical data revealed that among factors that govern teaching of physical sciences, they are influenced by the policies such as CAPS. This is the main document that highlights how and what needs to be covered in physical sciences content (cf. 2.2.5). There are many factors that may affect the way in which science in general, and physical sciences in particular is perceived by the public. Such factors may include time provided for teachers' professional development in science and other factors which are listed in Table 5.6 as well as Appendix A. But these according to them, do not necessarily inhibit physical sciences instruction. The researcher assumes that teachers are eager to implement CAPS as far as possible, because through knowing the requirements of the policy, science instruction will be made effective.

The content in physical sciences has been designed in a clear and logical manner than before, so teachers just have to apply it in a concise manner (Nakedi, *et al.,* 2012). However, teachers still feel they need to be trained more on CAPS (cf. 5.19 & 5.3.2.1). In some schools where questionnaires were delivered, physical sciences would be taught by new teachers. These are teachers who have just graduated, who have not been exposed to workshops, who only have the theoretical knowledge from the universities but lack the practical experience. Shay, Wolff and Clarence-Fincham (2016) assert that it seems as if educator training institutions are still not aligned to the objectives and outcomes of CAPS, and as a result, newly graduated teachers may feel neglected when they join the world of work, where they are supposed to implement the policy. These teachers may also need an induction programme (cf. 2.6.2.7).

These are teachers who have also been referred to by the physical sciences subject advisor, that they are not receiving adequate support from the Department of Basic Education as they should (cf. 5.3.2.2).

6.3.1.6 Teachers support the use of mentors and external support structures

The analysed empirical data shows that teachers prefer the external support that they get from external agencies and mentors (cf. 2.4.3 & 5.3.2.1). During the interview with the subject advisor, he seemed to be satisfied with the initiative taken by the Free State Department of Education to have outsourced that type of expertise, from someone who specialises in methodology and mentoring. This was also supported by the quantitative data analysis which revealed that in those schools which do have study groups, the use of an external leader is always helping. Bjorklund (2015) and Bantwini (2011) suggest that continuous professional development support has to be rendered by skilled personnel because they are competent and address specific content.

Teachers also acknowledge the type of support they receive from their subject advisor, however they expressed their gratitude towards that external mentor, who was hired by the Free State Department of Education (cf. 5.3.2.1). The services of this individual have even impressed the subject advisor for physical sciences, such that teachers felt that their classroom problems might be addressed. They also suggested the need to involve other stakeholders such as Eskom and some technical schools, to render their expertise in terms of designing some laboratory equipment for their schools. These institutions may even help them with practical work. Internationally, the incorporation of external experts has been indicated also in a report by Education Scotland titled "*The involvement of External Experts in School Education"* compiled by Education Scotland in 2012, as well as the Education Department Policy Document for the States of Guernsey in 2015.

6.3.1.7 Teachers acknowledge the new topics added in physical sciences

Through the analysis of data, the researcher found out that teachers do acknowledge the new topics that have been added to physical sciences content and that they claim the content is even more interesting to learners (cf. Table 5.18). However, teachers seem to be concerned by the performance of most learners in grade 10, who seem to be challenged by the content that seems to be overloaded with difficult topics such as Mechanics and Waves, and for the fact that most of them had poor foundation in previous grades (grades 8 and 9 natural sciences).

Teachers feel that they would like to be supported fully in their respective classrooms. Accordingly, there is a need for school-based professional development that is content-specific (Masekoameng, 2014). The researcher assumes that as schools differ in diversity, each school has its own problems, and teachers in a school know their problems as well as needs, and the type of learners they deal with. So professional development programmes have to be tailored to suit individual teachers, in their different contexts.

This notion that teachers should be provided with relevant training that is appropriate to their needs is also supported by many researchers (Rogan & Grayson, 2003; Koopman *et al.,* 2016; Darling-Hammond, Hyler & Gardner, 2017).

A general feeling is that teachers feel that the support they are getting from their subject advisor is not enough, the fact that was acknowledged by the subject advisor himself. According to the subject advisor, there are some logistical reasons that prevent him to make follow-up visits to individual teachers, because of his work schedule, transport issues and administrative work that is part of his job description. This matter was a major concern of the subject advisor as he felt teachers need to be visited in their classrooms, to follow-up on the training and to motivate them (cf. 2.9).

6.3.1.8 Teachers manage to form study groups and collaborations

Analysis of quantitative and qualitative data revealed that in other schools, teachers form study groups with their peers, which help them to plan lessons together and analyse learners' assessment (cf. Table 5.12 & 5.3.2.1). This according to the researcher is a very good professional development activity, that in itself serves as a support mechanism to those teachers who are still struggling with CAPS. The researcher assumes that these might be some of the activities that they do in their clusters (cf. 2.6.2.2 and 5.3.2). These may be teachers who are newly graduated and feel the need to meet with their peers, so that they can help each other because the subject advisor is not able to visit them as he should (cf. 5.3.2).

Mogashoa (2013: 221) mentions that teachers are *lifelong learners, that is, ongoing education is a requirement for teachers in all schools. This can be in the form of workshops, seminars and training courses.* The literature in Chapter 2 revealed different professional development activities that teachers can participate in (cf. 2.6.2 & Table 5.3). These may be courses/workshops (on subject matter or methods and other education related topics) and education conferences or seminars (at which teachers and researchers present their research results and discuss education problems).

Other professional development activities may be improvement of qualification (e.g. diploma or degree programmes) as well as observation visits to other schools. Teachers may also participate in a network of teachers formed specifically for the development of teachers, or take part in individual or collaborative research, on a topic of professional interest. They may also participate in mentoring and peer observation or coaching as part of formal school arrangement. The attendance of such activities will help teachers to stay up to date with new trends and learn new strategies, techniques and methods for classroom challenges (Masekoameng, 2014). Professional development should also help to transform teachers in terms of new developments.

6.3.2 Negative Aspects of Professional Development Programmes Provided to Physical Sciences Teachers in Lejweleputswa

The following section discusses the negative aspects of professional development programmes as revealed by the empirical study. Some of these findings were also revealed by the literature reviewed in chapter 2.

6.3.2.1 No proper training and follow-up for Curriculum and Assessment Policy Statement

The data analysed revealed the need for proper and effective training for CAPS, as the majority of teachers feel that they do not have the necessary skills to deal with the content and many of them did not have any formal training in some topics such as electronics and semiconductors (cf. 5.3.2.1). Most physical sciences teachers lack the necessary subject content knowledge as well as pedagogical content knowledge. This was also corroborated by Kriek and Basson (2014), who found that most teachers had not been specifically trained in natural sciences (physics and/or chemistry), and this might have an influence on teachers' capacity and confidence to teach the new content.

The researcher assumes that these might be teachers who were underqualified, who had to improve their qualifications through the university programmes such as ACE (Advanced Certificate in Education), and in order to qualify to teach physical sciences, and most of these teachers were allocated natural sciences, technology and physical sciences.

Teachers also feel there is not enough follow-up after their training (cf. 2.9 & 5.3.2.1). The importance of a follow-up after training has been endorsed by Mogashoa (2013), who states that if there is no follow-up, teachers continue to be confused. This was also corroborated by the subject advisor who also blamed himself for not following up the teachers immediately after the training so that if there are any issues, they can be easily addressed (cf. 5.3.2.2). Mavuso (2013: 141) endorses this by stating that "*relevant district officials and principals need to know what is happening 'on the shop floor', that is, the classroom so that appropriate support strategies can be developed".* The researcher felt the importance of also evaluating the training so that professional development activity (training/workshop) could either be improved or continued as it is (cf. 2.12).

Teachers also feel they were not thoroughly consulted during the decision-making and planning of NCS and CAPS, as a result, most of them are still using the old methods of teaching (cf. 2.5). The same issue which is applicable to this study was revealed by researchers such as Cobbinah and Bayaga (2015). The researcher felt that in order for a curriculum to be implemented effectively, teachers' concerns should have been addressed, other than expecting them to implement it while they were still struggling with the previous NCS.

The implementation of CAPS has taken place without sufficient training of teachers (Nkosi, 2012). According to Guskey's model of evaluation, teachers concerns and needs need to be considered before they can implement a new curriculum (cf. 3.2.4.1). The Department of Basic Education should develop a differentiated professional development programmes to respond to teachers' range of concerns.

During the one-on-one interview, the subject advisor also added that this time around, teachers were not involved like during C2005, where the use of cascade model was prevalent (cf. 5.3.2.2). Continuous and proper training should also be done because a workshop of two days cannot be enough to implement CAPS effectively (Bjorklund, 2015). Lack of continuous training for teachers hinders the success of CAPS.

6.3.2.2 No professional support in schools

Analysis and discussion of both the quantitative and qualitative data revealed that there is a very limited in-school support provided by their HODs or even the principal (cf. 5.3.2.1). The researcher assumes the reason for that may be that in many schools, the sciences (life sciences, physical sciences, mathematics, natural sciences and technology) are manned by one HOD, who might not necessarily be a specialist in all of them. As a result, this affect the way in which he/she supports the teachers in different departments because of lack of content knowledge. Monitoring and support in the context of class visits give the HODs an opportunity to observe teachers' work, provide motivation and exercise influence and if this is done properly, it will determine the successes, deficiencies and challenges that are encountered by teachers (Phasha, Bipath & Beckmann (2016).

Teachers also feel that the subject advisor is not visiting them in their respective schools as he should (cf. Table 5.17 & 5.3.2.2). This finding is in accordance with what was revealed in a study by Tshiredo (2013), who found out that it seems subject advisors do not give required support and monitoring because of the inadequate resources and human capacity. According to the report by the Portfolio Committee meeting on the "*Progress on the implementation of CAPS*", subject advisors are acting as intermediaries between policy and implementation, and they do not do justice to qualitative in-class support to teachers (DBE, 2017). The Portfolio committee then recommended that they should specify the exact nature of in-classroom and school support they should provide to teachers. On the issue of principals, most of them were not properly trained for CAPS (Bantwini, 2011), as a result, principals normally rely on the expertise of HODs. Principals play a critical role in focusing decisions and instilling a culture of learning at schools (Mouton, Louw & Strydom, 2013).

6.3.2.3 Inadequate funds to purchase science equipment

The analysis also revealed a problem of inadequate funds to purchase necessary science materials (cf. Table 5.7 & 5.3.2.1). This problem lies with the SGBs, who run the affairs of schools. Most of the schools in South Africa and specifically Lejweleputswa fall under Section 21, where they are totally or partially funded by the Department of Basic Education. Most of the time the funds are not released in time to schools, and as a result the required science equipment is not bought in time for schools. This in itself hinders the normal teaching and learning of physical sciences in schools. Mestry (2016) highlights the SGBs' functions as follows:

- Maintaining and improving the school's assets, buildings, grounds and hostel;
- Determining the extra-mural curriculum and the choice of subject options in line with provincial curriculum policy;
- Purchasing textbooks, educational materials or equipment for the school; and
- Paying for municipal services provided to the school.

The subject advisor clearly stated that the Department of Basic Education does not provide schools with science apparatus (cf. 5.3.2.2), it follows therefore that it is solely the responsibility of SGBs to support teachers in buying relevant learning material and equipment for physical sciences.

6.3.2.4 Lack of proper science facilities

Data analysis also revealed that most schools lack proper facilities for physical sciences (cf. Table 5.7 & 5.3.2.1). These may be new textbooks, chemicals and science models. Although efforts are made to supply schools with equipment, Physical sciences teachers are still not confident in their ability to use and manage it. This implies a need for appropriate training once more. Teachers are worried about the state in which their laboratories are in, using expired chemicals or unused chemicals which may be hazardous to learners (cf. 5.3.2.1). This issue also emanated in a study by Tshiredo (2013), who revealed that in most schools, teachers have to operate in unequipped laboratories. Inadequacies of laboratories make it problematic for teachers and learners to conform to the needs of curriculum change.

In a report by Umalusi (2014), it has been noted that there is a plight on lack of availability of adequate resources for the experimental work for physical sciences. Teachers feel that if companies such as Eskom could be engaged in helping with the expertise because they have necessary equipment, this problem may be reduced. A good reference may be the involvement of Eskom and Tracker in places such as Jeffrey's Bay, which was announced through SABC news, on the 24th of February, 2017, where Eskom sends specialist to schools once a week to perform physical sciences practical, using their own mobile laboratory and equipment, so that teachers could have more time to cover the content. This exercise helped a certain school in the area by increasing the physical sciences pass rate by 25% in 2015. The provisioning of science centres with well-equipped laboratories in each and every district will play a greater role in effective teaching and learning of physical sciences in schools.

Another option that teachers suggested is to involve technical schools to manufacture science equipment for some schools as their science is not the same as the physical sciences. Most of these schools offer Technical sciences which is not the same as physical sciences, and they are in a good position to create such equipment as part of their practical work (cf. 5.3.2.1).

6.3.2.5 Inadequate supply of textbooks in physical sciences

The analysis of empirical data also reveals that teachers are in need of science textbooks in their respective schools. The subject advisor confirmed this fact, that the Free State Department of Education takes time to deliver textbooks to schools, and this affect teaching and learning in most schools (cf. 5.3.2.2). Bantwini and Diko (2011) state that teachers' resistance to implement CAPS stems from the fact that the Department of Basic Education does not support them effectively in buying the necessary science material such as textbooks. The researcher feels that this problem lies solely with the Free State Department of Education, that the curriculum development personnel at the province has to deliver textbooks in time, starting in the last quarter of the year to prepare for the next academic year.

6.3.2.6 Inadequate time to teach science

During the analysis of data, the teachers complained about the limited time that is allocated to physical sciences in the school time table. They believe that physical science content is overloaded, and it needs more time for teachers to cover the required content as well as practical work (cf. 5.3.2.1). Kriek and Basson (2012) comment on the same concern regarding teachers who need more time to prepare for physical sciences because of the newly added topics. The researcher feels that this is a real concern as physical sciences is not an easy subject that needs teachers who are focused and fully prepared as it is too demanding.

6.3.2.7 No parental involvement

Analysis of the empirical data shows that parents do not show the necessary support to physical sciences teachers (cf. 5.3.2.1). The researcher assumes that parents might be reluctant to be involved in their children's education, more especially physical sciences, because of the nature of the subject. This is supported by Fullan (2007) who was cited by Maharajh, Nkosi and Mkhize (2016), who state that most parents felt incapacitated because of ignorance and not being able to help their children with homework.

6.3.2.8 Low learner interest in science

During the analysis of data, teachers also brought about a problem of low interest in learners (cf. 5.3.2.1 & Table 5.7). The researcher assumes that the poor foundation that most learners have in science and mathematics, may be the reason why learners lose interest in physical sciences as they reach FET phase.

6.3.2.9 Physical sciences content is overloaded

Analysis of empirical data revealed that physical sciences content is overloaded (cf. 5.3.2.1 & 5.3.2.2). This was also verified by the interview with the subject advisor. There are some new topics that have been added to grade 12 content whereas others have been shifted from grade 10 to grade 11(cf. 5.3.2.1). Teachers are of the opinion that their work will be much easier if more topics can be distributed in grade 10 and 11 content, to allow grade 12 learners to prepare for the final examinations. The issue of content overload has also been reported as a continuing challenge by the Portfolio Committee meeting of the Department of Basic Education (DBE, 2017).

6.4 RECOMMENDATIONS

This section provides recommendations which emanate from the empirical findings of this research. The data presented and analysed (cf. 5.2 & 5.3) have yielded a number of recommendations. These recommendations are discussed in the following subsections. The purpose of these recommendations is to provide an effective framework for continuous professional development of physical sciences teachers in Lejweleputswa.

6.4.1 Physical sciences content should be streamlined

There are a lot of changes that took place in reshuffling the physical sciences content. Gudayanga (2017) revealed these changes in terms of the cognitive weighting and Changes in the way examination questions are asked. He alluded to the fact that these changes in content, assessment strategies and content weighting may require some form of intervention strategies to enhance subject content knowledge (SCK), PCK and other knowledge domains. It would therefore imply that teachers need to be retrained in order to be "…*able to simplify and comprehend those topics and concepts that are considered difficult to understand"* (Gudayanga, 2017:47).

The CAPS for physical sciences is more inquiry-based and it needs more competent teachers (Ramnrain, 2014). Rammnarain and Fortus's (2013) study report entitled *South African physical sciences teachers' perceptions on new content in a revised curriculum,* investigated teachers' experiences and perceptions of the educational value of new topics in the NCS physical sciences. In their study, conclusions were made that, though teachers positively endorsed the new topics, "…*a substantial number of teachers had difficulty understanding concepts related to these topics, and this consequently compromised their PCK"* (Ramnarain & Fortus, 2013: 12).

These changes affected the way in which the topics were distributed among grade 10, 11 and 12. An example is the introduction of motion in mechanics that has been shifted from grade 11 to grade 10. The topic in itself is rather difficult and if it has to be tackled by grade 10 learners, who are still struggling with other new topics and who come from GET phase with limited foundation, they carry on this baggage into grade 12, and this might result in poor performance at the end of grade 12 (Gudayanga, 2017). The grade 10 content should not be regarded as the preparation for grade 12, rather, learners should be introduced to more relaxed physical sciences, which will then be intensified in grade 11, in preparation for grade 12.

There should be less topics in grade 12 so that learners can be afforded enough time to prepare for their final examinations. The Portfolio Committee meeting also suggested the separation of physical sciences into physics and chemistry as a long-term plan for Department of Basic Education for the period from 2020 to 2030, so that the load can be bearable (DBE, 2017).

6.4.2 Incorporation of external experts

According to the data analysis, it seems the incorporation of external experts is favoured by most teachers. External experts are a valuable resource to support teachers in delivering the curriculum. The initiative that has been taken by the Free State Department of Education is a good one that needs to be applauded and continued, because of the relevance of the expert. Teachers seem to listen and value information which is delivered by someone they are not familiar with, because of their experience with the Department of Basic Education officials. This exercise might also relieve the burden off the shoulders of subject advisors who seem to be overloaded with administrative work and who have limited time to train and follow up on their teachers. Mouton, Louw and Strydom (2013) suggest that the Department of Basic Education should invite senior personnel from countries such as Finland and Singapore and allow teachers to listen to how things are done in those countries.

6.4.3 There should be school-based training for teachers

Physical sciences teachers know their local problems. They should be able to identify their respective needs according to how they want to be developed and when they want to be developed (Mestry, Hendricks & Bisschoff, 2009). Through the formation of collaborations and peer observations, physical sciences teachers can identify their problems and then be able to consult their HODs on their need to be developed. The HODs in turn will then be able to directly involve the subject advisors to conduct content-specific training at the school.

This training should be continuous and hands-on in order to address the gaps that might still exist. This will enable the subject advisors to follow-up the training immediately after training, so that if there is any remediation needed, it can be provided. Bantwini (2009) also suggests that districts should have the responsibility of developing their own professional development models that will respond to contextual issues so that teachers are sufficiently developed.

6.4.4 Teachers should be able to take full responsibility of their own professional development

Investing in a formal system of professional development for classroom teachers, and asking them to take responsibility for running it, would be a highly effective and non-confrontational way to improve school standards. If teachers can be more inclined on self-study and then meet regularly to discuss their problems, this may motivate them to put more effort into their own learning (Attard, 2017). This notion was supported by the physical sciences subject advisor during the interviews that it is about time that teachers reflect on their own development (cf. 5.3.2.2). Masekoameng (2014) also endorsed the sentiment by stating that teachers should be involved in further studies related to their career in order to keep abreast with the new developments of their profession. Teachers can also engage in professional development activities that will benefit them, like attending conferences and academic seminars that are content-related.

Taking responsibility for professional development involves:

- Understanding one's professional needs, interests and learning preferences in order to identify areas for development.
- Defining one's short, medium and long-term career goals.
- Understanding the developmental pathways available to reach one's specific career goals.
- Using technology to facilitate one's professional development.
- Staying up to date with developments in education in teaching and learning.
- Being aware of, selecting and engaging in, appropriate professional development opportunities and resources to inform one's classroom practice, including:
  - collaborating with colleagues and other professionals
  - reflective practice
  - educator research and other forms of classroom enquiry
  - attending and presenting at conferences
  - participating in training
  - reading and publishing
  - joining teachers' associations

Hall (2017: 8) states that effective reflection "…*is at the heart of continuing professional development and should be seen as a means of making sense of the practice environment by learning through questioning and reframing future responses* *and actions".* It implies therefore that teachers do not solely learn by engaging in formal educational processes, but rather, they need to develop the necessary tools that are needed for them to take charge of their own continuous professional development.

6.4.5 Professional development programmes should be continuously evaluated

Evaluation is an essential part of the educational process. The focus of evaluation is quality improvement. However, research shows that there is a limited amount of evaluation when it comes to professional development programmes. For instance, these limitations are summarized as follows:

- *Most 'evaluation' consists merely of summarising the activities undertaken as part of the professional development program: what courses were attended, how many credits accrued etc. This clearly gives no indication of the effectiveness of the activities undertaken, making this form of data-collection inadequate as a means of examining the effects of CPD.*
- *Where some evaluation does exist, this usually takes the form of participant satisfaction questionnaires. Obviously, these allow one to gauge whether participants consider the event to have been enjoyable and successful, but this method does not engage with issues such as gains in knowledge, or changes in practice expected from professional development, and certainly does not evaluate whether there have been associated changes in student outcomes.*
- *Evaluations are also typically brief, one-off events, often undertaken post hoc. As most meaningful change will tend to be long-term, and many professional development activities will take place over a longer period of time, evaluation efforts need to reflect this and likewise take place over time* (Guskey 2000: 8-10).

It implies that it is very important for the Department of Basic Education to evaluate the professional development programmes before and after they have been rendered, mainly because of the fact that South African education system has undergone several curricula changes that are still confusing its teaching fraternity. The following section provides the proposed model of professional development that could be suitable for physical sciences teachers.

6.4.6 A Maopetic model of school based professional development program

Recent research by Masekoameng (2014) have shown that school-based professional development programmes are possible. In her study, this researcher endorsed the possibility of SMTs in organising school-based training sessions, where teachers who are a bit enlightened in CAPS, train others. Masekoameng (2014: 279) suggests that "*school-based departmental meetings are also encouraged whereby individual teachers of the same department can be able to assist each other in matters related to curriculum development and that teachers are always urged to discuss educational policies (even if not formally) with other teachers in order to promote a common understanding".* This sentiment is also supported by researchers such as Bantwini (2011), who states that school-based professional development programmes should be contextualised to suit the environment they are expected to be used in. An evaluation plan must also be put in place by the participants and developers to assess the success or failure of professional development programme before its implementation. The researcher's contribution to new knowledge is the following model of school-based professional development that can be used in schools.

Below is a diagrammatical representation of the model and explanation of different stages as well as the roles of different stakeholders who will be responsible for the professional development programmes at a school level.

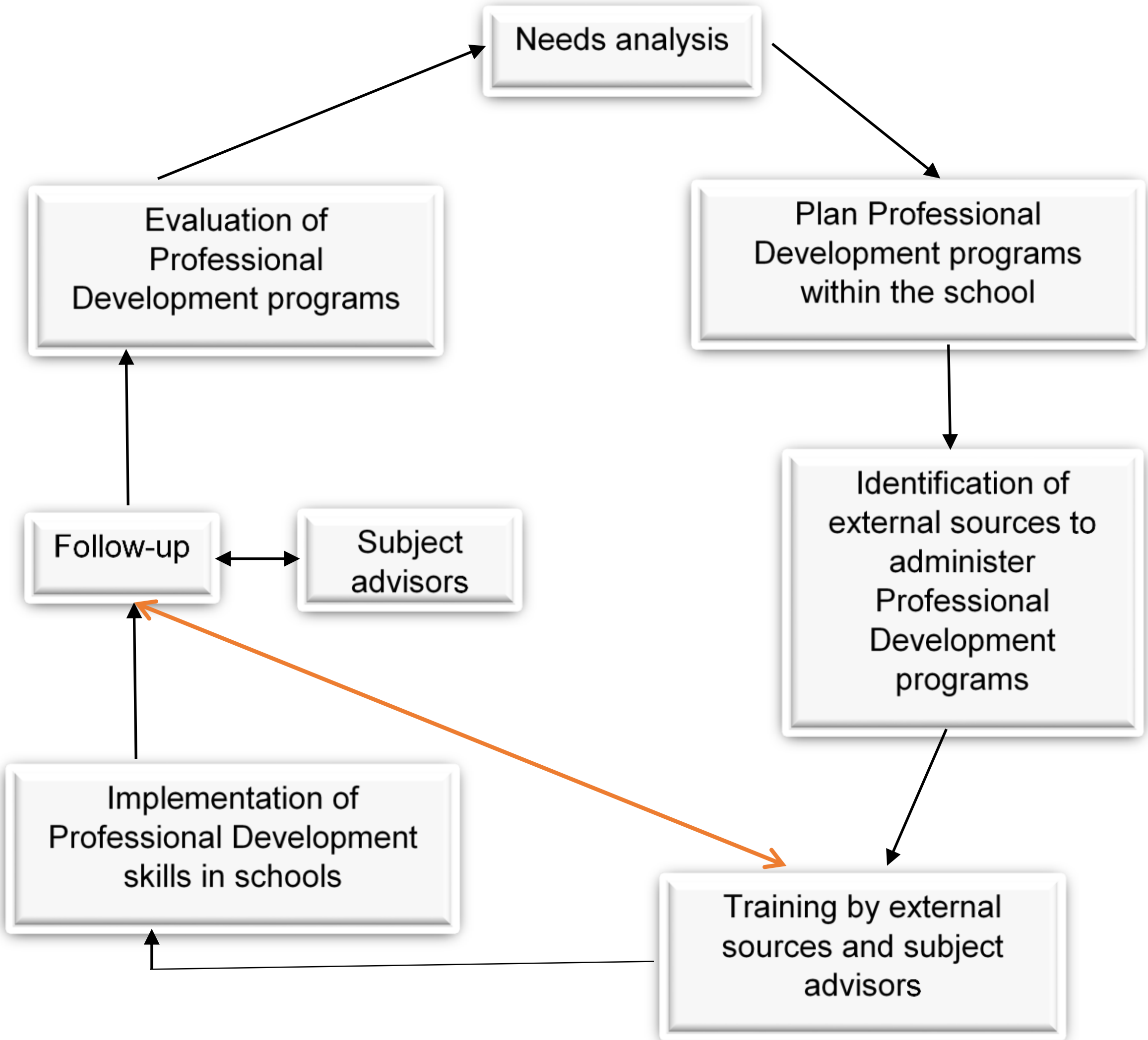


Figure 6.1: Maopetic Model of School-based Professional Development Programs

6.4.6.1 Needs analysis

In general, needs are defined as a gap between what is expected and the existing conditions. Moeini (2008:4) describes needs analysis as "…*an examination of the existing need for training within an organization".* It identifies performance areas or programmes within an organization where training should be applied. A needs analysis identifies the problem or need and then proceeds to identify the aims, content, implementation, target population and outcome of an intervention (Cohen, Manion & Morrison, 2003 in Moeini, 2008). Applying needs analysis before an educator-training program defines fields in which teachers need to develop their skills. This also provides a baseline against which accomplishment of educator training can be measured. In fact, teachers require a wide variety of ongoing opportunities to improve their skills. Effective professional development of teachers begins with an understanding of teachers' needs and their work environments. It is believed that the main step in any training program is to determine whether training is needed and, if so, to specify what that training should provide.

Although the majority of teachers consider themselves to be knowledgeable and confident, at the same time, due to the new expectations and challenges, more especially with the implementation of CAPS, they have a perception of a gap between their current knowledge and what they need to know to become expert teachers. This implies therefore that, physical sciences teachers should form peer collaborations where they plan lessons together and visit one another in their respective classes to observe their peer lessons. It is then that they can easily come together to identify their needs for training, with the help of their HODs and subject advisor.

6.4.6.2 Planning of Professional Development Programmes

An effective comprehensive plan for professional development should be based on a shared vision developed in a collaborative process, carried out by the education partners involved in the implementation and delivery of the plan. Teachers and other stakeholders need to elect a committee which will be responsible for consolidating the program. These stakeholders may be other members of staff, the school management teams (the principal and SMTs), the school governing body (SGB) and the district officials (subject advisor). An effective PD planning process begins with a review of what constitutes quality professional development, discussions about jurisdiction and school needs, and the role of various education partners. When this background search has been completed, the PD planning committee will then be ready to develop a shared vision for professional development that includes the following:

- core belief statements, including statements as to the purpose of professional development,
- a vision for effective professional development at the jurisdiction and school levels, and
- operational guidelines to support the development and implementation of the plan.

Taking the time to develop a shared vision for professional development will help meet the needs of all parties and address unique contextual issues of the classroom, school and jurisdiction. After they have identified their respective needs, then they can invite the subject advisor to plan their professional development programmes. These will be activities that they feel require special attention in order to implement CAPS**.** These will obviously be different according to their respective school contexts. Once the plan has been finalized it may need to be approved by the principal or the District Director and/or the SGB. The developed plan should be communicated in a timely manner to stakeholders. This is done to allow necessary budgetary allocations.

6.4.6.3 Identification of external experts to administer the training

With the help of the school management, physical sciences HOD and the subject advisor, external experts can be sought in relation with the envisaged training in curriculum issues. The subject advisor may use his expertise and consultancy to seek for relevant and suitable candidates who will render these services according to expertise and merit. The use of external experts by schools is widespread even in overseas countries such as Scotland (Alba, 2012). According to the report on "*The involvement of External Experts in School Education in Scotland"* (Education Scotland, 2012), external experts are a valuable resource to support teachers in delivering the curriculum. Many of these experts are skilled professionals whose daily work involves learning and teaching, although in a different environment and their contribution works best as part of a planned, continuous experience based on appropriate preparation and effective follow-up activity.

6.4.6.4 Training

After scanning the environment, assessing participants' needs and developing goals, the committee or whoever has been chosen to foresee the smooth running of the training is ready to develop focused, comprehensive, ongoing PD programmes. This is the stage where the external resource person, in the presence of the subject advisor or the HOD, renders professional development training to physical sciences teachers. During the training, teachers can use their own classrooms as training sites, where the training happens, according to their individualised problems. The second level of evaluation in Guskey's model is relevant at this stage.

The success of the plan relies on careful attention to details during implementation. The following needs to be accounted for:

- What strategies are in place to support the committee?
- How will the committee maintain communication with participants?
- How will the committee maintain communication with PD providers?
- How will the committee recognize and celebrate success along the way?

6.4.6.5 Implementation of the knowledge and skills after training

Collecting formative data to monitor implementation of the plan is critical to success. As strategies are completed, the committee will collect evidence of program success. The following questions can then be asked:

- Are participants applying their new knowledge and skills?
- Is the program influencing practice and learner learning?

The newly acquired knowledge and skills can now be implemented in the classrooms. This will have to happen immediately after the training, for instance, a day or two after the training while the information is still fresh in the minds of the teachers.

6.4.6.6 Follow-up

The subject advisor may visit the schools after a reasonable time frame to check whether all what has been rendered during the training has been successful or useful, and if not, what can be done to remedy that. If for instance, during training, they were dealing with a topic and how to conduct the practical work on that content, it is then advisable for the subject advisor to visit teachers early enough, while they are still treating the same topic, so that if there are any hiccups, the subject advisor will be in a position to give advice as he was also present during training. The services of the external expert may be sought again during this stage, to clarify any issues and to offer support.

6.4.6.7 Evaluation of professional development or recommendations

The recommendations should include an overview of the program, a judgment of the program's success and recommendations for future PD planning. This report should meet reporting requirements and be shared with all relevant stakeholders

- Did you celebrate what worked well?

- Did you examine what did not work and why?
- Did you identify what should be done next?

When designing a comprehensive professional development program, PD planning committees need to consider a broad range of activities. Planning and selection of activities should balance the needs of the individual, the school and the jurisdiction.

6.5 LIMITATIONS TO THE STUDY

This research provides an insight in the professional support of physical sciences teachers in the FET phase in Lejweleputswa district. It is a step further in the investigation of professional development of teachers. However, the sample of this study was drawn from the teachers, and the physical sciences subject advisor of Lejweleputswa only. Therefore, it is not representative of the entire population of physical science teachers in South Africa in general and Free State province in particular. As such this research does not have population validity. Its findings might not necessarily apply elsewhere as schooling in South Africa varies within districts in a province and across various provinces in the country. The sample presented only one district in the Free State province. Only public schools were the target population in this study. Further research, focusing on independent schools is also needed.

Another limitation is that most teachers who took part in this study were involved in grade 12 and therefore could not dedicate their time fully to the study. The sample of this study was drawn from the FET phase only. Questionnaires and interviews, were used to collect data. In further research, using a combination of these tools and others is needed. In spite of the limitations and further areas of research mentioned above, this study has achieved its objectives of understanding the need for support of physical sciences teachers and their perception with the present support from the Department of Basic Education.

6.6 FURTHER RESEARCH

Further studies need to be conducted in other provinces of the country, to investigate the support that physical sciences teachers receive from the Department of Basic Education. There is a need for a study of the GET phase as natural sciences form part of the foundation subject for physical sciences. Another empirical study should be conducted focusing on independent schools, as these schools seem to be performing better than most public schools. There should also be further research on the feasibility of having school-based subject advisors who will be able to monitor and support physical sciences teachers on a daily basis. Further research on physical sciences teachers' qualifications to determine whether they have education qualifications or not should be a necessity. Such information may shed more light on the preparedness of physical sciences teachers to implement the CAPS and may enhance researchers' efforts to explore teachers' concerns and challenges during curriculum reforms.

6.7 SUMMARY

The main purpose in this study was to investigate the professional support system that physical sciences are provided with by the Free State Department of Education in the Lejweleputswa district. The background to this study was discussed by describing the context, the problem statement and the significance for the investigation. The theoretical framework underpinning this study was discussed as well as the review of relevant literature. The methods of research and pertinent concepts were highlighted. Data generated was presented, discussed and analysed.

It is the researcher's submission that a critical discourse of quality professional development support of physical sciences teachers poses many challenges. In plotting the way forward, it is recommended that further research be undertaken on the practice of teachers in investigating the interaction between teacher content knowledge of new topics and how they engage in the reorganisation and reconstruction of this knowledge, one of the hallmarks of good pedagogical content knowledge (PCK). The discrepancy in content knowledge as perceived by teachers in this study shows the need for a professional development programme that is customized to the particular needs of teachers, hence the design of the proposed Maopetic model of school-based professional development programme. The utilisation of this model may help in alleviating the problems faced by subject advisors, of lack of time and resources to visit schools. The traditional 'one-shot' approaches to professional development have been inadequate and inappropriate in addressing the developmental needs of teachers.

From the empirical evidence gathered, the physical sciences teachers are males (cf. Table 4.1). Even though my population for the study was small, if data revealed that most teachers who participated in the quantitative study were males, then it is an issue of concern as it also affects the way female learners perceive physical sciences. The study also revealed that teachers have the acceptable qualifications to teach physical sciences, but there is still a considerable amount of teachers in the “near retirement” bracket, which will affect the performance of physical sciences in schools as most of the trained teachers will leave the profession. There seems to be a problem of overcrowding in the physical sciences classrooms, and this will impact negatively on the teaching and learning of the subject. Most teachers are allocated other lower grades, than physical sciences. This affects their performance in grade 12, which is regarded as a measure against other countries because they might not have adequate time to concentrate on this demanding grade. The other issue which came up is the overloading of physical sciences. The overloading of the physical sciences curriculum affects the way teachers teach as they are still expected to carry out other duties such as administration and extra-curricular activities.

The study also showed that physical sciences teachers attend some professional in-service training activities, mostly in the form of workshops. The results also show that CAPS has benefited teachers a lot in terms of the newly added topics that are relevant for the learners’ needs in the 21st century (cf. Table 4.18).

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APPENDICES:

APPENDIX A

QUESTIONNAIRE TO BE COMPLETED BY PHYSICAL SCIENCES TEACHERS (FET) IN THE LEJWELEPUTSWA DISTRICT -FREE STATE PROVINCE

INSTRUCTIONS:

Complete the missing particulars or mark the appropriate block.

You are assured that your anonymity will be protected during this investigation.

SECTION A: GENERAL BACKGROUND INFORMATION

Please tick in the appropriate box or supply the answer in the space provided.

1. Please indicate your:

1.1 AGE

20 – 30 years [ ]   31 – 40 years [ ]   41 – 50 years [ ]

51 years and above [ ]

1.2. SEX

Female [ ]   Male [ ]

1.3 HIGHEST QUALIFICATIONS

PTC [ ]   DEP [ ]   B Ed [ ]   BED Hons [ ]

M. Ed [ ]

1.4 TEACHING EXPERIENCE

0 – 5 Years   6 – 10 years   11 – 15 years   15 years and above [ ]

1.5. On average how many learners do you teach? [ ]

SECTION B: IN- SCHOOL PROFESSIONAL DEVELOPMENT

3. Indicate whether each of the following programmes and/or practices is currently being implemented in your school. (select one on each row).

	Yes	*No*
3.1 Students go to a Career and Technical Education Centre for science		
3.2 Science courses are offered by telecommunications		
3.3 Students attend holiday science classes in other schools		
3.4 Students go to a college or university for extra classes in science		
3.5 Students in FET classes receive science instruction from a science specialist instead of their regular teacher		
3.6 Students in FET classes receive science instruction from a science specialist in addition to their regular teacher		
3.7 Students in FET classes pulled out for remedial instruction in science		
3.8 Students in FET classes pulled out from science instruction for additional instruction in other content areas		

2. TEACHER APPRAISAL AND FEEDBACK

Appraisal is defined as when a teacher's work is received by the principal, an external inspector or by his/her colleagues. This appraisal can be conducted in a range of ways from a more formal, objective approach (e.g. as part of a formal performance management system, involving set procedures and criteria) to the more informal, more subjective approach (e.g. through informal discussions with a teacher).

FEEDBACK is defined as the reporting of the results of a review of your work (however formal or informal that review has been) back to

the teacher, often with the purpose of noting god performance or identifying areas for development. Again feedback may be provided formally (e.g. through a written report) or informally (e.g. through discussions with the teacher).

4.1 From the following people, how often have you received appraisal and/or feedback about your work as a teacher in this school?

4.1.1Principal...

4.1.2 Other teachers of the school management team.................................

4.1.3 External individual or body (e.g. external inspector) ....

4.2. Concerning the appraisal and/or feedback you have received at this school, to what extent have they directly led to any of the following?
Please mark one choice in each row.

	No change	**A small change**	**A moderate change**	**A large change**
4.2.1 A change in salary				
4.2.2 A financial bonus or another kind of monetary reward				
4.2.3 Opportunities for professional development				
4.2.3 A change in the likelihood of career advancement				
4.2.4 Public recognition from the principal and/or your colleagues				
4.2.5 Changes in your work responsibilities that the job more attractive				
4.2.6 Role in school development initiatives (e.g. curriculum development group, development of school objectives)				

5. INFLUENCES ON SCIENCE INSTRUCTION

5.1 Please rate the effect of each of the following on the quality of science instruction in your school. (Select one on each row).

	Inhibits Effective instruction	Neutral		Promotes Effective instruction	N/A Or Don't know
5.1.1 District science professional policies and practices	1	2	3	4	5
5.1.2 Time provided for teacher professional development in science	1	2	3	4	5
5.1.3 Importance that the school places on science	1	2	3	4	5
5.1.4 Public attitudes towards science instruction	1	2	3	4	5
5.1.5 Conflict between efforts to improve science instruction and other school and/or district initiatives	1	2	3	4	5
5.1.6 How science instructional resources are managed (e.g. distributing and	1	2	3	4	5

refurbishing materials)				

SECTION C: PROFESSIONAL DEVELOPMENT, PROFESSIONAL DEVELOPMENT NEEDS AND SUPPORT STRUCTURES

5.2 PROFESSIONAL DEVELOPMENT

> ***In this survey, professional development is defined as activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher.***

Please only consider professional development you have taken after your initial teacher training/education.

5.2.1 *During the past 3 years, did you participate in any of the following kinds of professional development activities, and what was the impact of these activities on your development as a teacher?*
For each question below, please mark one choice in part (A). If you answer "yes" in part (A) then please mark one choice in part (B) to indicate how much impact it had upon your development as a teacher.

	(A) participation			***(B) Impact***	
	Yes no	***No impact***	***A small impact***	***A moderate impact***	***A large impact***
5.2.1.1 Courses/workshops (e.g. on subject matter or methods and/or other education-related topics.					
5.2.1.2 Education conferences or seminars (where teachers and/or researchers present their research results and discuss educational problems)					

5.2.1.3 Qualification programme (e.g. a degree programme)					
5.2.1.4 Observation visits to other schools....					
5.2.1.5 Participation in a network of teachers formed specifically for the professional development of teachers...					
5.2.1.6 Mentoring and/or peer observation and coaching, as part of a formal school arrangement.........................					

5.3 Who provided the professional development training?

5.3.1 Department of Education staff (subject advisors) ....

5.3.2 University staff...

5.3.3 N.G. Os (e.g. publishers) ....

5.3.4 Experts (book authors, curriculum developers etc.) ....

5.4 The type of training that you attended, was it on the following?

5.4.1 New curriculum content: ....

5.4.2 Practical work in new curriculum: ....

5.4.3General policy on the new curriculum (CAPS)....................................

5.4.4 Assessment: ....

5.5 How often were these types of training?

5.5.1 Once per term: ....

5.5.2 Once every two weeks: ....

5.5.3 Once every school holiday: ....

5.5.4 Twice in a year: ....

5.6 How you would prefer to participate in professional development activities? (Select only one)

5.6.1 One that is scheduled on a release-time basis, with coverage provided

5.6.2 One that is scheduled after regular working hours and on week-nights

5.6.3 One that is scheduled during times when school is not in session (i.e. during school holidays).

6. What type of follow-up activities have you participated in? *Please select all that apply:*

*6.*1 Demo lessons

6.2 Coaching

6.3 One-on-one session with the Physical Science subject advisor

6.4 Appraisal by my Head of Department at this school

6.5 Videos/DVDs

6.6 Other, please specify..

7. PROFESSIONAL DEVELOPMENT NEEDS

7.1 Which of the following are provided to teachers considered in need of special assistance in Physical science teaching (e.g. new teachers?)

7.1.1 Seminars, classes and/or study groups: ....

7.1.2 Guidance from a formally designated mentor or coach: ....

7.1.3 Mentor or coach: ....

7.1.4 A higher level of supervision than for other teachers: ....

Central University of Technology, Free State

7.2 in your opinion, how great a problem is each of the following for science?

	Not a Significant Problem	Somewhat Of a problem	Serious problem
7.2.1 Lack of science facilities (e.g. lab tables, electricity etc)			
7.2.2 Inadequate funds for purchasing science equipment and supplies			
7.2.3 Inadequate supply of science textbooks/modules			
7.2.4 Low student interest in science			
7.2.5 Inadequate science-related professional development opportunities			
7.2.6 lack of opportunities for science teachers to share ideas			
7.2.7 Inadequate teacher preparation to teach science			
7.2.8 Insufficient time to teach science			

7.3 PROFESSIONAL DEVELOPMENT SUPPORT/ *OPPORTUNITIES*

This question is about in-service (professional development) programmes offered by your school and/or district, possibly in conjunction with other organisations (e.g. other school districts, colleges or universities, museums, professional associations, commercial vendors).

7.3.1 in the past three years has your school and/or district offered in-service workshops specifically focused on science or science teaching?

7.3.1.1 Yes

7.3.1.2 No

7.3.2 Please indicate the extent to which in-service workshops offered by your school and/or district in the past three years addressed deepening teacher understanding of each of the following: *(select one on each row).*

	Not At all		**somewhat**		**Not a great extent**
7.3.2.1 Science content.	1	2	3	4	5
7.3.2.2 National science standards.	1	2	3	4	5
7.3.2.3 How to use particular science instructional materials (e.g. modules or textbooks).	1	2	3	4	5
7.3.2.4 How to monitor student understanding during science instruction.	1	2	3	4	5
7.3.2.5 How to adapt science instruction to address student perceptions.	1	2	3	4	5
7.3.2.6 How to provide alternative science learning experiences for students with special needs.	1	2	3	4	5
7.3.2.7 How to use investigation-oriented science teaching strategies.	1	2	3	4	5

7.4 In the past three years, has your school offered teacher study groups where teachers meet on a regular basis to discuss teaching and learning of science, and possibly other content areas as well (sometimes referred to as ***Professional Learning Communities or lesson study)?***

7.4.1 Yes

7.4.2 No (*if No, skip to 7.12*)

7.5 Has your school specified a schedule for when these science-focused teacher study groups are expected to meet?

7.5.1 Yes

7.5.2 No

7.6 Over what period of time were these science-focused teacher study groups typically expected to meet?

7.6.1 The entire school year

7.6.2 One semester

7.6.3 Less than one semester

7.7 How often have these science-focused teacher study groups typically been expected to meet?

7.7.1 Less than once a month........

7.7.2 Once a month.......................

7.7.3 Twice a month.......................

7.7.4 More than twice a month......

7.8 Which of the following describe what the typical science-focused teacher study groups in this school is comprised with? (***Select all that apply***).

7.8.1	Organised by grade level
7.8.2	Include teachers from multiple grade level (Grades 10, 11 & 12)
7.8.3	Include teachers from other schools in the district
7.8.4	Include teachers from other schools outside your district
7.8.5	Include school and/or district administrators (subject advisors)
7.8.6	Include parents/guardians or other community members
7.8.7	Include higher education faculty or other consultants.

7.9 Which of the following describe the typical science-focused teacher study groups in this school? (***Select all that apply***).

7.9.1	Teachers engage in science investigations
7.9.2	Teachers plan science lessons together
7.9.3	Teachers analyse student science assessment results
7.9.4	Teachers analyse classroom artefacts (e.g. student work samples)
7.9.5	Teachers analyse science instructional materials (e.g. textbooks or modules).

7.10 To what extent have these science-focused teacher study groups addressed deepening teacher understanding of each of the following? (*select one on each row)*

	Not At all		**somewhat**		**To a great extent**
7.10.1 Science content	**1**	**2**	**3**	**4**	**5**
7.10.2 National curriculum standards in science	**1**	**2**	**3**	**4**	**5**
7.10.3 how to monitor student understanding during science instruction	**1**	**2**	**3**	**4**	**5**
7.10.4 how students think about various science ideas	**1**	**2**	**3**	**4**	**5**
7.10.5 how to monitor student understanding during science instruction	**1**	**2**	**3**	**4**	**5**
7.10.6 how to adapt science instruction to address student misconceptions	**1**	**2**	**3**	**4**	**5**
7.10.7 how to use technology in science instruction	**1**	**2**	**3**	**4**	**5**
7.10.8 how to use investigation-oriented science teaching strategies	1	2	3	4	5
7.10.9 how to provide alternative science learning experiences for students with special needs	1	2	3	4	5

7.10.10 how to conduct practical in new curriculum	**1**	**2**	**3**	**4**	**5**

7.11 Have there been designated leader for these science-focused teacher study groups?

7.11.1 Yes.........

7.11.2 No...........

7.12 The designated leaders of these science-focused teacher study groups were from...... (***Select all that apply).***

7.12.1	This school
7.12.2	Elsewhere in this district
7.12.3	College or university
7.12.4	External consultants
7.12.5	Other (please specify)

7.13 Thinking about the last school year, which of the following were used to provide teachers in this school with time for in-service (professional development) workshops/teacher study groups that included a focus on science content and/or science instructions regardless of whether they were offered by your school and/or district? ***(Select all that apply).***

7.13.1	Early dismissal and/or late start for students
7.13.2	Professional days'/teacher work days during the students' school year.
7.13.3	Professional days/teachers work days before and/or after the students' school year.
7.13.4	Common planning time for teachers
7.13.5	Substitute teachers to cover teachers' classes while they attend professional development.

8. Do any teachers in your school have access to one-on-one "coaching" focused on improving their science instruction?

8.1.1 Yes...........

8.1.2 No............ (Skip to 9)

8.2 To what extent is science-focused one-on-one coaching in your school provided by each of the following (*select one on each row).*

	Not At all		**somewhat**		**to a great extent**
8.2.1 the principal of your school	1	2	3	4	5
8.2.2 Head of Science at your school	1	2	3	4	5
8.2.3 district administrators including science subject advisors	1	2	3	4	5
8.2.4 teachers/coaches who do not have classroom teaching responsibilities	1	2	3	4	5
8.2.5 teachers/coaches who have part-time classroom teaching responsibilities	1	2	3	4	5
8.2.6 teachers/coaches who have full-time classroom teaching responsibilities	1	2	3	4	5

SECTION D: GENERAL FEELING ABOUT THE NEW CURRICULUM AS PRESENTED IN CAPS (PHYSICAL SCIENCES).

9. The statements below describe general feeling about the new curriculum in Physical sciences as depicted by CAPS. For each respond as strongly agree, disagree, agree, strongly agree, uncertain or no response.

9.1 It was a mistake to have introduced the new topics

9.2 The new topics help to make science more relevant to students

9.3 The new topics are an extra burden on Physical science teachers

9.4 I see no reason to teach a new topic if it is not going to be examined in the National Senior Certificate examinations

9.5 The new topics have concepts which are difficult for me to understand

9.6 I struggle to make the new topics understandable to students

9.7 It is more demanding to find ways to teach the new topics compared to the old topics

9.8 I spend more time in planning lessons to teach the new topics compared to the old syllabus

9.9 My students find the new topics interesting

10. For the following question***, select all that apply.***

I can benefit from additional content-specific professional development in Physical science:

10.1 CAPS for Physical science
10.2 Inquiry-based instruction
10.3 Content-based reading strategies
10.4 Using standards-based/Performance-based assessment and grading
10.5 Progress monitoring tools to inform instruction
10.6 Effective use of curriculum tools (curriculum maps and technology tools)
10.7 Science curriculum resources (new science textbooks)
10.8 Unpacking standards/writing learning goals and scales
10.9 Others please specify..

APPENDIX B:

INTERVIEW SCHEDULE FOR FET PHYSICAL SCIENCES TEACHERS

SECTION A: INFORMATION ABOUT AN EDUCATOR

1. What grades are you teaching in?
2. How long have you been teaching in those grades?
3. Have you undergone any subject-specific training in FET Physical sciences in the past three years?

SECTION B: PROFESSIONAL DEVELOPMENT TRAINING

4. Can you elaborate on the contents of training that you received?
5. Who provided the training?
6. How often were these types of training?
7. After the above-mentioned training sessions, would you say you are confident to deliver teaching?
8. Have there been any follow-up training sessions that occurred?
9. In your opinion, do you feel the INSET training that you received is enough?
10. Do you think other stakeholders such as NGOs, university lectures or curriculum developers should have been included in the INSET?
11. What topics/themes would you like to be included in the INSET?

SECTION C: TEACHERS' PERCEPTION ABOUT CAPS/NEW CURRICULUM

12. What are your views on the new topics that have been introduced as per CAPS?
13. Do you feel confident in teaching these new topics?
14. Do you do anything different in planning your lessons on the new topics?
15. Which further skills would you like to acquire in order to be an effective Physical sciences educator?

APPENDIX C:

INTERVIEW SCHEDULE FOR THE SUBJECT ADVISOR

The following were guiding questions as the interview was an open interview (unstructured).

1. Can you kindly summarize your duties as a physical sciences subject advisor in this district?
2. Is it possible for you to offer support to all your teachers?
3. How do you support physical sciences individually in your jurisdiction?
4. How often do you visit them in their respective schools?
5. What types of professional development programmes do the department of education provide to physical sciences teachers?
6. In your opinion, do you think the professional development programmes are enough?
7. What is your opinion on caps?
8. If you were to suggest some improvements on caps (in terms of content, workload and assessment), what can they be?

APPENDIX D: APPROVAL FROM THE DEPARTMENT OF BASIC EDUCATION

Enquiries : MS Mokgobo /rf
Reference:

education
Department of Education
FREE STATE PROVINCE

24 February 2014

MeMB Maope
19 Lark Street
Flamingo Park
WELKOM
9459

REQUEST TO CONDUCT RESEARCH AT SCHOOLS

1. Receipt of your communiqué regarding the above-mentioned is hereby acknowledged and has reference.

2. Permission is hereby granted to you to approach Schools in the Lejweleputswa Education District to conduct research for your studies.

3. However, permission is granted on condition that the activity will not interfere with the smooth running of the school.

4. Learning and teaching time should be protected at all costs and therefore we suggest that activities are arranged for after school hours.

5. It is also imperative that proper arrangements and consultations are done with the Principals of the Schools.

6. Hoping you will find this to be in order.

MS MOKGOBO
District Director

Lejweleputswa District, Private Bag X30, Welkom, 9460
Anmercosa House, Cnr Stateway and Tulbach Street, Welkom
Tel: (057) 3917200 Fax: 0865191639

APPENDIX E: LETTER TO PRINCIPALS

19 Lark Street

Flamingo Park

Welkom.

9459.

The Principal,

....

....

....

Dear sir/madam,

RE: PERMISSION TO CONDUCT RESEARCH IN YOUR SCHOOL

I hereby ask for permission to conduct educational research in your school. I am presently busy with my THESIS, a compulsory requirement towards the completion of a PhD in Education at the Central University of Technology (Welkom campus).

Attached is a letter granting permission to conduct research in the Free State Department of Education.

The topic of my Thesis is: **Towards the development of a quality external support framework for the Further Education and Training (FET) Phase Physical Science teachers in the Lejweleputswa District - Free State province.**

I am prepared to observe the following stipulations:

1. Participation in the research will be voluntary.
2. Questionnaires will be administered during non-teaching hours.
3. All information obtained will be treated confidentially and used for academic purposes only.

Yours sincerely,

Maope MB

APPENDIX F: LETTER TO PHYSICAL SCIENCES TEACHERS

Central University of Technology

School of teacher education

Welkom Campus

<u>CONSENT LETTER TO PHYSICAL SCIENCE TEACHERS</u>

Lejweleputswa district

Dear colleagues,

I am hereby humbly requesting your participation in the educational research that I am conducting in this district. I am a part-time lecturer at the Central University of Technology, in the school of Teacher Education. I am busy with my Thesis, a compulsory requirement towards the completion of a PhD.

The topic of my research is:

Towards the development of a quality external support framework for the FET Phase Physical science teachers in the Lejweleputswa district.

I am prepared to observe the following stipulations:

1. Participation in the research is voluntary.
2. Questionnaires will be administered during non-teaching hours
3. All information obtained will be treated confidentially and used for academic purposes only.

Yours sincerely,

Maope MB

Student number: 212087738

NB

Each colleague who participates in this study will receive a CD containing all the Grade 10, 11 & 12 Physical Science content (activities, practical work) PowerPoint slides.

APPENDIX G

DECLARATION

This is to certify that I have edited (proof-read) **Mrs. Maope's** Thesis which excluded the references and appendices.

I hold a Master's Degree in English Education from Atlanta University in United States of America (1990).

Most of the work I have done at the Lesotho College of Education, where I was employed for 20 years involved a lot of editing different pieces of work inclusive of Thesis. I was a member of the Evaluation and Research Committee where I was a Chairperson.

My editing experience covered the following activities:

- Edited Research paper to be presented at Conferences.
- Application letters for Senior Academic staff were assigned to me to find the merits and demerits of each applicant.
- Edited the Rector's speech for the graduation ceremonies.
- I was also responsible for editing a college magazine run by the English Department students for the college before its publication.
- I have edited three Thesis for different lecturers in the Science Department for Doctorate Degrees, two for Technology Department Lecturers and two for English Language.
- In addition to this, I have read and edited about six Thesis papers for different individuals.

Thank you.

Yours Sincerely,

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