A PROFESSIONAL DEVELOPMENT FRAMEWORK SUPPORTING LIFE SCIENCES EDUCATORS’ PEDAGOGICAL CONTENT KNOWLEDGE IN THE RELATIONSHIP BETWEEN THE HUMAN NERVOUS SYSTEM AND THE ENDOCRINE SYSTEM

by

NATHASIA NAIDOO

Submitted in full requirement for

DOCTOR OF PHILOSOPHY
IN MANGEMENT SCIENCES:
HUMAN RESOURCE MANAGEMENT

in the

Department of Human Resource Management
Faculty of Management Sciences

at

DURBAN UNIVERSITY OF TECHNOLOGY

SUPERVISOR: DR. M. LOURENS

NOVEMBER 2021

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ABSTRACT

The aim of this study was to determine whether current professional development programmes are effective for Life Sciences educators within the Kwa-Zulu Natal Department of Education to gain pedagogical content knowledge. The main problem focused on the quality of education determined by the quality of educators who are knowledgeable of the content and knowledgeable about strategies to be used to convey learning of the content. An objective of the study included determining whether current Life Sciences educators gain aspects of pedagogical content knowledge through teacher professional development programmes. The objectives also included the development of a Conceptual Framework Model to improve Life Sciences education.

The study made use of a quantitative research methods approach. A structured questionnaire in the format of scaled questions namely the Linkert scale was used. The target population comprised of 210 Life Sciences educators in the Umlazi District of the Kwa-Zulu Natal Department of Education. For the purpose of pre-testing, 10 samples were randomly selected. Therefore, from a target population 200 Life Sciences educators, 132 samples were randomly selected for the purpose of this study. A total of 127 questionnaires were returned by the sample respondents, providing a high response rate of 96%.

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 26.0.0. Results were shown as descriptive statistics of the quantitative data obtained in the form of graphs, cross tabulations and other figures. The use of correlations and chi-square test values were interpreted and used to test the 10 hypotheses for various components of this study. The researcher observed some significant results from the data analysis which included: more than 40% of respondents required a form of professional development to improve pedagogical content knowledge and that more than 40% of teacher training workshops need to be aspect specific. This study culminated with proposals for future research in this field of study.

DECLARATION

I hereby declare that the thesis submitted for Doctor in Philosophy Degree in Management Sciences: Human Resource Management in the Department of Human Resource Management, Faculty of Management Sciences at the Durban University of Technology is my original work in the text and the bibliography and has not been submitted to any other institution. I further declare that all sources cited or quoted are indicated and acknowledged in the bibliography.

Nathasia Naidoo
Student No: 21751994

DEDICATION

This study is dedicated to very extraordinary people, my parents Mother and Father "thank you for motivating me, your constant encouragement and unconditional love which you have given me helped me in completing my study", my children Yashodhan and Abigail "thank you for your support and patience during this time and for being my light at the end of the tunnel".

Thank you for believing in me.

ACKNOWLEDGEMENTS

It is my deepest appreciation and indebtedness that I acknowledge those who have motivated and supported me throughout this learning process. First and foremost my sincere gratitude is given to my Supervisor, Dr.M.Lourens. Thank you for your guidance and encouragement. Her encouragement and professionalism assisted me to progress in spite of obstacles that prevailed. Her constant encouragement and drive for success were praiseworthy. This PhD thesis would not have been possible without the assistance of the following: Mr Deepak Singh, for his expert analysis of the data and his advice on the presentation of the results; Mrs Mitha for her assistance with referencing skills; Mrs Mercilene Matthews for her services in language editing the whole thesis; my friend Navendran Nair for his computer technology assistance in the design of my thesis; the Kwa-Zulu Natal Department of Education for giving me permission and the DUT Ethics Committee for giving me ethical clearance to conduct this investigation with Life Sciences educators in the Umlazi District, who completed the questionnaire. At the home front I would like to express my sincerest thanks and appreciation to my Mum, Santha Naidoo and late Dad, Joe Appalsamy for always believing in me and encouraging me to pursue my dreams, my children Yashodhan and Abigail for their encouragement, support and tolerance of me, my Sister Priya Naidoo, and MuthuRaja Ramalingam. Above all I would like to thank God for giving me the energy and endurance to complete this study.

Om Namah Shivaya.

LIST OF ACRONYMS

ICT	Information Computer Technology
CAPS	Curriculum and Assessment Policy Statement
NCS	National Curriculum Statement
NSC	National Senior Certificate
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
PCK	Pedagogical Content Knowledge
TPACK	Technological Pedagogical Content Knowledge
DoE	Department of Education
KZN DoE	Kwa-Zulu Natal Department of Education
DBE	Department of Basic Education
SACE	South African Council for Educators
CPTD	Continuous Professional Training and Development
CDE	Centre for Development and Enterprise
PGCE	Postgraduate Certificate in Education
BEd.	Bachelor of Education
SPSS	Statistical Package for Social Sciences

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CHAPTER ONE:

BACKGROUND AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The school system is evolving globally, as the needs learners within the learning spectrum changes. This results in an evolution in the expectations of teaching by educators. The South African education system also sees this evolution and needs to embrace it. According to the Organisation for Economic Co-operation and Development (2009:3), educator pre-service training, no matter how good, will not be able to equip educators for the hurdles they may encounter in the classroom. DeMonte (2013:1) states that continual interest in educator training a form of professional development is needed to transform pedagogy and develop classroom objectives. Experience is not necessarily a precursor to better methods of instruction.

In order to be as effective as possible, educators must broaden their knowledge and abilities to integrate best practices. Xing and Marwala (2017:10) state that the needs of the workplace such as schools must be transformed according to the outcomes of the Fourth Industrial Revolution (4IR). The authors emphasise that education is required to adapt to economic and government issues, but the move towards 21st century needs, shift the education system to lead the social issues such as poverty as well as economic issues resource and under-resource schools such as within the country.

The integration of 4IR skills into teaching and learning strategies will surely impact on how people live, learn and work. Goldschmidt (2017:1) highlights that the 21st century has seen the rise of a highly informed generation, that is interconnected. Individuals' lives increasingly depend on information technology, thus impacting on the way people live and relate to one another. The fourth industrial revolution is the future of man and technology.

The infrastructure of many schools is inadequate and schools struggle for basic resources to ensure effective teaching. Hence the professional development of teachers to adapt teaching to circumstances is crucial. The education system must evolve to equip educators to impact and prepare learners through teaching and learning for the future. Basic education and higher education curricula must be reformed to incorporate technology as technology becomes part of every field of life.

Almasaeid (2014:134) highlights that traditional teaching methods have a limiting effect on learners as the entire learning process depends on the educator. This is supported by Gambari, Yaki, Gana and Oghovwa (2014:79) who emphasise that traditional learning is through the direction and instruction of the educator at all times. Khurshid and Ansari (2012:47) believe that the one-way transmission of knowledge which is theory-based is least concerned with understanding.

There is a definite need to develop 21st century skills through education to ensure future labour (Goldschmidt 2017: abstract). The future of education is a hybrid of digital technology and human interaction in teaching. Embracing teaching as an instrument of empowerment in the classroom can be enhancing (Doucet, Evers, Guerra, Lopez, Soskil and Timmers, 2018:2). The use of a variety of teaching strategies to promote the construction of knowledge in Life Sciences excites and attracts many learners to the subject learning area, be it through scientific inquiry or integrated computer technology.

The level of learner performance in Life Sciences is directly linked to the quality of Life Sciences educators, where Life Sciences educators are well developed in their pedagogical content knowledge. Educators are directly impacted by the curriculum and any changes that may occur therein. South Africa has seen many education reforms post 1994. Outcomes Based Education (OBE) mainly focused on the outcomes being assessed, followed by Curriculum 2005 which was created with the purpose of improving the education quality for all South African learners. The National Curriculum Statement followed in 2002, which was revised to the present day education policy Curriculum and Assessment Policy Statement (herein after referred to as CAPS).

Therefore, the professional development of educators needs to enable educators to learn new knowledge and skills and to transfer these into their practice. There are many forms of professional development for educators in South Africa. A study carried out by Cronje (2011:8) revealed that the Department of Education in South Africa outlines the professional development of educators for the preparation and implementation of the policy documents to facilitate teaching and learning. Interviewees mentioned that information was received via circulars and pamphlets, whilst some indicated that they never attended the training workshops, or that the training workshops did not cover the subject area that the interviewee was teaching, especially content knowledge, which was highlighted as a need by all interviewees in this study.

This study aims to determine whether current Life Sciences educators possess the necessary content knowledge to successfully facilitate knowledge construction, and whether they are equipped to choose the appropriate strategies of conveying this knowledge to learners by means of a quantitative study in the form of a questionnaire.

The study will add value to the education system by determining whether current professional development programmes contribute to the pedagogical content knowledge of educators and determining which aspects of pedagogical content knowledge need to be developed. The conceptual framework linking professional training and development to improved Life Sciences Education output focuses on factors that contribute to the professional development of Life Sciences educators. This conceptual framework will provide an overview on how the factors influence one another, with the aim of improving learner output in the subject.

1.2 BACKGROUND TO THE STUDY

Over the years, the South African Education system has evolved according to the social and political needs of the country. Nineteen ninety-four saw the rise to a democratic South Africa where education would be equal for all children. However, this meant that the education curriculum would need to be adjusted. The pre-1994 curriculum was created and implemented by the nineteen different education departments of South Africa. The general policy was however determined by the Department of National Education. The other eighteen departments comprised of ‘own affairs’ and other racially divided education departments, including the four provincial departments (Natal, Cape, Transvaal and Orange Free State) under the Department of Education and Culture (NEPI, 1993:104). Mission schools were taken over by the state in 1948 and the Bantu Education Act of 1953 came into existence thereafter. This act allowed the state complete control of mission schools. Homeland schooling was referred to as Bantustans and teacher training colleges were established to produce educators for this system. Although educator training expanded in the Bantustans for Black African educators, the quality of education deteriorated over time. In the 1960s, the number of Black African educators possessing university degrees fell (Chisholm, 2012:85).

Post-apartheid saw a restructuring of the South African education system. Chisholm (2012:91) highlights the change from a nineteen department system to one national department responsible for policy, framework, monitoring and evaluation, while the nine provincial departments were responsible for implementation. Many curricula were tried and tested, from Report 550 which was outcomes based in 1997 to C2005 in 2005 to the National Curriculum Statement in 2002, which was revised to the present day education policy ‘Curriculum and Assessment Policy Statement’ (here in after referred to as CAPS) (Du Plessis, 2013:1). The curriculum is focal to education with reference to the teaching and learning activities within schools. Activities revolve around the aims and objectives of teaching, content being selected, pedagogy and types of assessment activities (NEPI,1993:102). The curriculum has undergone numerous revisions in South Africa's educational system.

Curriculum reforms referred to the issue that educators needed to be up to date with changes that needed to be implemented in the classroom. Educators needed to adapt themselves by improving their quality, as this impacted on the teaching and learning process. According to Onwu and Sehoole (2011:122), an audit conducted in 1995 on educator quality concluded that the biggest problem facing the educator sector was the quality of educators and the educator training programmes on offer. Mukeredzi (2009:33) explains that professionally unqualified individuals as those who are not officially competent to perform given activities. Mukeredzi (2009:36) further states that a professional educator is one who has acquired the required academic qualification and training and understands facts and information.

An article in Times Live (Savides, 2017) highlights the current plight of South African schools regarding the qualification status of educators. A notable 5 139 educators were either unqualified or underqualified. Statistics improved slightly over the years because in 2014 there were 6 719 underqualified or unqualified educators and 6 030 in 2016. Savides (2017) further stated that crucial subjects such as Mathematics and Sciences were the hardest hit. Coetzee (2015: abstract) indicates that quality teaching is directly affected by underqualified or unqualified educators teaching a subject.

Life Sciences is a subject that is a prerequisite for various fields of post-matric studies such as Nursing, Agriculture, Medical Sciences and Sports Management amongst many more. Learner performance in the subject determines acceptance into these fields of study. Moreover, the level of learner performance is directly linked to the quality of Life Sciences educators. Additionally, educators are directly impacted by the curriculum and any changes that may occur therein. The Life Sciences CAPS document (formerly known as the Biology teaching subject) highlights the purpose of studying the learning area as developing scientific knowledge; developing scientific processing skills and developing a following of the societal role of science (Department of Education, 2011a:5). Support needs to be provided to educators in order for them to implement the aims of the policy. Educators teaching this subject area should have content knowledge of the topics to be taught; be able to determine the pedagogy to be used; and choose appropriate assessment techniques, all of which form part of implementing the curriculum.

Educators are the primary agents of education, hence the development of quality educators is a primary condition for education transformation (NEPI, 1993:235). Findings by Scott (2013: abstract) indicate that educators having a BSc degree might be beneficial to their conceptual understanding in the profession. At higher education institutes, the school Life Sciences curriculum requires educators to be able to integrate knowledge from various domains of scientific knowledge. Research has shown that the educators who participated in a study had different views, implying that trained and educated educators could experience problems with implementation in the classroom (Booi, 2017:1). Tertiary education systems do not seem to complement what is required in the classroom, leaving the certified, qualified educator as unskilled in performing their duty.

Professional development through the training and development of educators is necessary to equip educators for implementation in the classroom. Educators need to be professionally developed on aspects of the curriculum, namely assessment, content and pedagogy (teaching methods). Traditional teaching methods do not promote learners to participate and construct the understanding needed to study the Life Sciences learning subject. The one-way transmission of knowledge which is theory based is least concerned with understanding (Khurshid and Ansari, 2012:47). Studies conducted by Almasaeid (2012:133) and Gambari et al. (2014:78) found that a move away from traditional teaching methods impacted on learner achievement, understanding and their attitudes towards learning. Therefore, there is a necessity to improve the quality of Science education by improving the quality of Science educators. As a result, there is an ongoing need to create programs to develop Life Science educators on key factors such as content knowledge and teaching methodologies, with the aim of supporting learners academically.

Science educator education and development is not only a South African problem, but affects other countries globally as well. Although the South African Department of Education has devised many policies to address the continuous need for teacher support, many more development programmes are needed.

In experimental research conducted to analyse the psychological effects of educators' behaviour and teaching styles on learners' learning, it was found that the use of innovative strategies enhanced the cognitive levels of learners (Khurshid and Ansari, 2012:52). The use of a variety of teaching strategies to promote the construction of knowledge in Life Sciences excites and attracts many learners to the subject learning area, be it through scientific inquiry or integrated computer technology. Consequently, educators' content knowledge and their appropriate use of teaching methodologies influence their teaching practices and learner performance.

South African education presents with multi-cultural classrooms; often over-crowded classrooms; and under-resourced Science subject departments. Providing professional development for educators, to adapt the aspects of the curriculum to these daily challenges will improve the quality of educators and the quality of the teaching and learning process.

1.3 DEFINITION OF KEY TERMS

Clarification of terms listed below are to introduce terms at this point, while detailed descriptions of the concepts follow in the literature review.

1.3.1 Pedagogy or Teaching Strategies

A teaching strategy is defined as "the use of instructional methods in the classroom to accomplish understanding of the course content, goals and actively engage in learning" (Tewksbury and MacDonald 2005:np). "Teaching is a process which involves attempts by a teacher to bring about understanding of content to learners, by making use of teaching techniques which include teaching material and knowing the subject matter in order to achieve the set objectives" (Clark and Starr 1996:70).

1.3.2 Pedagogical Content Knowledge (PCK)

The term pedagogical content knowledge was first used in 1986 by Lee Shulman. He described pedagogical content knowledge as being ways that educators would represent and formulate subject matter that makes it understandable for others (Shulman 1986:9). This understanding is further explored by Schneider and Plasman (2011:533) who state that PCK is heuristic for teacher knowledge, about what educators know about teaching and how it changes over time.

1.3.3 Knowledge

Knowledge is defined as understanding and adding awareness of a subject gained through experience or study (Van Staden, 2009:7). Henry (2012:1) highlights that knowledge is a changing system with interactions amongst experiences, skills, facts, relationships, values, thinking, processes and meanings.

1.3.4 Knowledge Worker

Knowledge workers are highly educated, have superior interpersonal communication skills and are able to digest and process information better than most (Denson 2012:7). Education, training and learning is part of the development process of any knowledge worker, whereby formal and informal training is a lifelong process (Van Staden 2009:35).

1.3.5 Learning

Killen (2011:3) describes the learning process as making connections and identifying patterns. Abdulkarim and Jadiry (2012) cite Vygotsky (1978), who explains that individuals learn and work co-operatively throughout their lives and not in isolation. Killen (2011:7) explains that learning is not a passive process of simply receiving information but involves deliberate, progressive construction and a deepening of meaning.

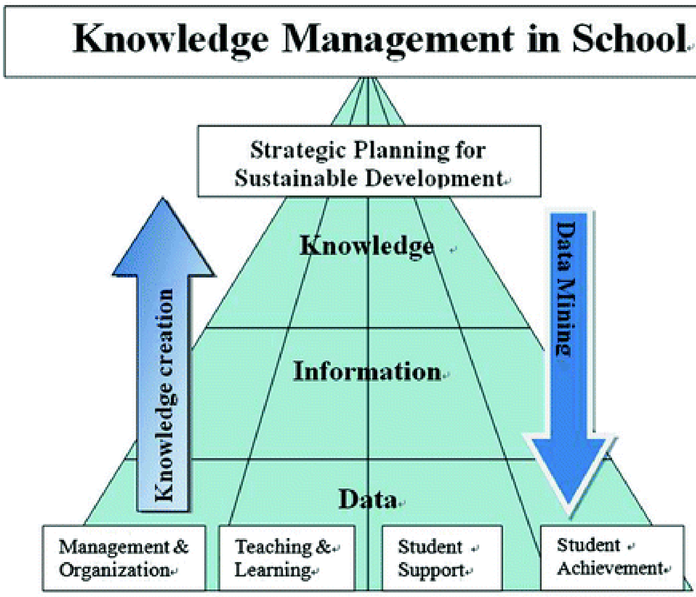
1.3.6 Teacher Professional Training and Development

Keke (2014:18) defines educator professional development as the processes and activities engaged in by educators that enhance professional career growth.

1.4 RESEARCH PROBLEM STATEMENT

The quality of education is derived from many factors such as curriculum, socio-economic factors, resources as well as the quality of educators who are knowledgeable of the content. Van Staden (2009:7) defines knowledge as understanding and adding awareness of a subject, gained through experience or study. Knowledge workers are an integral part of any workforce. Knowledge workers are highly educated, have superior interpersonal communication skills and are able to digest and process information better than most (Denson 2012:7). Van Staden (2009:i) posits that the worker needs to be able to deal with large amounts of information, analyse and then generate knowledge out of this vast wealth of data. A school runs as a business, thus Henry (2012:4) highlights that a decline in returns may arise should relevant and timeous steps not be taken towards knowledge work management. It is the responsibility of the management to ensure that educators gain knowledge through training and development in order to become vital assets as knowledge workers.

FIGURE 1.1: KNOWLEDGE MANAGEMENT IN SCHOOL



SOURCE: Cheng (2015)

Figure 1.1. represents knowledge management in schools, where the management and organisational teams are accountable for evaluating the knowledge requirements of educators in order to obtain knowledge systems thus enabling educators to evolve knowledge. The knowledge gained impacts on teaching and learning in the classroom as well as on learner support mechanisms, which ultimately impact on learner achievement.

Quality educators can select appropriate teaching strategies to promote the learning of content amongst learners. In a background paper prepared for UNESCO, it was shown that to improve the quality of education, focus should be on improving teaching and learning while paying attention to factors such as teacher competencies (Barrett, Ali, Clegg, Hinostroza, Lowe, Nikel, Novelli, Odura, Pillay, Tikly and Yu, 2007:3). Teacher competencies is one of the factors that directly impact learner performance levels.

According to Van Staden (2009:35), education, learning and training are aspects of the growth process of a knowledge worker. The author also highlights that training, whether formal or informal, is an ongoing process in life. Due to technological evolution in today's working environment, employees need to be skilled in an efficient manner so that outcomes are achieved. Van Staden (2009:41) states that knowledge workers such as educators enter the world of work, while continuing education that is expected to make certain that their knowledge is current. Hartoyo (2017:141) affirms that training is intended to improve the mastery of various skills and techniques of routine work implementation.

In order to find the most strategic training and development program for teacher knowledge workers, the management team must be able to determine the knowledge needs of educators. This is supported by Ludwikowska (2018:180), highlighting that training as a method is an ideal approach for developing employees' skills and bridging gaps in their levels of competency. Hartoyo (2017:140) states that needs assessment is a deliberate method to determine the appropriate training program for employees.

Within the education sector, Mathematics and Science education are major cause for concern. Martin, Mullis, Foy and Stanco (2012:41) reported on Trends in International Mathematics and Science Study (herein after referred to as TIMSS) 2011 indicating that South Africa was placed second to last out of 40 countries in the Grade 8 Science studies. This raises concern and a red flag for urgent intervention of training and development of Mathematics and Science educators.

The Grade 12 National Senior Certificate (hereinafter referred to as NSC) performance trends for 2013 – 2016 for Life Sciences show a decline in the number of learners who achieved 30% and above (Department of Education 2017:115). The National Senior Certificate Diagnostic Report 2021 for Life Sciences also shows a decline in the number of learners who achieved 30% and above for the years 2017-2021 (Department of Education 2022:148) The analysis of learner performance in Paper 1 and Paper 2 for the NSC Life Sciences matric exam 2016 reports a lack of basic knowledge of terminology, which impacted negatively on other skills being tested (Department of Education 2017:116 and 123).

This study focuses on The Human Nervous System and The Endocrine System learning areas. It is crucial to note that in the report data from a sample of candidates reflected, average marks per sub-question is shown as a percentage. It was found that the lowest average percentage of marks attained (31%) was reflected in the question on Pollution, followed by The Eye (32%); Motor Neuron 34%, whilst only 44% was achieved in the essay on Hearing and Adrenalin (Department of Education 2017:117). The report suggests that educators need to employ teaching strategies to remedy these problems (Department of Education 2017:118). The sections on The Nervous System and Endocrine System seem to pose a problem to learners, especially when they are required to show the relationship between these as systems, as per the essay question.

Educators must possess the ability to teach, which is the use of appropriate teaching methodologies to attain learner understanding. Emphasis in the present day classroom is placed on the construction of knowledge. Many recent studies have been conducted on teaching strategies in secondary school subjects, but there is less focus on the sciences. In an investigation carried out into learning and teaching problems with Biology (Life Sciences) in Transkei Senior Secondary Schools, Matoti (1990:12-13) found that of 124 Matric Biology teaching educators, 67.7% had Matric as their highest qualification and 59.7% had 1-5 years' teaching experience. Matoti (1990) therefore concluded from evidence that amongst over-crowded classrooms and a lack of facilities, underqualified educators was another problem. Too many educators did not possess content knowledge skills on how to teach, which impacted on the success of learning.

1.5 AIMS AND OBJECTIVES

This study aims:

(i) To ascertain whether current Life Sciences educators gain aspects of pedagogical content knowledge through teacher professional development programmes;

(ii) To determine the type of pedagogy most commonly used in present day Life Sciences lessons; and

(iii) To develop a professional training and development framework for Life Sciences Educators' Pedagogical Content Knowledge in teaching the relationship between the Human Nervous system and the Endocrine System.

The objectives that the researcher will undertake are as follows:

- To review literature on aspects of teacher knowledge and training and development models that may influence the teaching and learning process;

- To explore the variety of teaching methodologies / pedagogies that may be used when teaching the Human Nervous System and the Endocrine System;

- To investigate the viewpoints of Life Sciences educators on training and development programmes offered by the Department of Education, which they have attended; and

- To develop a Conceptual Framework Linking Professional Training and Development to Improved Life Sciences Education Output from reviewed literature.

1.6 RESEARCH QUESTIONS

I. Do current Life Sciences Educators possess content knowledge-related qualifications?

II. Which training and development models are able to guide the development of the researcher's Professional Development Framework?

III. What is the evaluation result of training and development programmes attended by Life Sciences educators?

IV. What are the current teaching methodologies being used to achieve learner understanding of content?

1.7 SIGNIFICANCE OF THE STUDY

This study will be able to investigate whether Life Sciences Educators possess a form of content knowledge training. It is important to determine this as educators who fully understand the content will be capable of conveying knowledge successfully to learners, as well as answer questions posed to them. This study will also determine the teaching strategies employed during lessons by educators. It is essential to point out that different learners learn differently and should be accommodated during lessons and assessments (Department of Education White Paper 6 July 2001:6-7). This implies that a variety of teaching strategies should be employed that compliments the content being taught and accommodates the learners' learning needs. This study also strives to develop a training and development framework in the form of content and teaching strategies-driven workshops to better equip educators with regard to The Human Nervous System and the Endocrine System. The research also aims to develop a monitoring tool in the form of a questionnaire to assess the impact of the workshop.

1.8 SCOPE OF THE STUDY

This research study is confined to the South African Department of Education, with particular reference to Life Sciences educators. A sample of 145 samples educators will be randomly selected from a population of 230 Life Sciences educators in the Umlazi District of the KwaZulu Natal Department of Education. The researcher selected this district as Life Sciences educators within this district belong to schools that extend along the South Coast of Durban to the Durban Central Area, as well as the North Coast of Durban. This study also aims to develop a training and development framework to workshop current Life Sciences educators on the content knowledge specific to The Nervous System and Endocrine System by exploring, analysing and reviewing already existing professional development models and frameworks both nationally and internationally. A monitoring tool to assess the impact of the training and development framework will also be formulated. Cronje (2011:8) highlights that training workshops facilitated by the Department of Education cover policy aspects and do not address the skills and knowledge of educators. This supports the notion that there are limited professional development programmes promoting content knowledge and related teaching strategies. A pre-coded structured questionnaire will be distributed by the researcher. The data will be recorded to create a data set. The data set will then be statistically tested using more robust tools of parametric tests with the aid of the Statistical Package for the Social Sciences (SPSS) version 24 for Windows.

1.9 POTENTIAL VALUE OF THE STUDY

- To provide information regarding the need for pedagogical content knowledge professional development for Life Sciences educators;
- To create a training and development framework for the professional development of Life Sciences educators within a specific topic of the subject area; and
- For the KwaZulu Natal Department of Education to acknowledge and employ the use of the pedagogical content knowledge professional development framework for Life Sciences educators, allocating to it CPTD points, which is what all educators are required to attain.

The expected effects of this research study would be to improve pedagogical content knowledge on the topic of Life Sciences, which would impact the classroom by improving teaching and learning.

1.10 LITERATURE REVIEW

1.10.1 The Life Sciences curriculum and assessment policy statement

As South Africa undergoes various social and economic changes, one also sees changes in the South African educational system in terms of curriculum. The Curriculum and Assessment Policy Statement (CAPS) for Life Sciences was implemented in 2012 (for Grade 10), 2013 (for Grade 11) and 2014 (for Grade 12) as part of the curriculum reform. The National Curriculum Statement for Grades R-12 emphasised the shift away from traditional autocratic pedagogy and towards an active process in which learners build knowledge.

The NCS Grades R-12 serve to "equip learners irrespective of their socio-economic background and diversities with the knowledge, skills and values necessary for meaningful participation in society" (Department of Education, 2011a:4). The importance of assessment in the learning process cannot be over-stated. To determine a learner's degree of comprehension, the educator is supposed to employ a variety of assessment methods or procedures.

In order for a learner achieve the specific aims of CAPS in Life Sciences, the teacher must be competent to use methods that are appropriate to scientific enquiry. The Department of Education Policy Document highlights: “the purpose of studying Life Sciences is for learners to develop scientific knowledge and understanding, to develop scientific process skills and to develop an understanding of science’s role in society” (Department of Education, 2011a:8).

Booyse and Du Plessis (2014:43) state that the inspiration for education that arose focused to combine education and training into a lifelong learning system. Educators, as life-long learners, constantly update their knowledge and abilities to stay up-to-date with curriculum changes, ensuring that learning in the classroom is a productive and constructive process. Moodley (2013:21) highlighted that it was difficult to switch from a traditional teacher-centred to a more learner-centred teaching style.

Research by Ipinge and Likanda (2012) as well as Raselimo and Mahao (2015) on the Curriculum and Assessment Policy Statement (CAPS) in Namibia and Lesotho found that there is shift towards assessment as part of the teaching and learning process. Within this curriculum is the focus on learner-centred learning moving away from the traditional teacher-centred one-way transmission of knowledge.

The researcher also found that Australia, Finland, Singapore, Japan, Canada and China encourage advanced current skills, having guidelines for the curriculum at a national level. However, only one provided a holistic core curriculum. Australia looks at being able to compete in the global economy on knowledge and innovation, emphasising literacy and numeracy (ACARA (2014:1); OECD (2013:6); OECD (2010:160); OECD (2018:np); OECD (2019:3); OECD (2015:np)).

1.10.2 Knowledge

In order to become a knowledge worker, an individual must first gain knowledge. Henry (2012:1) explains that knowledge is a changing system with interactions amongst experiences, skills, facts, relationships, values, thinking, processes and meanings. Additionally, Van Staden (2009:7) highlights that knowledge is an understanding, adding familiarity and awareness of a subject through experience.

However, Heibibi, Rami and Milicievic (2019:119) state that knowledge can be defined as a synthesis of information, professional and research knowledge and experiences that have practical value. They further break down knowledge into general knowledge and special knowledge. General knowledge refers to the knowledge of some areas that are in principle the subject of interest of the wider population and as such is available to everyone. Special knowledge refers to the knowledge of some narrow areas of interest, which is not available to everyone (Heibibi, Raimi and Milicievic, 2019:120).

Akure (2015:26) recognises that knowledge can be seen as the associations that people form from information and its possible applications. Akure (2015:26) also provides a description of knowledge as personalised information that is refined and understood in the minds of individuals.

Researchers often refer to types of knowledge as being either explicit or focal knowledge or tacit knowledge. Mostert and Snyman (2007:5) summarise that "tacit knowledge consists of an individual's memories of his or her experiences of the external environment". They also describe tacit knowledge as a highly individualised source of theoretical knowledge and experimental knowledge, obtained through years of experience. Akure (2015:30) states that tacit knowledge is the type of knowledge that resides within the human mind and is made up of conceptual and sensory information that is embodied in personal experiences, beliefs, values, preferences, intuitions and insights.

Mostert and Snyman (2007:5) describe explicit or focal knowledge as the object or phenomenon that is in focus. The authors indicate that focal knowledge is selected from the person's database of knowledge to relate to a particular situation at hand. Akure (2015:30) posits that explicit knowledge refers to knowledge that is transferrable in formal, systematic language and highlights that this type of knowledge can be easily documented, categorised and articulated into words.

Knowledge workers depend on two types of knowledge. Knowledge obtained through experiences that an individual has and can be documented to be shared with others. The information or data may be general and available to all, or may be more subject specific. New knowledge is built on existing knowledge, which again is documented and shared. The knowledge worker is always busy learning and sharing information.

1.10.3 Knowledge workers and knowledge management

With masses of data available regarding every aspect of life, one can confidently say that this is the age of information. According to Van Staden (2009:11), the knowledge worker is a person with substantial theoretical knowledge and learning. Akure (2015: abstract) states that with an increasing demand for the number of knowledge workers in the workforce, productivity of the knowledge worker has become an imperative management task. Knowledge management refers to the identity, storage and retrieval of knowledge.

Part of managing knowledge is creating a system that allows for the use of knowledge in an organisational manner, such as a teacher in the classroom. This requires recording and storing knowledge; distributing it to others; and creating systems allowing others to use the knowledge in an organisation (Adelstein 2007:5-6). An educator attending professional development programmes should allow for new knowledge to be acquired and constructed, which is stored in the form of handouts or documents. This information adds to existing knowledge and is shared amongst colleagues in the same subject area. The aim of gaining this new knowledge is to benefit the learner in the classroom. Continuous professional development allows the teacher to gain knowledge continuously, thus being termed a 'knowledge worker'. Van Staden (2009:11) explains that the knowledge worker is an educated individual in a specialist knowledge area and possess theoretical, contextual or tacit knowledge. Adelstein (2007:1) acknowledges that knowledge has become a structural asset to be fastened by technology and protected by law even from those who created it.

With the fourth industrial revolution on the doorstep, the individual's thirst for information is quenched. The ongoing extension of computer systems with extensive databases of information allows all access to information and experiences (Cortada, 1998:xviii). Educators seeking information on subject topics or information of how to teach may easily access this on the internet. The system may link to the government education websites, with links to the information required. Gerke and Evers (2006:5) state that as data banks are widely accessible through the internet, it is regarded as globalised knowledge. Educators may be able to find service providers that can assist them to formally gain knowledge through certification. All of this reinforces pedagogical content knowledge, boosting the confidence level of the educator so that learners may be able to construct meaning in the learning process and thus progress.

Over time, countries have evolved into knowledge-based economies where the creation of knowledge playing a role in technological change is the foundation. Knowledge is the key to human development and economic sustainability.

In Albania, the unemployment rate, although decreasing, is still high. In 2017, the youth unemployment rate was 25,9% resulting in individuals accepting jobs way below their education levels. If the employed individuals requested training which could enable them as knowledge workers, they could be easily replaced (Nientied and Toska 2019:6).

The Chinese believe that knowledge and data are becoming principle aspects of global competition and the international economy. This comes as China seeks to become an industrial-based economy, moving away from being an agricultural-based economy, eventually becoming a knowledge-based economy. China's plan to move towards a knowledge based economy includes upgrading economic and institutional systems as well as updating education and training while creating information systems. The key aspect lies in greater investment in education, training, research, development and software (Dahlman and Aubert 2002:3).

The kingdom of Saudi Arabia strives to achieve full employment and aims to achieve this by moving towards a knowledge-based economy, with the requirements of developing scientific education and training programmes aimed at creating knowledge workers. This is meant to be achieved through inculcation of a culture of work, persistence and endurance, creativity and innovation through the different stages of education as set out in Section 10.3.1 of the Ninth Development Plan of the Ministry of Economy and Planning 2010 (James and Alshammari 2017:161).

South Africa is part of a five-member grouping of economies of the world known as BRICS (Brazil, Russia, India, China and South Africa). Brazil, Russia, India, China and South Africa are increasingly gaining importance in global innovation (Vadra 2017:1229). Blankley and Booyens (2010:np) state that policies related to science and technology focus on driving South Africa's change towards an economy that is knowledge-based. The authors also highlight that these policies are created on the foundation of innovation and knowledge, which are basic requirements for the growth of the economy and developing South Africa towards global competition.

These policies should influence the development of education curriculum policies. Once a knowledge worker ethos is instilled in the youth through the application of the education curriculum policies, knowledge building and sharing influences the economy. Vadra (2017:1240) highlights that matters such as finance and the inability to establish areas of knowledge indicators pose stumbling blocks to the advancement of a knowledge-based economy. Investment in human competencies is essential to build a knowledge economy. Ambrosi (2010) posits that South Africa's economy is quickly becoming knowledge inclined, reliant on skilled and knowledge workers. A study conducted by Ambrosi (2010) aimed to determine whether undergraduates in South Africa have the qualities that are expected of knowledge workers. He found that they possess soft skills. Soft skills do not equip the qualified South African undergraduate educator to be effective knowledge workers in the classroom with a drive to improve their pedagogical content knowledge.

In order for South Africa to move forward, investment in educators may be undertaken to ensure continuous professional development to equip the teacher to create a nation of knowledge workers through the construction of meaning in the classroom. Educators who are knowledge workers are confident to guide the construction of knowledge in the classroom and to share their acquired knowledge, thus forming the foundation of a knowledge economy.

1.10.4 Pedagogy

Learning styles differ from one learner to the next, and teaching tactics should reflect this. The varied needs in the classroom are met by integrating approaches to build one effective approach. Youseff and Mohamed (2016:6) believe that the approach adopted for teaching and studying science is one aspect that has led to a low interest in science by learners. Killen (2011:18) emphasises that if educators expect meaningful learning to take place in classrooms, they must actively teach in ways that encourage and inspire learners to participate in academic activities that facilitate quality learning.

In today's world, the emphasis is on knowledge acquisition in the classroom. The acquisition or construction of knowledge saw the move away from rote learning to methods of teaching and learning that involved the learner in the learning process. Matoti (1990:48) supports the notion that educator and educator trainees should be exposed to relevant exercises, which will develop their awareness, sensitivity and competency for diagnosing learner misconceptions. This process would guarantee that their methodology is appropriate in the classroom, allowing for the construction of meaning as the topic is delivered and successful learning takes place.

According to the Department of Education's Policy White Paper 6 on Inclusive Education (July 2001), all schools are intended to be inclusive, acknowledging differences in learners and changing teaching practices to meet these differences. Bojuwoye, Moletsane, Stofile, Moolla and Sylvester (2014:1) feel that it is the duty of schools to promote successful learning by creating a favourable and welcoming learning atmosphere in which learners feel valued; curriculum and instructional methods complement the educational preparation of learners; and educators recognize the individuality of each lesson.

In this study, the researcher explored different pedagogies such as co-operative learning; the use of integrated computer technology; whole class/ small group discussions; scaffolding; and inquiry-based learning. Research shows that each of these pedagogies, if used effectively, stimulates the learning process in a science classroom, allowing learners to construct meaning of the information.

1.10.5 Professional educator training and development

Knowledge workers are individuals who strive to gain knowledge, build on knowledge and share knowledge. Training and development in the form of short courses, formal long courses or workshops serve as the platform where knowledge is gained, built upon and shared. Ludwikowska (2018:180) highlights that currently, training processes and the benefits therefore have become a matter of attention and concern. “Within the South African public school system, professional development is externally driven by the Department of Education” (Govender 2015:487). Educator training is the basis of professional development at various levels. Education of educators is life long process allowing the educator to be professionally developed on a continuous basis.

Education is the spearhead of creating a knowledge-based economy. This is supported by Federica (2018: 962) who states that there is a level of importance to training and development in both the basic education and higher education system for the development towards a knowledge-based economy. The world is shaped by an education system, but in order to transform society, the development of educators must become priority.

Ludwikowska (2018:179) states that training as a method is an ideal approach for developing employees' skills and bridging gaps in their levels of competency. Govender (2015:487) highlights that the Department of Education's introduction Continuous Professional Development for educators does not take into consideration the needs of educators. Govender (2015:492) further indicates that educators engage in different ways of improving their qualifications and developing themselves as professionals.

A study conducted by Makunye (2012) found that the reasons for apathy towards professional development programmes at North-West University; was that their needs do not coincide with the purpose statement of the organisation; there are conflicting commitments; as well as a lack of support and lack of rewards or incentives to attend training. Makhunye (2012) believes that there is a dire need to evaluate the effectiveness of the existing professional development initiatives in higher education.

Chabaya (2017) conducted a study in Zimbabwean State Universities to determine the factors impeding the implementation of academic professional development programmes. The study suggests that faculties with academic professional development programmes should have teaching and learning centres set up. This will lead to the development of a culture that values teaching and learning.

Educators require adequate content knowledge and an understanding of the appropriate teaching strategies to engage learners in an active process of scientific inquiry. The education department has been devising and revising frameworks and policies with the focus of upgrading the quality of educators and to upgrade the calibre of teaching and learning. One such document is the Integrated Strategic Planning Framework for Teacher Education and Development, where the objective to improve the quality of teacher education and development is outlined (Department of Education 2011b:1).

Continuous teacher qualification programmes at DoE level in partnership with DHET (Department of Higher Education and Training) institutes are being revised continuously to improve the quality of currently practicing educators. Mathematics and Science education are the main problem learning areas. It is therefore stated in a Mathematics and Science strategy document that educators without specialised qualifications in Mathematics and Science need to be targeted for in-service training to address the lack of subject knowledge (Department of Education 2001:12). This sentiment was reiterated in a report by the Centre for Development and Enterprise (hereinafter referred to as CDE) (2015:2), which reported that government devised a policy requiring initial teacher education programmes to be re-designed, with particular emphasis on subject content knowledge and how to teach that content knowledge.

In-service training takes place in the form of short training workshops or seminars usually facilitated by subject advisors. Cronje (2011:8) explains that in-service workshops cover policy aspects and do not address the skills and knowledge needed by educators. Educators who attend in-service training are thereafter expected to cascade the information gained to colleagues at school. There is usually no follow up or monitoring process to evaluate the success of the in-service training or to determine whether information was actually cascaded to other educators in a school.

The solution of a change in teaching strategy cannot be fulfilled by a Life Sciences teacher who only employs a traditional teaching strategy of one-way transmission of knowledge. Van Wyk (2013:iv) emphasises that some educators in South Africa did not possess the required pedagogical knowledge and content knowledge to facilitate teaching science at the level of Grade 12. Professional development models to solve the problem of a lack of pedagogical content knowledge in Life Sciences are limited. Teaching strategies have evolved from the traditional one-way transmission of knowledge to a learner-centred approach. Learners are encouraged to construct knowledge guided by educators. Educators require training on what content to teach and how to effectively promote the learning of the content. Cronje (2011:8) highlighted that training workshops facilitated by the DoE cover policy aspects and do not address skills and knowledge of educators. This supports the notion that there are limited professional development programmes to promote content knowledge and related teaching strategies.

The training and development of educators leads to the development of knowledge workers. The demand for knowledge workers is on the rise, hence expertise and career development are needed to make sure that the knowledge of knowledge workers does not become obsolete (Van Staden 2009: abstract). Knowledge workers wishing to be successful are able to see new opportunities of progress and development for themselves. This results in career changes where, in the present day, the trend is many career changes as compared to a lifelong career with one organisation. However, one must understand that being competent at one place does not necessarily imply competence at a higher level of work in the organisation. The Peter Principle states that the skills needed to advance at one level in the organisational hierarchy may be different from the skills needed in the subsequent level (Benson, Li and Shue 2019:1).

Benson, et al., (2019:4-5) explain that organisations are prone to promote those individuals who perform at an excellent level in their current job positions despite their tendency for managing. Being a knowledge worker and undergoing training and development through the organisation will never be enough to equip an individual for the next level of career change, unless individuals make the effort to equip themselves by all available means possible. Decisions about placing people are critical because they determine the performance of the entire organisation (Ghinea, Ghinea and Cantargiu 2019:74).

1.11 RESEARCH DESIGN OUTLINE

1.11.1 Research design

This study will make use of a quantitative methods approach. “Quantitative researchers seek causal determination, prediction and generalization of findings; qualitative researchers seek instead illumination, understanding and extrapolation to similar situations. Qualitative analysis results in a different type of knowledge than does quantitative inquiry” (Hoepfl, 1997: 2-3). This study will be of a descriptive nature and will be cross-sectional in time-frame.

1.11.2 Population

The study defines the sample population as educators, currently teaching Life Sciences to learners in mainstream government secondary schools.

1.11.3 Sampling method

To choose samples for the research, the researcher will employ the random sampling technique. This sampling technique allows for samples from the populations to be chosen as a representative of the topic randomly. They will serve as a sample which is information rich (McMillan and Schumacher 2006:126). Simple random sampling is described as a technique where the researcher assigns numbers to the subjects and selects samples by a random method (Struwig and Stead 2004:116). This type of sampling makes certain that every member of the population has an equal chance of being selected (Graziano and Raulin 1997:214).

For the purpose of this research, the research will make use of digitally generated random numbers. In this study, Sekaran’s (2003:294) computed table (Annexure E), a method for identifying the optimal sample size from a particular population, was utilised to select the sample size for this quantitative research design. In this study, for a target population of N = 200, a sample size of n = 132 is recommended by Sekaran (2003:294).

1.11.4 Measuring instrument

The researcher will make use of structured survey questions. The questionnaire will be in the format of scaled questions, namely the Likert scale, ratio type questions and nominal type questions. The questionnaire is comprised of two parts, namely biographical details and professional development. Data from the questionnaire will inform the format of the development workshop framework of the specified subject topic to cover aspects of pedagogical content knowledge. The next aspect of the development framework includes a monitoring tool to assess the impact of the development workshop by means of a questionnaire. Quantitative data collection will take place at the sample subjects' work settings.

1.11.5 Data analysis

In this study, data will be analysed using the appropriate statistical and inferential techniques. Descriptive analysis assists in seeing the world or phenomenon. As a result, creating research questions and hypotheses based on what has been observed, and is a crucial component of the scientific method (Loeb, Dynarski, McFarland, Morris, Reardon and Reber, 2017:2). Sarmento and Costa (2019:9) highlight that the technique of deriving conclusions about populations or scientific discoveries from data is known as statistical inference.

1.11.6 Delimitations

The sample population is stipulated as educators who are currently teaching Life Sciences in government secondary schools in the Umlazi District within the eThekwini Municipality in KwaZulu Natal. Respondents within this sample population are to conform to the aspects of the sampling frame highlighted as:

I. to be currently teaching Life Sciences to grade 12 learners and
II. to be teaching for a minimum of 6 months.

1.11.7 Validity and reliability

1.11.7.1 Validity

According to McMillan and Schumacher (2006:324-326), validity is the measure to which analysis and understanding of data have interchangeable understandings between samples and researchers. Graziano and Raulin (1997:63) defines validity as referring to how well a study or procedure does what it is supposed to do. They emphasise the use of participant review as a strategy to enhance validity. Questions in the questionnaire are formulated from the theory in the literature review. The pilot test will provide the researcher with vital information of how sample subjects will react to the questionnaire. The researcher will also be able to adjust the questionnaire in the event of negative reactions.

1.11.7.2 Reliability

Cronbach's co-efficient will be used to assess reliability.

Reliability within the study is dependent on a detailed interpretation of what is to be observed and ensures the use of properly structured tools for recording (Gall, Borg and Gall, 1996:338-339). The standardised scaled questionnaire processes and the information gathered thereof, will be checked by the interviewee for verification of the data collected.

1.11.7.3 Anonymity and Confidentiality

These individuals need to be re-assured by means of written confirmation that their identity will be kept confidential always. An alias/pseudonym will be used in place of a respondent's name in order to maintain anonymity. The sample subjects will be provided with an outline of the study, which will also ensure anonymity.

1.11.7.4 Ethical Considerations

The questionnaire is grounded in the theory of the literature review and poses no deception to the subject. All biographic details and answers to the questionnaires will be treated with the strictest confidentiality. The study does not discriminate against any subject from the sample population. As a result of random sampling, all samples have an equal chance of being selected. The researcher will seek permission from the KZN DoE to conduct the study within the sample population, as well as permission from the Principals of the secondary schools within which the sample subjects teach. The sample subjects will be invited to participate in the survey and the purpose of the study will be conveyed to them verbally and in writing. Sample subjects will be required to complete a consent form.

1.12 STRUCTURE OF THE CHAPTERS

Chapter One: Introduction to the study

Chapter One introduced the research topic, highlighting the background to the study, aims, objectives, research problem, research question and outline of the research design. Key terminologies are highlighted.

Chapter Two: Conceptualising the curriculum and assessment policy statement in relation to understanding knowledge and the learning process

Chapter Two will provide a conceptual framework to the study, reviewing literature within the parameters of this research topic.

Chapter Three: Pedagogy and educator professional development

Chapter Three highlights the training and development needs of education, with special reference to career development.

Chapter Four: The professional training and development framework

Chapter Four will present the framework that the researcher has developed based on the theoretical framework and the literature review.

Chapter Five: Research methodology

The appropriate research methodology for this research will be substantiated. Data collection and data analysis techniques, as well as the reliability, validity and ethical considerations in respect of the samples in the research and key terminology will be briefly defined.

Chapter Six: Data presentation and discussion of results

This chapter will provide the analysis of the collected data in order to establish and present the results for the research that was conducted.

Chapter Seven: Summary of findings, recommendations and conclusion

The researcher will summarise the findings of the research study, state any further recommendations for the study and provide a conclusion to the study.

1.13 CONCLUSION

Vital information regarding the research study has been elaborated upon in this chapter by the researcher. An explanatory background to the study outlined the important points regarding Life Sciences as a teaching subject within CAPS; the knowledge worker within a knowledge based economy; as well as training and development. The research procedures and research design attempted during the study were demarcated by the researcher. Key terminologies were also explained.

The next chapter conceptualises the Curriculum and Assessment Policy Statement, highlighting international trends as well as challenges of the policy. The chapter also emphasises learning styles and knowledge management.

CHAPTER TWO:

CONCEPTUALISING THE CURRICULUM AND ASSESSMENT POLICY STATEMENT IN RELATION TO UNDERSTANDING KNOWLEDGE AND THE LEARNING PROCESS

2.1 INTRODUCTION

South Africa has seen many education reforms post 1994. Outcomes Based Education (OBE) mainly focused on the outcomes being assessed. This was the aim of the pedagogical system of Curriculum 2005, being the first curriculum change in South African Education (Moodley, 2013:1).

Curriculum 2005 was created with the purpose of improving the education quality for all South African learners. Ramabulana (2017:1) states that the unsuccessful implementation of the new curriculum in classrooms was due to educators who were not adequately provided with the requisite equipment, skills, knowledge and techniques. The implementation of the National Curriculum Statement in 2002 followed. This was revised to the present day education policy Curriculum and Assessment Policy Statement (hereinafter referred to as CAPS) (Du Plessis, 2013:1).

Booyse and Du Plessis (2014:9) state that the curriculum requires content and skills, which regulate the teaching methodologies to be heeded. The authors also state that these teaching methodologies have selected knowledge and skills which allow learners to control their learning through activity and creativity. Hewitt (2006:3) states that curriculum is complex and exists as four forms. The first form is *explicit curriculum* where the subject matter is specified in document that guide educators. The second form is *implicit curriculum,* which refers to what is being taught or engaged in by the educators and learners. The third form is *hidden curriculum*, which is often unintended such as behaviours circumscribed in the rules of the classroom. Lastly *null curriculum* refers to what is not being taught.

Alismail and McGuire (2015:151) explain that embracing a new-age curriculum should put together various aspects of learning and life experiences within the environment of basic academic subjects. However, Hewitt (2006:15) highlights that knowledge in the school curriculum as experienced by educators has changed as new knowledge emerges. Alismail and McGuire (2015:151) indicates that curriculum must centre its attention on creating knowledge and promoting the creation of valuable information that has meaning in order to create new skills.

The pre-1994 curriculum focused on merely educating learners. Educators, specifically referred to as 'teachers' at that point in time, were expected to impart knowledge. Post-apartheid saw the move away from 'teachers' to 'educators'. An educator is expected to guide the learning process, where learners are to construct meaning of knowledge. This creates the management of knowledge, contributes to a knowledge economy.

This chapter will focus on the Curriculum and Assessment Policy Statement and how it impacts on educators. Global factors impact on new educational trends in the country. The government strives to keep up with global skills in order to create global knowledge workers to drive the knowledge economy. The understanding of knowledge and how is it constructed in the implementation of the Curriculum and Assessment Policy Statement will also be discussed. This lends to the learning process.

2.2. UNDERSTANDING THE LIFE SCIENCES CURRICULUM AND ASSESSMENT POLICY STATEMENT

The Curriculum and Assessment Policy Statement (CAPS) focused on the construction of knowledge by learners in the classroom. In order for this to be successfully implemented in the Life Sciences classroom, Life Science educators needed to know what was expected of them. Life Science educators needed to understand the Life Sciences Curriculum and Assessment Policy Statement. As South Africa moves forward with many changes socially and economically. The country has also an experienced evolution in the South African education system with regard to curriculum.

From 2012, the National Curriculum Statement (NCS) Grades R-12 was a single document comprised of the two National Curriculum Statements. One for Grades R-9 and the other for Grades 10-12. This policy is made up of the:

a) Curriculum and Assessment Policy Statements for all approved subjects;
b) National Policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12; and
c) National Protocol for Assessment for Grades R-12"
(Department of Education, 2011a:3).

2.2.1 Principles and Aims of the Life Sciences Curriculum and Assessment Policy Statement

The Curriculum and Assessment Policy Statement (CAPS) for Life Sciences was implemented in 2012 (for Grade 10), 2013 (for Grade 11) and 2014 (for Grade 12) as part of the curriculum reform. The National Curriculum Statement Grades R-12 emphasised the move away from the traditional autocratic teaching method to one where learners are required to construct knowledge through active learning.

The principles upon which the National Curriculum Statement Grades R-12 is based include:

- ensuring that educational imbalances of the past are redressed;
- active and critical learning rather than rote and uncritical learning;
- high knowledge and high skills;
- progression, content and context of each grade shows progression from simple to complex;
- infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa;
- valuing indigenous knowledge systems; and
- providing an education that is comparable in quality to those of other countries.

(Department of Education, 2011a:4-5).

The CAPS document is created to ensure that knowledge facilitated by educators is acquired by a child. It also aims to ensure that children integrate important information and skills to their own lives (Department of Education, 2011a:4). The NCS Grades R-12 serves to provide learners with the knowledge, skills, and attitudes required for meaningful involvement in society, regardless of their socioeconomic background or diversity (Department of Education,2011a:4).

According to CAPS (Department of Education, 2011a:9), “Life Sciences is the study of life at various levels and comprises of a variety of sub-disciplines such as biochemistry, biotechnology, microbiology, genetics, zoology, botany, entomology, plant and animal physiology, plant and animal taxonomy, plant and animal anatomy, plant and animal morphology, environmental studies and socio-biology”.

The Department of Education Policy document (Department of Education, 2011a:20) highlights that educators must be competent to teach the subject and must be familiar with the equipment and its operation. Learning Programme Guidelines for Life Sciences focus on providing guidance to educators and schools in planning for the implementation of the National Curriculum Statement.

Figure 2.1 below illustrates the process of the learning programme for the Life Sciences subject area as stipulated in the CAPS document. This process highlights the subject framework, which is the result of subject outlines to bring about understanding of the content and the progression of topics to be learnt across grades 10, 11 and 12. The work schedule provides guidelines of the sequence in which content and context is to be presented. Lesson plans for educators is a tool which guides the learning, teaching and assessment activities as per requirements in the curriculum. This tool highlights the resources available and time available for content to be taught and knowledge to be constructed.

Stage 1:

Life Sciences Subject Framework for *Grades 10-12*

Combination of broad subject outline to understand content and progression across grades

↓

Stage 2:

Life Sciences Work Schedule for *each Grade*

Indicates the sequences in which the content and context will be presented

↓

Stage 3:

Life Sciences Lesson Plans for *each Educators*

Should include learning, teaching and assessment activities

FIGURE 2.1: OUTLINE OF THE PROCESS IN THE DESIGN OF A LEARNING PROGRAMME FOR LIFE SCIENCES

Source: Department of Education (2008a:12)

2.2.2 Content and Progression of Information taught in Life Sciences according to the Curriculum and Assessment Policy Statement

Table 2.1 illustrates the content and concept progression being taught from Grade 10 – 12 in the Life Sciences subject area. The subject framework highlighted in pages 22-65 in the CAPS Life Sciences document is detailed with reference to the topics shown in Table 2.1. It outlines the time allocation, the topic, the content to be covered, investigations to be carried out, as well as resources to be used (Department of Education, 2011a:22-65).

The work schedule is provided on an annual basis in the Life Sciences Teacher Orientation Support Document (Department of Education, 2019:3-14). Educators are required to create their individual lesson plans using the template provided in the Life Sciences Teacher Orientation Support Document (Department of Education, 2019:44). In order to successfully facilitate constructive learning of the content, which is progressively taught over a three-year period, educators must possess pedagogical content knowledge. Stage 3 mentioned in Figure 2.1 above is crucial in ensuring that the work schedule is followed through successfully, including the assessments and use of appropriate teaching methodologies.

The content progression shown in Table 2.1 shows the building of knowledge over time, where information gained in Grade 11 is needed for understanding content in Grade 12.

STRAND	LIFE AT THE MOLECULAR, CELLULAR AND TISSUE LEVEL	LIFE PROCESSES IN PLANTS AND ANIMALS	DIVERSITY, CHANGE AND CONTINUITY	ENVIRONMENTAL STUDIES
GRADE 10	• Chemistry of life -inorganic compounds -organic compounds • Cells – unit of life • Cell division (mitosis) • Plant and animal tissues	• Support and Transport systems in plants • Support systems in animals • Transport system in mammals	• Biodiversity and classification • History of life on Earth	• Biosphere to ecosystem
GRADE 11		• Energy transformations to support life: photosynthesis • Animal nutrition • Energy transformations: respiration • Gaseous exchange • Excretion	• Biodiversity-classification of microorganisms • Biodiversity-plants • Reproduction – plants • Biodiversity-Animals	• Population ecology • Human Impact on environment: current crisis
GRADE 12	• DNA code of life • RNA and protein synthesis • Meosis	• Reproduction in vertebrates • Human reproduction • Nervous system • Senses • Endocrine system • Homeostasis	• Darwinism and natural selection • Human Evolution	• Human Impact on environment: current crisis Grade 11

TABLE 2.1: LIFE SCIENCES CONTENT AND CONCEPT PROGRESSION

SOURCE: Department of Education (2011a:10)

2.3 ASSESSMENT IN THE CURRICULUM AND ASSESSMENT POLICY

The policy document is broken down into aspects, namely curriculum and assessment. Assessment plays an integral role in the learning process. The educator is expected to make use of different methods or techniques of assessment to determine a learner's level of understanding. Assessment is a crucial part of the knowledge and learning process. Assessment in the National Curriculum Statement is fundamental to teaching and learning. Every lesson should include an assessment. Educators should plan a year-long assessment programme along with informal daily assessments (Department of Education, 2008b:1).

The National Curriculum Statement Grades 10-12 Subject Assessment Guidelines for Life Sciences (Department of Education, 2008b:1) highlights that continuous assessment takes place by means of informal daily assessment and a formal programme of assessment. The purpose of the assessments for a learner is to:

1) develop knowledge, skills and values;
2) assess strengths and weaknesses;
3) re-visit or revise certain sections of the curriculum; and
4) motivate and encourage learners (Department of Education, 2008b:1).

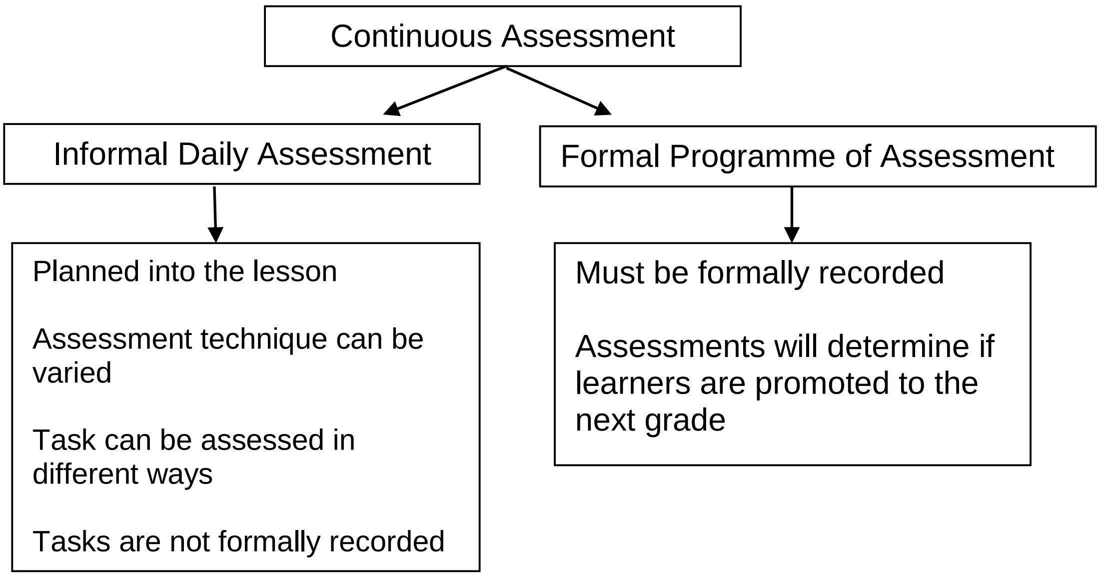


FIGURE 2.2: OUTLINE OF THE CONTINUOUS ASSESSMENT PROCESS

SOURCE: Researcher's own (2021) adapted from Department of Education (2008b:1)

Figure 2.2 highlights that informal continuous assessment tasks should be part of the teaching and learning process. Assessment tasks may take on various forms such as question and answers or short assessment tasks, which may be done individually or in groups. The assessment tasks may be self-assessed or peer-assessed, but these tasks may not be recorded formally. The formal programme of assessment must be recorded formally and will be used to determine whether a learner is promoted to the next grade (Department of Education, 2008b:1-2). Figure 2.2 shows that assessment which is an integral part of the Curriculum and Assessment Policy Statement, is either informal, where assessment may be done weekly or daily to determine the level of understanding of the content or information gained, or assessment is formal in order to test the learner's gained knowledge for recording purposes.

The National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement Grades R – 12 (Department of Basic Education, 2012: viii) defines "CAPS as highlighting the aim, scope, content and assessment for each subject listed in the National Curriculum Statement Grades R – 12. The policy document further highlights the promotion requirements in the General Education and Training Band and the Further Education and Training Phase".

The General Education and Training Band is ten years long and comprises three phases namely the foundation phase (Grade R-3), intermediate phase (Grade 4-6) and senior phase (Grade 7-9). The Further Education and Training Phase is three years. In order to be promoted, the learner must adhere to the assessment and promotion requirements outlined in CAPS (Department of Basic Education, 2012:3).

As this study focuses on the Life Sciences subject area found in the Further Education and Training Phase, assessment details regarding the Further Education and Training Phase will be explained. Learners in Grades 10-12 will be promoted from grade to grade if they have offered and completed the School-Based Assessment, Practical Assessment Tasks, where applicable, oral assessment and end-of-year examination requirements in not fewer than seven (7) subjects as contemplated in the policy document National Protocol for Assessment Grades R – 12, and the Curriculum and Assessment Policy Statements of the various subjects (Department of Basic Education, 2012: 33)

A learner in Further Education and Training must select four subjects from Group A, namely two (2) official languages, provided that one of the two official languages is offered on the Home Language level and the other on either Home or First Additional Language level, and provided further that one of the two languages is the language of learning and teaching; Mathematics or Mathematical Literacy and Life Orientation. A learner must also select a minimum of any three subjects selected from Group B. Group B comprises of subjects such as Agricultural subjects; Culture and Arts subjects; Business, Commerce and Management Studies subjects; Engineering and Technology subjects; Human and Social Studies subjects; Physical, Mathematical, Computer and Life Sciences subjects; Services subjects; as well Official and Non-official Languages (Department of Basic Education, 2012: 28 and 55).

For a learner to be promoted in the subject area of Life Sciences according to CAPS, the learner must be able to Know Life Sciences (Specific Aims 1); Investigate Phenomena in Life Sciences (Specific Aims 2); and Appreciate and Understand the History, Importance and Applications of Life Sciences in Society (Specific Aims 3) (Department of Education, 2011a, 13).

Knowing Life Sciences (Specific Aims 1) entails that a learner should be able to choose important concepts from a variety of sources; access information from a variety of sources In the Life Sciences, recall facts; describe concepts, processes, phenomena, mechanisms, principles, theories, rules, and models; construct a conceptual framework for science concepts; compose summaries; organize or reorganize knowledge to gain new meaning; create flowcharts, diagrams, and mind maps; identify patterns and trends; apply knowledge to new and unfamiliar circumstances; utilise information in a new way; analyse data and information; recognize connections between current knowledge and new ideas; critically evaluate scientific facts; identify assumptions; and categorize data.

Investigating Phenomena in Life Sciences (Specific Aims 2) entails that a learner should be able to follow instructions; handle equipment or apparatus; observe phenomenon; record information; measure; interpret and design/plan investigations or experiments

Appreciating and Understanding the History, Importance and Applications of Life Sciences in Society (Specific Aims 3) entails that a learner should be able to understand the history and relevance of some scientific discoveries; the relationship between indigenous knowledge and Life Sciences; and the value and application of Life Sciences knowledge in the industry in respect of career opportunities and in everyday life (Department of Education, 2011a, 13).

The specific aims stated above are the skills that the learner must gain over the three-year period. In order for a learner to achieve the specific aims of CAPS in Life Sciences, the teacher must be competent to use methods that are appropriate to scientific enquiry. The Department of Education Policy Document highlights that “the purpose of studying Life Sciences is for learners to develop scientific knowledge and understanding, to develop scientific process skills and to develop an understanding of science’s role in society” (Department of Education, 2011a:8). The quality of Life Sciences educators’ impact on the successful implementation of CAPS. Underqualified educators and those lacking pedagogical content knowledge would require intervention in the form of professional development programmes to improve their impact on teaching and learning. Educators need to be taught how to implement the curriculum.

2.4 NUMBER OF CURRICULUM AND ASSESSMENT POLICY STATEMENTS

South Africa is a country that has embraced the Curriculum and Assessment Policy. Challenges have been highlighted by various researchers as a lack of resources and mis-interpretation of the curriculum, amongst others. Other African countries such as Namibia and Lesotho have embraced the Curriculum and Assessment Policy Statement.

Iipinge and Likando (2012:np) describe the Curriculum and Assessment Policy of Namibia as one founded on the basis of dissatisfaction expressed towards "the lack of relevance in both the content of the school curriculum and assessment systems of the Cape Matriculation Examinations of South Africa".

Iipinge and Likando (2012:np) cite the Ministry of Education and Culture (1993), stating that in order for the country to support equal education, it had to re-inforce changes in various areas such as curriculum and assessment. Methodologies in the classroom represent the curriculum principles of leaner-centred teaching and learning. The researcher further elaborates that the Higher/International General Certificate of Secondary Examination (H/IGCSE) replaced the Cape Education Department Matriculation examination in 1994 in grade 11. The new approach saw arrangements being made for assessments or compulsory course-work in certain subjects. This reform was devised on the guidance by Representatives of the Cambridge International General Examinations (CIE).

Since 1966, the end of British colonial rule, Lesotho has seen many curriculum and assessment reforms, with little success however Curriculum and Assessment Policy Statement 2009 saw a move away from a subject and examination oriented curriculum to one which is ordered into learning areas that reflect practical life challenges (Raselimo and Mahao, 2015:np). Researchers also highlight that the Curriculum and Assessment Policy Statement is more process oriented, with a greater integration of assessment with teaching and learning.

Raselimo and Mahao, 2015 make reference to the Ministry of Education and Training 2009, that the goals of the new curriculum are to secure quality and relevance in the education sector, amongst other factors.

In all three countries, Namibia, Lesotho and South Africa, there is a shift towards assessment as part of the teaching and learning process. Within this curriculum is the focus on learner-centred learning, moving away from the traditional teacher-centred one-way transmission of knowledge.

When considering a country as Ireland, authors MacPhail, Halbert and O'Neill (2018) highlight a shift in assessment practices as to how some subjects are taught in school and learnt, which includes high stakes assessments. The authors also indicate that subjects such as science are a reflection of the experience of educators.

Globalisation, critical knowledge and the development of human skills have become essential drivers for the development of curriculum and assessment education policies in various countries. This aspect lends to the fact that countries are trying to balance their education systems to meet international demands and standards.

The information and skills that an individual requires in the actual world differ significantly from those provided by the educational system. The issue for school systems is to create learning that develops the learner holistically. The use of integrated computer technology is key to driving success within the teaching and learning process. Researchers exploring international trends in the Curriculum and Assessment Policy Statement education systems will find many differences which are primarily influenced by global political; social; cultural; and economic factors.

2.5 MODELS OF THE CURRICULUM AND ASSESSMENT POLICY STATEMENT IN OTHER COUNTRIES

Curriculum is central to schooling and the content being taught. It is the single most important reason for the existence of schooling. Educators are considered as curriculum workers who give specialised meaning to the curriculum as an activity (Hewitt, 2006:14,33). This is supported by Pinar, Slattery and Taubman (2008:3), who believe that curriculum practice is integral to the modern institution of schooling. CAPS is a document used in certain countries, while other countries practice other curriculum models. The researcher has chosen to compare the curriculum models of Finland, Japan, China, Canada, Australia and Singapore as these countries were mentioned in the Organisation for Economic Cooperation and Development Reports for their management of their education systems.

2.5.1 FINLAND

In Finland, equal education strengthens the concepts of the social system. Inclusive policies for education in early childhood have contributed towards a system of equal education (OECD, 2013;6). The National Core Curriculum in Finland has been in practice for the last forty years. It is a framework around which local curricula are designed (Vitikka, Krokfors and Hurmerinta, 2012: abstract). “Basic education includes nine years of compulsory schooling, with a voluntary tenth year. Education is free, textbooks and a daily meal are provided. Early intervention and individual guidance and support by all educational personnel are key to ensuring that no child is left behind” (OECD, 2013:6).

The government and the Ministry of Education and Culture create and implement educational policy, while Parliament decides on educational legislation. The government adopts an Education and Research Plan every four years, which highlights education policy objectives. The educational system is democratic, with authority and responsibility devolved to local governments. (OECD, 2013:14).

The policy consists of the aims and basic content of teaching for all school subjects. The policy describes “the mission, values and structure of education, as well as the conception of learning and goals for developing the learning environment, school culture and working methods” (Vitikka, Krokfors and Hurmerinta, 2012:abstract).

2.5.2 AUSTRALIA

The Australian Curriculum prepares the generation to come for the future by laying down the educational foundation (ACARA, 2014:1). McGaw (2014) highlights that the overall structure of the curriculum was determined by the Council of Commonwealth. The curriculum emphasises that no matter where learners live, they can obtain the same content and their level of success is assessed against the same standards.

ACARA (Australian Curriculum, Assessment and Reporting Authority) is creating material to assist educators during the implementation of the curriculum. ACARA is also obtaining data regarding the efficiency of the curriculum in order to recognise ways to improve the curriculum (ACARA, 2014:2). The need for introducing the Australian Curriculum focuses on enhancing aspects of Australia’s education system. Quality is defined by outlining the knowledge, comprehension, and abilities required for life and work in the twenty-first century (McGaw, 2014).

ACARA (2014:4) states that the Australian Curriculum would Develop a strong groundwork in knowledge, comprehension, abilities, and principles on which future education can be built, as well as deep knowledge, abilities, and principles that enable advanced learning and the ability to generate new ideas and put them into practical applications.

2.5.3 JAPAN

Curriculum revision in Japan takes place regularly approximately every 10 years based on evidence from teaching practices. Such revision allows for the continuous update of the curriculum. In the latest reform, Japan has focused on updating teaching and learning to create competencies for the 21st century. The new curriculum (to be implemented in 2020-2022) focuses on the use of active learning to develop competencies such as knowledge; developing problem- solving; and creativity skills and instilling good learning habits. Compared to the other OECD (Organisation for Economic Co-operation and Development) countries, Japan's education system is one of the top performers.

Amongst other factors of curriculum design, the education of educators and educators being life-long learners form part of the changes that Japan has put in place to embrace the future. A key driver of Japan's success in education is the complete comprehensive education model for children. Skilled educators, oversee learners; learners learn together; parents fund extra learning outside of school; and communities support learning. However, due to the extremely long working hours for educators and the high degree of responsibility, the ability for educators to train and adapt to the new curriculum is problematic (OECD, 2018).

2.5.4 CHINA

China is the largest developing country with a sizeable education system in the world (OECD, 2016:8; Guo, Huang and Zhang, 2019:2). The promotion of education development contributes to reducing poverty and boosting prosperity in the country (Guo, Huang and Zhang, 2019:2). China's education reform has lasted for over a 100 years, establishing China as one of the largest modern education systems in the world, with its own Chinese characteristics (Guo, Huang and Zhang, 2019:3).

Development of education is always part of the Five-Year Plan for National Economic and Social Development and always includes basic methods for development in education (OECD, 2016:12-13). Modern education systems adapt to the modern industrial society, focusing on scientific and cultural knowledge education. The recent education system is built on the foundations of educational ideas from other countries (Guo,Huang and Zhang, 2019:3).

The Compulsory Education Law of the People's Republic of China implements a nine year free and compulsory education for all school-age children and adolescents (Guo, Huang and Zhang, 2019:3). Learners often enter preschool at the age of two or three and exit at the age of six. Most students attend primary school for six years, beginning at the age of six, followed by three to four years of junior secondary school. After that, students can choose whether or not to pursue a three-year senior secondary education. General senior secondary school, technical or specialized senior secondary school, adult secondary school, vocational secondary school, and crafts secondary school are the five types of senior secondary schools. Students must pass a public examination before being admitted to senior secondary school. The outcomes of this test are used to assign grades. The results of this examination are used to assign students to the different senior schools (OECD, 2016:9).

The OECD (2016:24) highlights that China utilises a three level curriculum model consisting of curricular development at the following stages: at the national level, the Ministry of Education produces the curriculum plan, develops guidelines on curriculum management, determines national level curriculum, determines lesson hours and sets national curriculum standards. At the provincial level, the relevant authorities develop an implementation plan for the national curriculum, attempt to interpret the intentions and objections of the national curriculum and translate them into a local curriculum; and at school level, schools organise their educators to develop their own courses and carry out educational research according to the provincial plan. China's curriculum model allows for holistic involvement in the development and implementation of the curriculum. This model allows educators to customise their lessons while implementing the actual plan.

2.5.5 CANADA

The OECD (2015:np) describes the Canadian education system as a decentralised system. The Canadian government encourages provinces to work together and be creative in their method of teaching, while emphasising inclusion policies and focusing education in the best interests of the child (Anderson, 2016:564). There are jurisdictions and departments that are responsible for the implementation of the education system (OECD, 2015: np). The Ministers of Education of each province met in 2008 to work together on education change and subsequently released the Learn Canada 2020 document.

The project addressed Canadians' needs and goals, with four pillars of lifetime learning: early childhood learning and development, elementary and secondary school systems, post-secondary education, and adult learning and skills development (Anderson, 2016:564). This lifelong learning ensured that individuals became knowledge workers who contributed to the national knowledge economy.

Anderson (2016:566) mentions eight activity areas that were identified during the reform meeting as areas that needed attention. These areas were ensuring that secondary systems are meeting the training needs of all students, raising students' awareness, and encouraging them to become actively engaged in sustainable development; raising literacy levels; eliminating the achievement gap between Aboriginal and non-Aboriginal students; ensuring that secondary systems are meeting the training needs of all students; ensuring that secondary systems are meeting the training needs of all students; in international and national representation, speaking effectively and consistently about Canadian education; promoting and implementing minority language and second language education support programs; assisting with the implementation of learning assessment programs and performance indicators; and developing comprehensive, long-term strategies for collecting, analysing, and disseminating nationally and internationally comparable data and research. Each province uses data successfully to improve the level of learner achievement (Anderson, 2016:568). By addressing these areas, the education system evolved to place the learner at the centre of the learning process and to develop skills within the learner that would carry them well into the future.

All provinces provide pre-primary education to five-year olds. School is compulsory until the age of sixteen or eighteen years old (OECD, 2015: np). Anderson (2016:564) states that Canada identifies that the success of its children depends on the school system, which includes the promotion of health and well-being.

According to a review conducted by the OECD (2010:160), Singapore has transformed itself from being a developing country to a modern industrial economy in one generation. The country consistently ranks at the top of the OECD’s programme for the International Student Assessment (Simonds, 2018:np).

2.5.6 SINGAPORE

Singapore has been attempting to become a player in the knowledge economy since the mid-1990s, supporting greater research and innovation, intense industry, and attempting to attract scientists and scientific enterprises from across the world (OECD, 2010:160). Simonds (2018:np) states that Singapore favours traditional pedagogy and is not introducing reforms in education to improve creativity and reduce stress. Over the past forty years, there has been a rise in Singapore's education level (OECD, 2010:161).

Singapore looks at the education system comprehensively, contributing heavily to education research. All changes within the education system are evaluated with strict monitoring before being implemented (Simonds, 2018:np). Simonds (2018:np) highlights that Singapore has a characteristic approach to teaching, especially of mathematics, placing emphasis on narrower but deeper curriculum and ensuring whole class progression through the syllabus.

OECD (2010:161-162) indicates that Singapore's education system emerged through phases. During the first phase, known as the Survival Driven Phase: 1959-1978, the goal of education, according to the Prime Minister at the time, was to "create a good man and productive citizen." The emphasis was on rapidly expanding basic education. The majority of Singapore's two million citizens were uneducated and unskilled when the country gained independence. While more schools were created and personnel were recruited, schools built by different ethnic groups were amalgamated into a single Singaporean education system. In 1965, universal primary education was achieved, and by the early 1970s, universal lower secondary education had been achieved. However, the education provided was of poor quality.

During the second phase, the Efficiency Driven Phase, which lasted from 1979 to 1996, a new educational system was implemented. It saw a shift away from a consistent approach to education, allowing pupils to choose from a variety of options. The goal was to lower dropout rates, increase quality, and develop a more technically trained workforce.

The Curriculum Development Institute was founded to create high-quality textbooks and instructional materials for the various educational paths. (OECD, 2010:161).
The third phase, the Ability, Aspiration-Driven Phase: 1997 to present day, saw Singapore create a new educational vision. To provide more flexibility and choice, and to transform education, this project adapted teaching to students' strengths and interests. Another priority is the development of outstanding educators. Educators receive one hundred hours of training per year to stay current on the latest practices (Simonds, 2018).

A study was conducted by Creese, Gonzalez and Isaacs (2016) on Australia, Canada, China, Finland, Japan and Singapore as these countries were identified as high performing countries based on rankings on the OECD's (Organisation for Economic Co-operation and Development) 2009 PISA (Programme for International Student Assessment) assessments. The study focused on the instructional system, which it defined as "the standards, curriculum and associated assessments of a jurisdiction". The purpose was to interpret the common aspects amongst the high performers with respect to instructional system design.

The study found that all six jurisdictions encourage advanced current skills, having guidelines for the curriculum that are at a national level. However, only one provided a holistic core curriculum. Australia looks at being able to compete in the global economy on knowledge and innovation, emphasising literacy and numeracy.

To contribute to a knowledge economy, one must become a knowledge worker. A knowledge worker creates understanding of the information gained and constantly updates their knowledge. The South African education curriculum promotes the construction of knowledge, whether it is explicit knowledge or focal knowledge through the learning process. Therefore, the curriculum, which aims to inculcate a culture of being a knowledge worker in the youth, must first professionally develop educators to become knowledge workers. Educators need to understand what is knowledge and the types of knowledge before imparting knowledge to the learners.

2.6 CHALLENGES WITH THE CURRICULUM AND ASSESSMENT POLICY STATEMENT

The motivation for developing a curriculum is to focus on improving education. In the present day, as systems move into the fourth industrial revolution, it is imperative that the curriculum policy focuses on developing the necessary skills and level of thinking amongst the youth so that an era of knowledge workers are created in order to drive a knowledge economy. Booyse and Du Plessis (2014:43) explain that the inspiration for education that arose focused on combining education and training into a lifelong learning system. To develop the youth with these necessities, the teacher must be an example of a knowledge worker in order to drive the knowledge and skills-based education system. Educators as life-long learners always upgrade their knowledge and skills to keep up with the changes in curriculum so that learning in the classroom is a successful, constructive process.

Moodley (2013:3) explains that curriculum development highlights the need for a new form, which entails new materials, changes in practice, as well as a change in beliefs and understandings. Moodley (2013:21) highlighted that transformation from a conventional teacher-centred to a more learner-centred teaching approach proved to be problematic. A study conducted by Mbatha (2016) in selected schools at Ndwedwe in Durban found that educators were at first eager to welcome and accept the Curriculum and Assessment Policy. However, some challenges emerged and impeded the effective implementation of the Curriculum and Assessment Policy namely shortage of resources, teacher training and a lack of time. The researcher made a recommendation to aid the effective implementation of the policy.

Although the Curriculum and Assessment Policy is aimed at a learner-centred teaching and learning environment, with assessment being continuous and reflective in nature, many educators still do not fully understand the expectations of themselves as part of curriculum implementation. This misinterpretation and misunderstanding hinders the success of curriculum implementation. Selepe (2016:19) supports this assertion by emphasising that Educators and administrators are tense because of a lack of clarity and misinterpretation, which makes implementation challenging Moodley (2013:22) states that the training programmes as well as support mechanisms for educators do not efficiently address their needs. Moodley (2013:48) also emphasises the significance of professional development related to the learning and practice of educators at the initial stages.

Curriculum change should consider the challenges of a society and provide possible solutions. Ramabulana (2017:22) believes that issues with curriculum clarification and execution can hamper the effectiveness of curriculum changes. The curriculum aims to improve education but the aspects to be improved does not look at every public school in their uniqueness. Public schools are considered to be identical and ideal to implement changes. This is not the situation. Every schooling system is unique in its own way, be it by class sizes, the qualifications of educators, the years of experience of educators, the resources available to learners and educators or the infrastructure of the school. The curriculum should be devised in such a manner that it can be easily interpreted and implemented to suit the needs of the school.

2.7 THE LEARNING PROCESS

Killen (2011:3) highlights that are different explainations of learning, but describes the learning process as making connections and identifying patterns. Killen (2011:4) also suggests that top notch learning is significant, profound, ground-breaking and metacognitive.

Carey and Smith (1993:236) believe that it is imperative to give learners a constructivist epistemology of science. Learners build up and arrange knowledge that scientists have speculations about that can underlie the generation and understanding of explicit theories and investigations. Much current educational practice outgrows curriculum programme changes. These changes underpin the educating of the cyclic abilities engaged with the development of scientific knowledge. Carey and Smith (1993:246) explain that scientific knowledge incorporates different abilities, for example, perception, characterization, estimation, directing controlled investigations and building information tables and diagrams of trial results.

Youseff and Mohammed (2016:7-8) cite various researchers who mention and describe theories of learning namely:

i. **Traditional Method (Transmission Method)**

Educators pass on their knowledge to their students in this technique of teaching and learning, implying that students' role in the learning process is primarily passive. The traditional method has several advantages, including the ease with which an educator can stimulate a student's interest in a topic; the ease with which learners can acquire knowledge; the ability of educators and students to clarify and gain a better understanding of a subject or topic; and the ability of educators and students to cover more content material in a short period of time. The method's drawback is that there is little learner interaction (Youseff and Mohammed, 2016:7-8).

ii. **Discovery Method**

With the help of meta-cognitive processes, this is self-directed learning that can encourage higher types of thinking. Learners take an active role in their education with this strategy. The discovery method has several advantages, including: it aids learners in better understanding the material; it aids learners in remembering concepts and principles; it is far less likely to be forgotten; it aids learners in learning on their own and promotes independent learning; and it keeps educators in touch with their classes to determine whether the students understand the work (Youseff and Mohammed, 2016:7-8).

2.7.1 Constructivism in learning

The concept of constructivism was founded on the psychological principles of Piaget (1967), while the actual Constructivist Theory was proposed by Vygotsky (1978) (Dagav and Yadav 2016:2). Fosnot (2005:5) explains that “from a constructivist perspective, meaning is understood to be the result of humans setting up relationships, reflecting on their actions and modelling and constructing explanations”.

Abdulkarim and Jadiry (2012) cite Vygotsky (1978), that individuals acquire knowledge and work co-operatively throughout their lives and not in isolation. Therefore, learning should not differ in the classroom. Powell and Kalina (2009:241) indicate that constructivism as a method for teaching and learning is discussed in many schools. To use constructivism in the process of teaching and learning, educators must first identify the current stage of knowledge that a learner is at so that personal meaning can be created when new information is given. Powell and Kalina (2009:241) further explain that in Vygotsky’s social constructivism ideas are constructed through interactions with the teacher and peers. Booyse and Du Plessis (2014:95) explain that according to Vygotsky, the learner's culture and the circumstances in which he or she finds himself or herself can give all of the intellectual transformational tools required for what and how to think.

A critical component in Piaget's research is the possibility that children are brought into the world with reflexes that control their behaviour. Piaget was affected by a more extensive hypothetical idea called "Constructivism". Constructivism is acquired from the possibility that knowledge is not something fixed or stable. However, it is built bit by bit. Piaget presumed that children's intellectual improvement follows a typical example that is direct and aggregate in nature, basically understood as one stage leads into the following (Essays, 2018).

Booyse and Du Plessis (2014:96) highlight Piaget’s assertion that active involvement in the learning process is the foundation of cognitive development. Researchers emphasised that Piaget focused on the idea that knowledge is constructed from within.

McLeod (2018:np) discusses Piaget's theory of "cognitive development as a progressive re-organization of mental processes as a result of biological maturation and environmental experience". McLeod (2018:np) cites Piaget to explain "that children construct an understanding of the world around them, then experience discrepancies between what they already know and what they discover in their environment".

PIAGET'S THEORY OF COGNITIVE DEVELOPMENT		
STAGE	AGE RANGE	DESCRIPTION
Sensorimotor	Birth to 2 years	Object permanence, ability to recognise an object
Preoperational	2 years to 7 years	Symbolic thought, use of language
Concrete operational	7 years to 11 years	Logical thinking, classification of objects
Formal operational	11 years to adulthood	Scientific reasoning together with logical thinking

TABLE 2.2: PIAGET'S THEORY OF COGNITIVE DEVELOPMENT

SOURCE: Mcleod (2018). adapted

Table 2.2 describes Piaget's theory of Cognitive Development and shows the stages of cognitive development at the different stages of childhood. The table describes the cognitive accomplishments reached in each age group. Piaget's theory centres consideration around the necessities of the child, and urges educators to permit children enough space to take part in solid encounters and investigate their general surroundings (Essays, 2018:np).

McLeod (2018:np) further highlights that intellectual growth, according to Jean Piaget, is a process of adaptation (adjustment) to the world, which occurs through Assimilation (the use of an existing schema to deal with a new item or circumstance). When existing knowledge fails to cope with a new object or situation, accommodation is required, and equilibration is the drive that propels evolution forward. Piaget argued that cognitive development happened in leaps and bounds rather than at a continuous pace.

Youseff and Mohammed (2016,8) explain that Piaget's work produced the biggest and most important theory of cognitive development in the twentieth century. Piaget's theory identifies four stages of developmental psychology that children go through:

- The sensori-motor stage (0-2 years): when children learn through their senses and physical experiences
- The pre-operational stage (2-7 years): when children reason directly from what they perceive and may not be logical
- The concrete operational stage (7-11): when thinking characterised by logic and does not require real objectives at hand
- The formal operational stage (11 years and above): when children become capable of abstract thought.

Booyse and Du Plessis (2014:96) state that according to both Piaget and Vygotsky through the learner activities, knowledge should be constructed. Learners naturally are continuously active and therefore must explore and find logic in the world. Constructivism started to grab hold amongst psychological researchers as a suitable model to clarify epistemology and behaviour. It began to have an impact on models of education. A constructive pedagogy started to be formed and classrooms have educators as facilitators instead of transmitters of knowledge (Fosnot, 2005:4).

To further explain learning and teaching, Forehand (2011:1) makes reference to Bloom’s taxonomy, which is a multi-layered model of characterising thinking into six cognitive levels of intricacy.

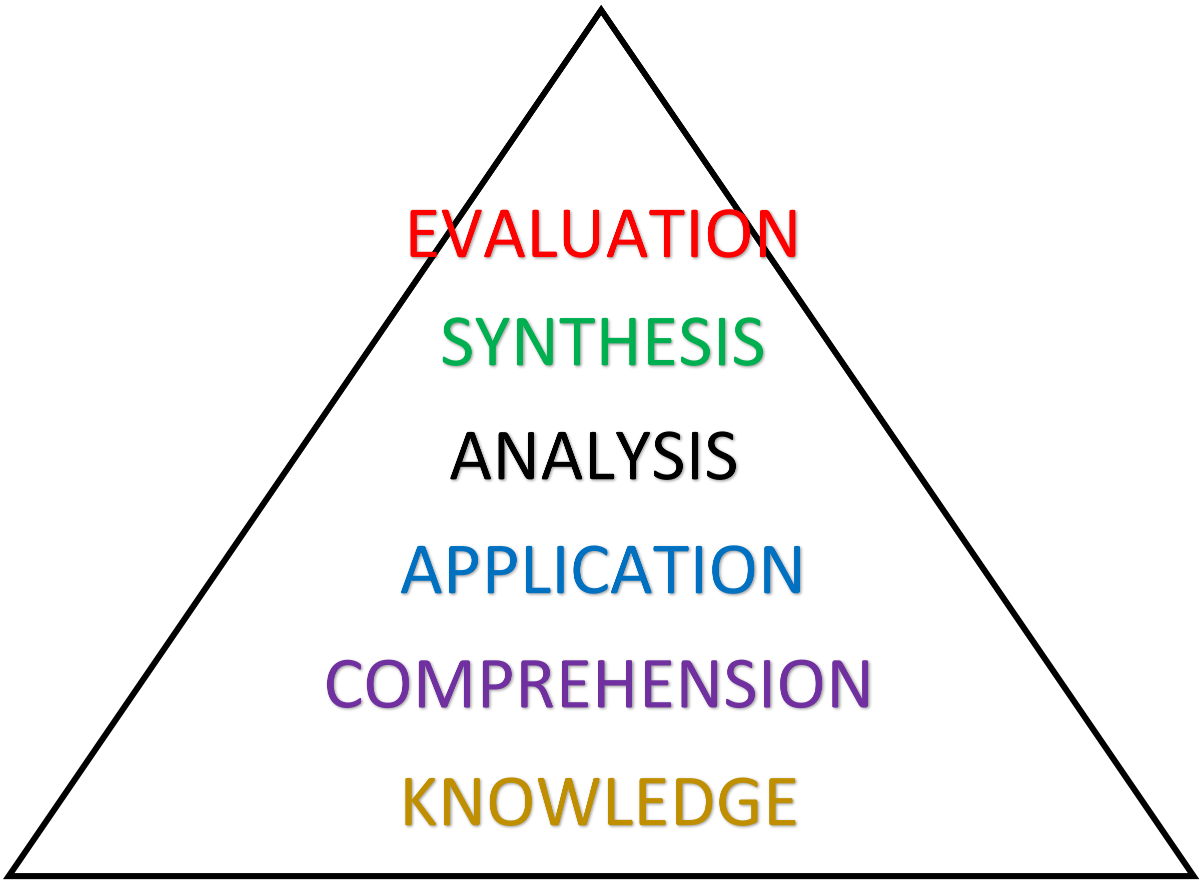


FIGURE 2.3: OLD VERSION OF BLOOM'S TAXONOMY WITH KEY WORDS AS A BRIEF DESCRIPTION AT EACH LEVEL

SOURCE: Researcher's own (2021, adapted Krathwohl (2002:213)

Krathwohl (2002:212) describes the six major categories in the cognitive domain of the old version of Bloom's Taxonomy in Figure 2.3. The domains include knowledge, comprehension, application, analysis, synthesis and evaluation. Domains were ordered from simple to complex and from concrete to abstract.

Forehand (2011:2) further explains that in the 1990s, a discussion was held to update the taxonomy with relevance to 21st century learners and educators (Figure 2.4).

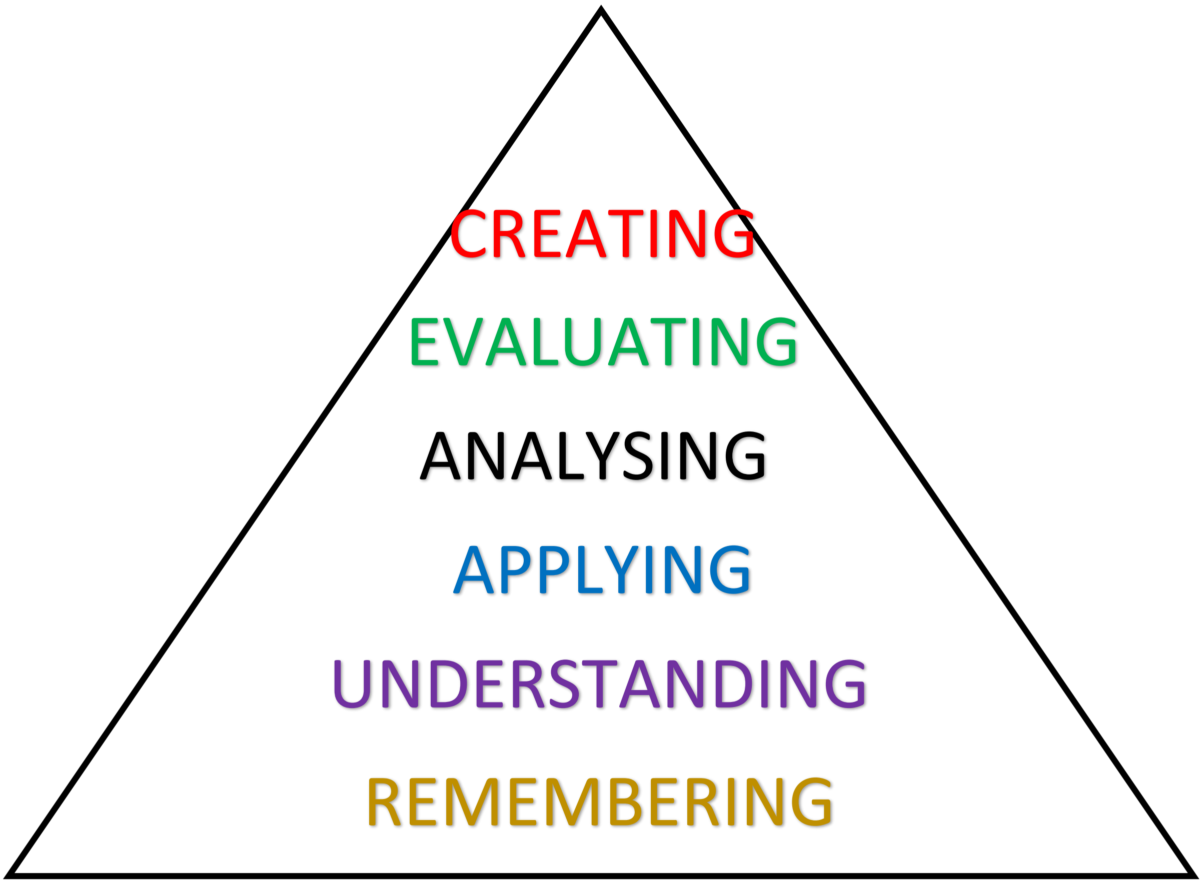


FIGURE 2.4: NEW VERSION OF BLOOM'S TAXONOMY MAKING USE OF VERBS INSTEAD OF NOUNS. A DESCRIPTION OF EACH LEVEL IS PROVIDED
SOURCE: Researcher's own (2021, adapted Krathwohl (2002:214)

Concepts of constructivism were founded on the psychological principles of Piaget (1967), while the actual Constructivist Theory was proposed by Vygotsky (1978) (Dagav and Yadav 2016:2). The theory emphasised the benefits of constructing knowledge through interactions between individuals, namely learners. In present day research, Dagav and Yadar (2016:1) describe constructive pedagogy as an approach where activities are proposed to learners that are meaningful for them. As curriculum practices continuously change to place the learner at the forefront of the learning process, Vijaya (2014:32) highlights that educators around the world are exploring the promises and practices of Constructivist Theory for preparing learners to create knowledge. However, in a survey conducted by Alsharif (2013:1014) to find out how educators interpret the term 'constructivism' as a teaching approach, the analysis of the study uncovered that educators' perceptions and capacity to implement a constructivist learning environment is unsatisfactory due their view on classroom control. It is therefore a concern that even in present education systems, educators still find it difficult to promote active constructive learning.

Radical constructivism, according to research by Mugaloglu (2001:35), is not only a theory of knowledge but also a theory of learning. Mugaloglu (2001:36) explains that the epistemological claims of radical constructivism have led to some strategies for teaching science. Hardy and Taylor (1997:143) states that much is said about student-centred learning in science and mathematics education as educators, curriculum creators, and educational researchers express their interests in reforming from a constructivist perspective. Radical constructivism asserts that all knowledge is constructed on the basis of individual experiences.

Killen (2011:6) emphasises several modern understandings of the idea of constructivism relating to education, but explains four common principles around constructivism, namely:

a) the active construction of knowledge structures from personal experiences is what meaningful learning is all about;
b) because knowledge is based on human experiences, it can never be completely transferred from one person to another;
c) within a given culture, people's understandings are typically constant.; and
d) ideas are developed via rigorous, open-minded debate and discussion.

Booyse and Du Plessis (2014:94) highlight that the when constructing understanding amongst learners and creating new knowledge, a teacher must consider the following:

i) the learner's existing knowledge and the fact that the learner is not a "blank slate" when it comes to the lesson;
ii) the learner makes meaning of new situations by applying previously learned concepts. As a result, learning requires the learner to reorganize and restructure his or her own prior knowledge; and
iii) the learner must be given the opportunity to explain and to substantiate for his/her answers.

Mugaloglu (2001:38) further highlights that science educators are responsible for preparing a learning environment from which learners can abstract the necessary fundamental elements and relations from their experiences. From an extreme constructivist point of view, knowledge comprises mental constructs which have fulfilled the limitations of target reality. The learner builds knowledge from his encounters, with an end-goal to understand those experiences (Hardy and Taylor (1997:136). Lui and Chen (2010:63) posit that from a point of radical constructivism, the way towards knowing or learning is powerfully adjusting to a variable understanding of experiences.

2.7.2 Models of learning styles

Educating and learning practices welcome cautiously developed strategies to direct different learning style models (Baig and Ahmed, 2016:665). Nicolaides and Yorks (2008:51) explain learning theory as learning from experience necessitates a focus on the concurrent dynamics of continuity and interactivity. The continuous process of learning from experience and reflecting on it is referred to as continuity. Killen (2011:7) explains that learning is more than just getting information; it is an intentional, continual process of building and expanding meaning. Tanner and Allen (2004:197 highlight that educators aspire to have all their learners learn.

Youseff and Mohammed (2016:11) states that learning as a process implies learners putting forth cognizant attempts to accomplish their own educational requirements, interests and objectives as per social conditions. Baig and Ahmed (2016:6696) highlight that learning styles are many and varied for the different learners, being mindful of the relation between their cognitive style and learning styles.

Pritchard (2014:np) states that learning is about understanding. Learning is not exclusive to the system of education. Learning begins long before school; is ongoing for even longer beyond the years of school; and happens quickly. Pritchard (2014:np) highlights that learning may be defined in a range of ways, namely a change in behaviour as a result of experience or practice, the acquisition of knowledge, knowledge gained through study, to gain knowledge of or skill in something through study, teaching, instruction or experience, the process of gaining knowledge. The author also highlights that learning is a process by which behaviour is changed, shaped or controlled and is the individual process of constructing understanding based on experience from a wide range of sources.

Wilson (1998:3) highlights individual variances in cognitive organization and functioning are defined as learning styles. The following models describe the different learning styles of learners that can affect the planning of lessons in order to ensure effectiveness.

2.7.2.1 VARK Model

VARK is a cipher standing for the four major sensory modes of learning: visual, aural, reading/writing and kinaesthetic. This concept was developed in 1989 by Neil Fleming as a tool for assessing where learners' learning preferences lie. Visual learners prefer to learn through drawings, photographs, and other image-rich teaching materials because they learn by seeing. Auditory learners are good at listening and learning through debates and lectures. Reading/writing learners learn best by interacting with text, while kinaesthetic students learn best by touching and prefer learning environments that emphasize doing (Tanner and Allen, 2004:198).

2.7.2.2. Three Learning Modalities of Barbe

Baig and Ahmed (2016:6698) make reference to the three sensory modalities mentioned by Barbe, namely Visual, Auditory and Kinaesthetic (VAK) for learners. The authors posit that learners may differ in stability regarding one specific method or a mixture of methods.

Learning Preference	Associated Teaching Strategies
Visual	Overhead slides, PowerPoint presentations, handouts, games, diagrams
Auditory	Recorded audio lectures, discussions, music
Kinaesthetic	Active exploration, activities involving movement, games

TABLE 2.3: VISUAL, AUDITORY AND KINAESTHETIC TEACHING TECHNIQUES
SOURCE: Gerschler (2012:10), adapted.

Wilson (1998:10) indicates that Barbe, Milone and Swassing believed that modalities of functioning of visual, auditory and kinaesthetic channels of learning are more important in the instructional planning of lessons. Primary grade children most often use auditory modalities shifting to visual and then kinaesthetic, while moving to visual and auditory in adulthood. Modalities become integrated over time.

2.7.2.3 KOLB'S Model

Kolb's (1984) model combines experience, perception, cognition and behaviour, while being influenced by the works of Dewey, Lewin and Piaget. The learner's reaction and proceedings between the individual and the environment for development and exchange of knowledge results in his or her modification of the world (Baig and Ahmed, 2016:6697).

Bergsteiner, Avery and Neumann (2010:30) explain that experiential learning, according to Kolb, is a cognitive process involving ongoing modification to one's surroundings. The authors cite Kolb and Kolb (2009a), describing that an individual creates knowledge from experience and that learning is a complete process as a result of collaborative relations with the environment. Raschick, Maypole and Day (1998:31-32) state that this model is formed on favoured learning styles and stages.

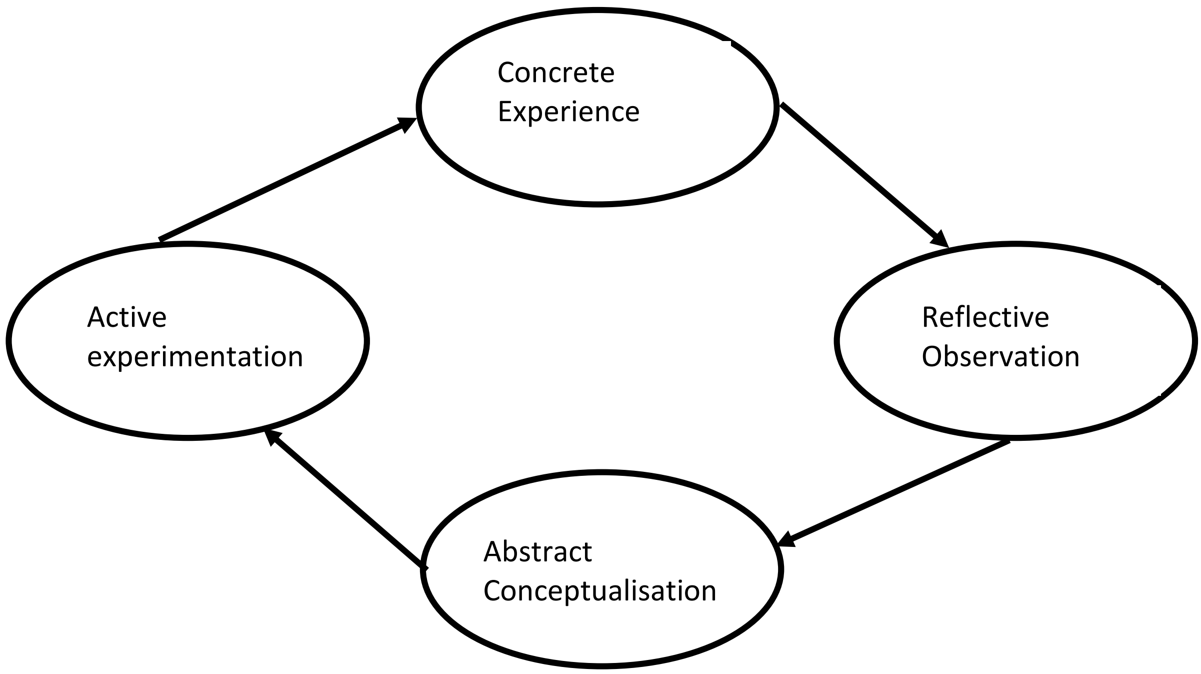


FIGURE 2.5: KOLB'S EXPERIENTIAL LEARNING MODEL.
SOURCE: Bergsteiner, Avery and Neumann (2010:32). adapted.

Bergsteiner, Avery and Neumann (2010:30) explain that the learning process is depicted as a cyclic model of four learning styles derived from a concrete abstract dimension and a reflective-active dimension. While Raschick, Maypole and Day, (1998:32) describes the four primary dimensions as:

i) concrete experience - learning through experience
ii) reflective observation - learning through examining
iii) abstract conceptualisation - learning through explaining
iv) active experimentation - learning through applying

Baig and Ahmed (2016:6697) believe that learners who are encouraged to participate and confidently take part in the learning process are inclined to attain outcomes.

2.8 UNDERSTANDING KNOWLEDGE

The goal of implementing a curriculum is to demonstrate how knowledge is connected to the real world. Learning is a growth process in which the learner engages with the environment to construct knowledge. Knowledge is undoubtedly a vital aspect of the learning process. Educators should possess pedagogical content knowledge to effectively implement the curriculum and guide a learner's construction of knowledge. According to Van Staden (2009:7), "knowledge is an understanding and adding awareness of a subject gained through experience or study". Henry (2012:1) defines knowledge as a changing system with interactions among experiences, skills, facts, relationships, values, thinking, processes and meanings. Van Staden (2009:11) defines the knowledge worker as an educated individual in a specialist knowledge area who possess theoretical, contextual or tacit knowledge. Akure (2015: abstract) states that with an increasing demand and number of knowledge workers in the workforce, productivity of the knowledge worker has become an imperative management task.

Epistemology is one of the parts of theory that examines the definition, sources, legitimacy and impediments of information (Azam, 2006:1). Silverman (2014:np) describes an epistemology as broadly speaking the study of what knowledge is and how one comes to have knowledge. Everson (1990:60) cites the Greek philosopher Plato's early theories of knowledge based on early dialogues with Socrates, another Greek philosopher. Socrates assumed a number of views of knowledge, although he never examined them or developed them into theory. His two conceptions of knowledge are the Theory of Expert Knowledge, which includes quite ordinary skills. This type of knowledge is possessed by specialised professionals, such as doctors and educators. The second is the Theory of Non-expert Knowledge, which includes extraordinary skills where one does not need to be an expert.

Plato assumes that there is knowledge or at least that it is possible and makes enquiry into the conditions that make knowledge possible. These conditions refer on the one hand to the rational capacities of humans and the on the other, objects of knowledge. The Meno is a transitional work by Plato, bridging the gap between the dialogues of Socrates and the Middle Period of Plato. The Meno is firstly concerned with what is virtue and whether it is teachable. Plato's epistemology states that virtue is knowledge (Silverman, 2014:np).

Clarke (1976:18) describes the work of Descartes, a French philosopher. Descartes' philosophy of knowledge shows his preference for the evidence of reason over experience in evaluating the justification of knowledge in both science and philosophy. His concept of experiences is evidently influenced by his theory on the nature of the subject of experience. Words such as observation, sensation and experiment are simply referred to as experience.

2.8.1 Types of Knowledge

Collins (1976:1) states that the purpose of education must always be two-fold: firstly, to teach a variety of knowledge and secondly, to teach the skills necessary for applying that knowledge to new problems or situations. Choo (1996:334) highlights that information creation is accomplished through the acknowledgment of the synergistic connection between implied information and unequivocal information in an association.

Knowledge analysis is the study of the content and form of knowledge for the purpose of understanding learning. It centres around the idea of information and its changes during learning and means to create another and unmistakable perspective on information, one that is genuinely receptive to instructive real factors (diSessa, Sherin and Levin, 2015:30).

Choo (1996:334) describes Personal knowledge that is difficult to formalize or explain to others is referred to as tacit knowledge. It is made up of subjective knowledge, insights, and intuitions gained during long periods of immersion in a particular activity. Van Staden (2009:17) states that tacit knowledge is hard to move to another information labourer as it is viewed as unpredictable, something installed in each information specialist. Van Staden (2009:18) posits that the exchange of knowledge through social interactions and person interactions develops more tacit knowledge arising out of meaningful relationship.

Van Staden (2009:19) explains that explicit knowledge is easily transferable, simple, not part of any system, can be articulated and taught. Van Staden (2009:19) also states that explicit knowledge can be formalised through speech, texts, graphics or data. Choo (1996:334) highlights that “explicit knowledge is formal knowledge that is easy to transmit between individuals or groups”.

Bojuwoye, et al., (2014:1) highlights that a few difficulties describe training in South Africa. Numerous variables are answerable for these, incorporating those related to students, schools and families. Bojuwoye, et al., (2014:1) express that schools have the obligation to advance successful learning by establishing a favourable and steady learning climate, inside which students feel appreciated. The use of educational programmes and encouraging procedures supplement students' instructive status as well as instructors who comprehend the uniqueness of each learner.

Hebibi, et al., (2019:120) propose that knowledge may be broken down further into five types of knowledge, which are considered as key components of knowledge with significance to the development of managerial competencies, namely:

a) procedural knowledge: to know how;
b) causal knowledge: to know why;
c) conditional knowledge: to know when; and
d) relational knowledge: to know who or what.

The information kept in the person's brain does not add to hierarchical achievement on the off-chance that it is not shared by different representatives inside the association (Mkhize, 2015:1). The deficiency of information from instructors who resign and leave the field is a waste that the training area should hope to check. The utilization and use of information computer technology is the scaffold that could help spread the development of an association in order to decrease the hardship experienced by educators today.

Van Staden (2009:19) points out that organisational knowledge exhibits both tacit knowledge and explicit knowledge characteristics. Van Staden (2009:19) explains that Explicit knowledge acquisition, which consists of organizational norms and operational procedures, is more observable. Tacit knowledge is described as the combination form of knowledge that is ingrained in organizational practices and relationships among knowledge workers.

2.8.2 Knowledge Management

In today's knowledge economy, the ability to handle knowledge is becoming increasingly important. Knowledge Management is a purposeful and methodical technique to ensuring that an organization's knowledge base is fully utilized. Individual knowledge is not intended to be replaced by organizational knowledge, but rather to be supplemented by it (Dalkir, 2005:2). Mostert and Snyman (2007) states that the main objective of the knowledge acquisition process in Knowledge Management is to acquire information from the inside and outer environments that can be utilized to create and support in competitive circumstances.

Knowledge Management is beneficial at three levels: at the individual level, at the community level and thirdly, at the organisation level. Dalkir (2005:20) explains that for an individual, knowledge management helps them to succeed in their jobs and be time efficient by means of better decision-making and problem-solving skills. The author further explains that for a community, the practice of Knowledge Management professional skills are developed, peer-to-peer mentorship is encouraged, and teamwork is made easier. Knowledge Management aids an organization's strategy, solves problems rapidly, and strengthens organizational memory. (Dalkir, 2005:20)

Diaz and Baldo (2005:90) highlight that the knowledge sharing work environment is a cycle-driven shared workspace that underpins the collaborative improvement of a knowledge storehouse. Any commitment includes 'combining' the contributed knowledge with the shared information vault. The authors further describe an argumentative contribution to knowledge sharing as one that can be integrated into the shared repository without any contradiction. A non-argumentative contribution is published openly as a varying presentation. Mkhize (2015:3) explains that collaborations are called for a particular goal, which may be planned or unplanned. Mkhize (2015:3) also states that many ideas are contributed and inspected to create a broader, wider border model of the concept.

Dalkir (2005:4) summarises the goals of an organisation that undertakes Knowledge Management as leveraging knowledge to the organisation's advantage. A few classical knowledge management aims include the facilitation of a smooth transmission of knowledge from those retiring to the successors; minimum loss of corporate memory because of wearing down and retirement; distinguishing basic assets and basic subject matter so the association 'knows what it knows and does it well and why'; and developing a toolbox of strategies that can be utilized to stem the expected loss of scholarly capital (Dalkir, 2005:4).

Mkhize (2015:1) highlights that associations are moving their investing focus to intellectual capital to support an upper hand in the worldwide commercial centre. Dalkir (2005:16-17) describes Competence is defined as the skills required to achieve a certain level of performance; capability is defined as the strategic skills required to integrate and apply competencies. and technologies, which are the tools and methods needed to achieve specific physical outcomes. Van Staden (2009:15) states that the knowledge inherent in individuals needs to be developed if knowledge is to be properly managed. The rise of the status of knowledge workers has sparked renewed interest in knowledge studies.

Additionally, Diaz and Baldo (2005:86) explains that the functionality of collaborative knowledge sharing systems is the core of any knowledge-based system in which a group of people that share a domain of interest develop knowledge memory collaboration.

The ongoing development of computer systems with their extensive databases of information allows all access to information, insight and collective experiences (Cortada, 1998:xviii). Van Staden (2009:8) highlights that The management of people and knowledge in order to maximize information exchange and utilization is known as Knowledge Management.

2.8.3 Models of Knowledge Management

The significance of knowledge sharing is perceived as beneficial to any association. For educators, there is a requirement for them to feel associated with knowledge. At this point, there are obstructions keeping them down (Kaur, Abidin and Megat, 2012:np).

2.8.3.1 The SECI Model

Kaur (2015:84) proposed a worldview for dealing with the dynamic parts of organisational knowledge-making measures through a consistent exchange between tacit and explicit information. Mazorodze (2017:22) states that there are two features of knowledge creation, namely the epistemological dimension and ontological dimension. The epistemological dimension is concerned with the transformation of knowledge from tacit knowledge to explicit knowledge, while the ontological dimension deals with the transformations of knowledge from people to gatherings and afterward from gatherings to the association. The merging of the two dimensions has development in the formation of the SECI model (Socialisation, Externalisation, Combination and Internalisation).

Choo (1996:334) also explains the four modes of knowledge conversion as *Socialisation* being the process of tacit knowledge through shared experiences; *Externalisation* being the process of converting tacit knowledge into explicit knowledge through the use of metaphors or models; and *Combination* being the process of creating explicit knowledge by bringing together explicit knowledge from a number of sources. Individuals exchange and combine their explicit knowledge through meetings and memos and *Internalisation* being the process of embodying explicit knowledge into tacit knowledge. These four modes of knowledge are represented by Figure 2.6 below.

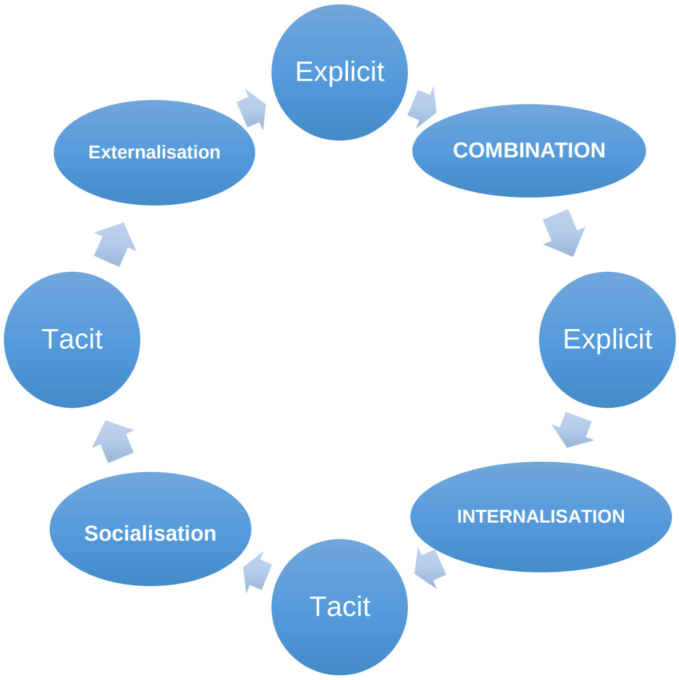


FIGURE 2.6: ORGANISATIONS OF KNOWLEDGE-CREATING ENTERPRISES
SOURCE: Choo (1996:335).adapted.

Figure 2.6 shows the four modes of knowledge conversion, namely socialisation, externalisation, combination and internalisation which feed off each other in a continuous spiral of organisational knowledge creation (Choo, 1996:336).

2.8.3.2 WIIG Model

Knowledge Management centres around knowledge as a critical creation factor and comprises of exercises that focus on the ideal use and improvement of knowledge, presently and later on (Wigg,1995:379). Cristea and Capatina (2009:360) explain that knowledge should be arranged in a different manner, depending on how it will be utilised. This model addresses the issue alluding to how pertinent can the knowledge can be, coming from a particular source, which incorporates the minds of the individuals or knowledge bases (tacit or explicit).

Wiig (1995) believes that in people and organizations, knowledge must be managed effectively to ensure that the basic objectives are attained. Knowledge is the asset that underlies all other aspects of the organization. Therefore, its management will affect every other activity and entity Wiig (1995:1;33).

The Wiig model characterizes numerous levels with respect to the disguise of knowledge. Wiig characterizes four kinds of knowledge in light of realities, theoretical knowledge, methodological knowledge and assumption knowledge. Conceptual knowledge suggests frameworks, ideas and points of view, whilst methodological knowledge is utilized by methodologies, strategies for choice refining and different procedures (Cristea and Capatina, 2009:360-361).

2.9 CONCLUSION

South Africa has been at the forefront of many educational reforms, some with the purpose of rectifying the injustices of the past and some due to international trends. However, Hewitt (2006:15) highlights that knowledge in the school curriculum as experience has changed as new knowledge emerges. Internationally, curriculum is developed with the assistance of various stakeholders who eventually take part in the implementation, assessment as well as review of the curriculum, whereas South Africa practices a top-down approach not considering the teacher as a stakeholder in the process. The most recent curriculum document is CAPS. This chapter focused on CAPS for the learning area of Life Sciences. The chapter also highlighted how the assessment of curriculum is undertaken. There are some countries that share a similar curriculum to that of CAPS. Knowledge is a concept that constructed in an environment. Knowledge is constantly evolving and so is the knowledge worker in a working environment. The knowledge worker directly impacts on the productively of the organisation. In order to gain knowledge, one must learn. The concepts of learning are founded on the principles of Piaget and Vygotsky, which promote the theories of constructing knowledge. There are various domains of constructivism that impact on how learning takes place in the classroom and influences teacher pedagogical content knowledge.

CHAPTER THREE

PEDAGOGY AND EDUCATOR PROFESSIONAL DEVELOPMENT

3.1 INTRODUCTION

From the background information provided in Chapter One, traditional methods of teaching Life Sciences does not impact successfully on learner achievement. Educators are directly impacted by the curriculum and the changes that occur. South Africa, post 1994, saw a new Constitution which formed the basis for curriculum change and development. Bantwini (2009:169) explained that for the purpose of addressing education system failures, the idea of curriculum change arose in South Africa. However, it has not been successful due to neglect of the implementation of curriculum change.

The professional development of educators professionally is a critical step in improving the standard of educators and their impact in the classroom. Mokhele (2011:16) referenced to information from the National Research Council (2007), which showed that many educators were unhappy with the professional development possibilities provided in schools, stating that the most effective development programmes were self-initiated. Educator content knowledge and their appropriate use of teaching methodologies (pedagogy) influence learner performances. Learning styles differ from one learner to the next, and teaching approaches should reflect this. The varied needs in the class are accommodated by combining strategies to build one holistic plan.

This chapter will focus on teacher professional development, teaching practices in Life Sciences and aspects of teacher knowledge in Life Sciences.

3.2 PEDAGOGY

The Life Sciences classroom is a unique environment, which serves to skill learners in aspects of Life Sciences while imparting critical knowledge of Life Sciences. The Life Sciences educator must be one who possesses content knowledge, skills and the ability of how to teach. Lamidi, Oyelekan and Olorundare (2015:2) highlight that an educator's skills include the ability to use effective instructional techniques for teaching; that the educator's instructional design seems to be the means of successful learning; and that good teaching benefits the learner.

Learning styles vary from learner to learner and so should teaching strategies. A combination of strategies to form one holistic strategy accommodates the various needs in the classroom. Tanner and Allen (2004:198) indicate different learning styles of learners which may be categorised as visual through seeing drawings and pictures; auditory by listening to lectures; reading and writing, which is seen as the interaction with texts; and kinaesthetic, referring to the physical involvement during the lesson.

Youseff and Mohamed (2016:6) believe that the approach adopted for teaching and studying science is one aspect that has led to a low interest in science by learners. The researchers referred to learning Sciences as relatively difficult, and many learners believe that there are more interactive, interesting, and less difficult subjects than Science, according to learners' perspectives. Science teaching is transmissive, the content has an abstractness that makes it inconsequential; learning Sciences is relatively difficult; and many learners believe that there are more interactive, interesting, and less difficult subjects than Science (Youseff and Mohamed, 2016:6). As it involves knowing things like how to make explanations, portray subject, and respond to misunderstandings, pedagogic content knowledge permits what the teacher knows to be accessible to learners. This is critical action in the sense of reflection and activity that leads to wise decisions about how to bring about new ideas and new learning.

Killen (2011:18) emphasises that if educators expect meaningful learning to take place in classrooms, they must actively teach in ways that encourage and inspire learners to participate in academic activities that facilitate quality learning. Booyse and Du Plessis (2014:100) highlights that in the classroom, a range of approaches may be used to expand the thoughts of students. Moreover, the awareness and values of educators can affect their teaching practice.

In the present day, the focus is on knowledge building in the classroom. Rote learning is an idea of the past as learners merely absorbed content but did not construct meaning around the content. In a study conducted by Keke (2014:69), results show that for effective learning to occur, educators need to determine what should be taught and how it should be taught (methodology) and determine whether learning has been effective (evaluation). It is therefore essential to expose educators to relevant teaching exercises that will develop them to be more effective in the classroom. It ensures that their pedagogy is apt in the classroom so that meaning is constructed as the content is taught and learning is successful.

Youseff and Mohammed (2016:7) explain that in the 1990s, significant legislative proposals were undertaken in Science education, emerging from the perception of Science as a method for creating knowledge, culminating in the establishment of the National Science Education Standards (NSES) in the United States. The NSES became international practice. Youseff and Mohamed (2016:7) further stated that the standards encourage learners to study Science and to seek careers in Science during their school years, as well as stressing that studying Science is an acquired skill and that doing science encourages learners to be interested in both physical and psychological processes (known as scientific research).

Effective learning is impacted by the correct choice of instructional teaching strategies. The Department of Education Policy White Paper 6 (July 2001) on inclusive education states that all schools are meant to be inclusive; to embrace diversities in learners; and to accommodate these diversities by adapting teaching strategies. Tanner and Allen (2004,199) state that Science educators need to distinguish and broaden their own teaching style and the pedagogical methods included in science lessons in order to meet broad groups of learners. The educator must use effective teaching methods to include a context in which particular teaching strategies can be used to include learners in elements of quality teaching, namely elements of the classroom, elements of the school and elements of the world beyond school. (Killen, 2011:35).

In another study conducted in South Africa, results showed that teaching strategies were amongst the determinants of poor performance in science in high schools (Monica, 2012:7). Evidence clearly points out that teaching strategies or pedagogy play an influential role in learner performance. Once again, it is emphasised that the professional development of educators in key areas such as teaching strategies will impact the classroom. However, support is critical. Support comprises of specialised functions aimed at improving teaching and learning (Bojuwoye, et al., 2014:2).

Bojuwoye, et al (2014:1) highlights that it is the duty of schools to promote successful learning by creating a favourable and welcoming learning atmosphere in which learners feel valued; curriculum and instructional methods complement the educational preparation of learners; and educators recognize the individuality of each lesson. In present day Life Sciences classrooms, many learners learn passively instead of actively. Active learning would involve constructing meaning from the subject content being taught. Educators' pedagogical content knowledge may be influenced by constructivism. Utani (2012:195) describes constructivism as a theory of meaning-making that describe the characteristics of knowledge and how humans learn. The selection of teaching strategies and how it is systematically integrated affects the teaching outcome and can lead to substantial improvements in learning (Booyse, 2010:13).

This can be done through educators who use instructional variables as this involves any element that may impact the process of teaching and learning, such as learner characteristics, curriculum content or classroom management. In order for teaching to be successful, an educator must ensure that along with learner progress, there is teaching variety as well as participation in the learning process.

Clark and Starr (1996:173) mention that in order to choose effective teaching and learning activities, educators must ensure that the activity can develop contextual concepts, explain ideas on the subject of learning and assess the success of learners and the activity of teaching and learning.

In an investigation carried out by Ramnarain and Hobden (2015:abstract) to determine whether practical investigations have moved from educator-centred to learner centred, it was found that educators believe in providing support. Educators provided support at almost every stage of the inquiry-based investigation and did not allow learners to discover for themselves. This investigation supports the idea that the construction of knowledge in the science classroom is not apparent.

Youseff and Mohamed (2016:6) highlight that "educational activities should reflect what real people actually do as biologically literate citizens or employees". Activities such as the application of information, investigations, critical thinking, creative thinking and information retrieval should be occurring in the lecture halls and classrooms in order to create an exhilarating learning environment. Simelane and Mji (2014:512) explain that a variety of techniques used in the sense of teaching and learning have been identified.

3.3 TYPES OF PEDAGOGY

3.3.1 Co-operative Learning

Co-operative learning is related to as an informative teaching strategy, whereby small groups of learners collaborate together on a common mission. Abdulkarim and Jadiry (2012:556) makes reference to the work of Vygotsky (1978) that people do not learn in solitude; rather, they collaborate throughout their lives, resulting in socially created knowledge. Killen (2011:215) describes co-operative learning as an instructional strategy in which learners work together in small groups to assist one another in achieving common goals.

Killen (2011:192) highlights the advantages of small group work as:

- transitioning the emphasis from learners who are passive recipients of knowledge to learners who actively engage in knowledge construction;
- enables learners to express their thoughts and emotions, which can assist in resolving the subject matter;
- Enhancing the problem-solving skills of learners and making them discover that there are many solutions to problems, thereby increasing the level of thought of learners;
- being able to improve oral communication skills;
- motivating learners and increasing their active participation; and
- allowing learners to experience roles as leaders and peers.

Co-operative learning may take place within or outside the class. It may include responding to or creating questions, discussing findings and strategizing in class exercises. Outside tasks may comprise carrying out experiments or research studies (Youseff and Mohammed, 2016:12).

Five characteristics of a successful co-operative teaching strategy include positive interdependence between learners; individual accountability in the group; face to face interaction in the group; group processing skills being developed; and development of small group interpersonal skills amongst learners (Abdulkarim and Jadiry, 2012:557).

Youseff and Mohammed (2016:10) refer to authors stating that “the co-operative learning strategy to instruction is where learners are arranged in small groups to help each other learn assigned material” and that “the interaction among learners is intense and prolonged”. However, Youseff and Mohammed (2016:11) highlight the disadvantages of this teaching strategy as “not all members of a group will participate in solving the problems they are confronted with, some very active members of a group may overshadow less active ones, the method is time-consuming; and low ability learners who solely depend on the educator for all information may not be able to make any contributions”.

A Co-operative learning strategy is an effective whole-group strategy, but has its negative points as well, if not properly managed. An educator must be able to control the groups without interfering with their learning process.

3.3.2 Integrated Computer Technology

Classrooms are also considered a significant place in which learners acquire an appreciation of the subject matter. The classroom consists of different modes of social interaction and communication activities during lessons that are used to characterize the learning environment in general (Wu, Chang and Guo, 2007:207).

In the present day, technology provides endless possibilities. It is therefore evident that the use of technological presentations could positively affect the teaching and learning process. The use of power-point presentations as a teaching strategy promotes audio-visual aid teaching. Murtaza, Mushtaq Sajid and Shahzad (2012:417) believe that “visual aids such as charts, models or apparatus add interest to lessons while increasing a learner’s retention level”.

Keengwe, Onchwari and Washira (2008:561) highlight that technology has entered all education industries, encouraging educators to be prepared to take benefit from technology resources. The researchers also indicate that in being successful in teaching with technology, educators must have a high level of confidence with and regularly use digital tools as part of their own toolkit in the subjects they teach.

Youseff and Mohammed (2016:12) believe that knowledge is complex and constantly transforms from one state to another, needing to be gained, preserved and used in life. They explain that Information Technology and cooperative scientific research expectations that learners must be able to communicate across disciplines are expanding worldwide. Keengwe, Onchwari and Wachira (2008:562) highlight that it needs knowledge of the subject area, an awareness of how learners learn and a level of technological competence to incorporate technology into the curriculum. However, the mind-set and abilities of an educator dictate the success of incorporating technology into the curriculum. Wu, Chang and Guo (2007:208) point out that the introduction of technology into teaching has re-shaped the ways in which educators, learners, curricula and innovations communicate to transform the classroom climate with the rapid diffusion of technology in schools. Educators have implemented different technologies in the science classroom to promote learning, from gathering, monitoring and assessing data to designing and envisioning concepts.

Simelane and Mji (2013:511) explain tablet computers, smart phones, blogs, instant messaging, and social networking sites are all examples of this technology. In various ways, including the education sector, this growth means that technology has had a positive impact (Simelane and Mji, 2013:512). The advancement of technology, which can be used to make education more efficient, has provided opportunities for new teaching and learning techniques to be developed.

Despite indications of the increased use of instructional technology, the educators do not incorporate it into their curriculum Keengwe, Onchwari and Wachira, (2008:560). Keengwe, Onchwari and Wachira, (2008:561) describes First-order hurdles include a lack of equipment, equipment instability, an inadequate support, and other resource-related concerns. Second-order hurdles to technology integration in the classroom include factors at the school and educator levels; as well as resistance to change; negative attitudes toward computers; training and support limits; and a lack of access to the correct types of technology in appropriate settings.

It is crucial that educators embrace information technology as a means of delivering the content and curriculum. This embraces the move into the fourth industrial revolution.

3.3.3 Whole Class / Small Group Discussions

In general, whole class discussions can be noisy and it often seems clear that there is a lack of control from the educator, or a regulation of actions. It is possible to consider whole-class discussions as a teaching technique, which is a structured conversation amongst those present. Participants analyse, compare and comprehend thoughts on an issue. The purpose of this approach is to integrate learners' knowledge with very little instruction from the educator.

According to the researcher’s understanding, a well-run, full-class discussion is an organized group interaction approach in which individuals exchange ideas, listen to a variety of opinions, express their ideas and exemplify on their attitudes and values. In this teaching strategy, the educator determines the desired lesson outcomes; controls learner activities; and maintains the focus of the lesson on some form of academic outcome. The discussion is both active and learner-centred.

To interchange ideas, five logical conditions should be satisfied, namely speaking to each other; listening to each other; responding to each other; learners must together contribute many viewpoints; and there must be intent to develop knowledge and comprehension of the matter under discussion (Killen, 2011:155).

Factors that contribute to whole-class discussion success encompass a clear create a learning environment; learner preparation; a defined set of learner guidelines; careful control of the learning environment; educator direction but not interference; educator monitoring and control Educator and learner time management; as well as a lesson conclusion directed by the educator (Killen, 2011:191).

Booyse and Du Plessis (2014:105) describe discussions as a learner-centred process where the aims are to obtain knowledge and acquire skills and attitudes, as well as motivation and personal satisfaction. Learners learn more from their peers than merely from an educator’s explanation, as the discussion is a lively discussion between group members.

3.3.4 Scaffolding

Booyse and Du Plessis (2014:101) explains that scaffolding is a method for supporting the educator in comprehending the learner's point of view. This method offers the learner a positive and flexible structure, which structure encourages him to attempt an activity or action beyond his/her scope (Booyse and Du Plessis, 2014:101). Scaffolding exhibits learner-centred characteristics due to the relationship between the educator and the learner. In Bakker, Smit and Wegerif (2015:1050), scaffolding is defined as learners with temporary, purposeful, and responsive support as they progress towards new abilities, concepts, or levels of understanding. Anghlileri (2006:33) states that as the educator's job shifts from showing and telling to responsive coaching in developing learners' own thinking, significant adjustments from traditional teaching methodologies are required.

Lin, Hsu, Lin, Changlal, Yang and Lin (2011:437) state that scaffolding has been debated as one of the facilitation methods to deal with changes in classrooms that make learners resolve their learning difficulties. Ramnarain and Hobden (2015:98) explain that "the term 'scaffolding' has traditionally been used to refer to the process by which an educator or more knowledgeable peer assists a learner by altering the learning task so that the learner can solve problems or accomplish tasks that would otherwise be out of their reach". Ramnarain and Hobden (2015:99) posit that The main notion behind scaffolding is that it can minimize the complexity of an activity as inquiry by giving structure, and that scaffolding is only successful if learners learn to complete the action or objective without support. Lin, et al., (2011:439) highlight that Vygotsky's concept of the zone of proximal development was represented in scaffolding. The feature describes the difference between what a learner can accomplish on their own and what can be completed with help.

The type of scaffolding used by an educator will be different according to the aims of the lesson and the type of learners. Scaffolding has been a common thought in education over the past decade. There are a variety of scaffolding interventions that can engage learners. Educators should assign tasks that are appropriate for what is being learnt and that appeal to the learners' talents as they go through the content.

3.3.5 Inquiry-Based Learning as a Teaching Strategy

Many students today passively study science in schools, where their educator arranges and introduces knowledge to them (Youseff and Mohomed,2016:7). Shamsudin, Abdullah and Yaamat (2013:2) indicates that it is through experiments, testing and further data search that individuals tend to see trends or associations that often lead to results in learning insight, ideas and generalizations. Ramnarain and Hobden (2015:94) believe that it was anticipated that a learner-centred research-based science curriculum would improve educators' classrooms and the learning environment of learners.

Shamsudin, Abdullah and Yaamat (2013:2-3) state that Educators that use inquiry-based learning incorporate more practical learning activities, with the educator serving as a facilitator. The researchers explain that experiments are a core of doing investigation in science classrooms. According to Shamsudin, Abdullah and Yaamat (2013:2-3), learners frequently seek out opportunities to manipulate items, test hypotheses, and collaborate in order to solve or verify a problem. Learners are frequently able to see or relate things better through experiments.

Ferreira (2011:103) highlights that the teaching and learning of Life Sciences has always been symbolic of hands-on work. Ferreira (2011:103) states that if learners conduct experiments themselves or observe a demonstration done by the educator, learning is considered more effective. An investigation-based hands-on work teaching approach can support the learning of Life Sciences while offering the means for language acquisition. Worksheets and reports have particular layouts and give practical work and documentation with some framework. An inquiry-based approach can give students the opportunity to work together, not only imparting knowledge, but also leading to the growth of social skills.

Samuels (1995:94) states that there are many ways to teach science as an inquiry and characterises an inquiry-based teaching strategy as step-by-step explainations limited to a few difficult concepts; frequent reference to the nature of science; regular use of experimental data; practical work designed to investigate problems; the answers to which are already known; and frequent learner-learner interaction.

In the school curriculum, analytical work has been the subject of curriculum process improvement. Learners identify the resources to be utilized, the variables involved, construct a question or hypothesis, and establish how the variables can be manipulated, controlled, and measured when preparing the inquiry (Ramnarain, 2011:91). Ramnarain (2011:91) highlights that The learner examines the data gathered by looking for patterns and trends, then generalizes using simple principles. Ramnarain (2011:92) believes that many of the practical exercises conducted by learners merely validate or demonstrate the theory, but allowing learners independence in doing research would also cause educators to give up much power over the educational process.

3.4 ASPECTS OF EDUCATOR KNOWLEGDE

An educator's role in education has shifted as the curriculum has reformed over time. Educators have evolved from merely conveying factual knowledge and promoting memorising skills amongst learners to a role which encourages active learning amongst learners. In the learning experience, the educator takes on the role of a research instrument. Such role cannot be effective if the educator lacks content knowledge or is incapable of selecting the appropriate teaching and learning strategies to enhance that content in the classroom.

"The Integrated Strategic Planning Framework for Teacher Education and Development highlights that educators' poor subject matter knowledge and pedagogical content knowledge are contributors to the quality of the education system" (Department of Education, 2011b:4). This is supported in a report issued by CDE (2015:1), which states that one of the most pressing issues confronting the South African educational system is the lack of certified and competent educators. Keke (2014:5) makes reference to the 2009 Department of Education policy document, which stipulates that of the 89% of professionally qualified educators, only 18% are university graduates. This implies that a minimal number of educators possess a content-related qualification. Having content knowledge alone is not sufficient to impact drastically on the learning process. Life Sciences educators need to know and understand how to encourage and promote the construction of knowledge through the use of content appropriate teaching strategies.

There's a significant difference between knowing about a topic (content knowledge) and understanding about how to teach and learn about that topic (teaching and learning knowledge) combined as pedagogical content knowledge. Pedagogical content knowledge is a construct widely used in literature and is considered specific professional knowledge (Fernandez, 2014:80).

Fernandez (2014:80) makes reference to Shulman (1987), who explains that in order to encourage learning amongst learners, the categories of educator knowledge are outlined and educators should have seven forms of basic knowledge, whereby pedagogical content knowledge is a special assemblage of content and pedagogy:

1) content knowledge;
2) general pedagogical knowledge;
3) curriculum knowledge;
4) pedagogical content knowledge;
5) knowledge of learners and their characteristics;
6) knowledge of educational contexts;
7) knowledge of purposes, educational purposes and educational values and their philosophical and historical bases.

Figure 3.1 below illustrates a model by Grossman (1990) in Fernandez (2014:85), which was the first representation of a system of the components of the knowledge base of educators proposed by Shulman, where pedagogical content knowledge occupies a central position. It shows the transformation of the pedagogical knowledge, context and content specific pedagogical content knowledge, with other aspects of educator-based knowledge.

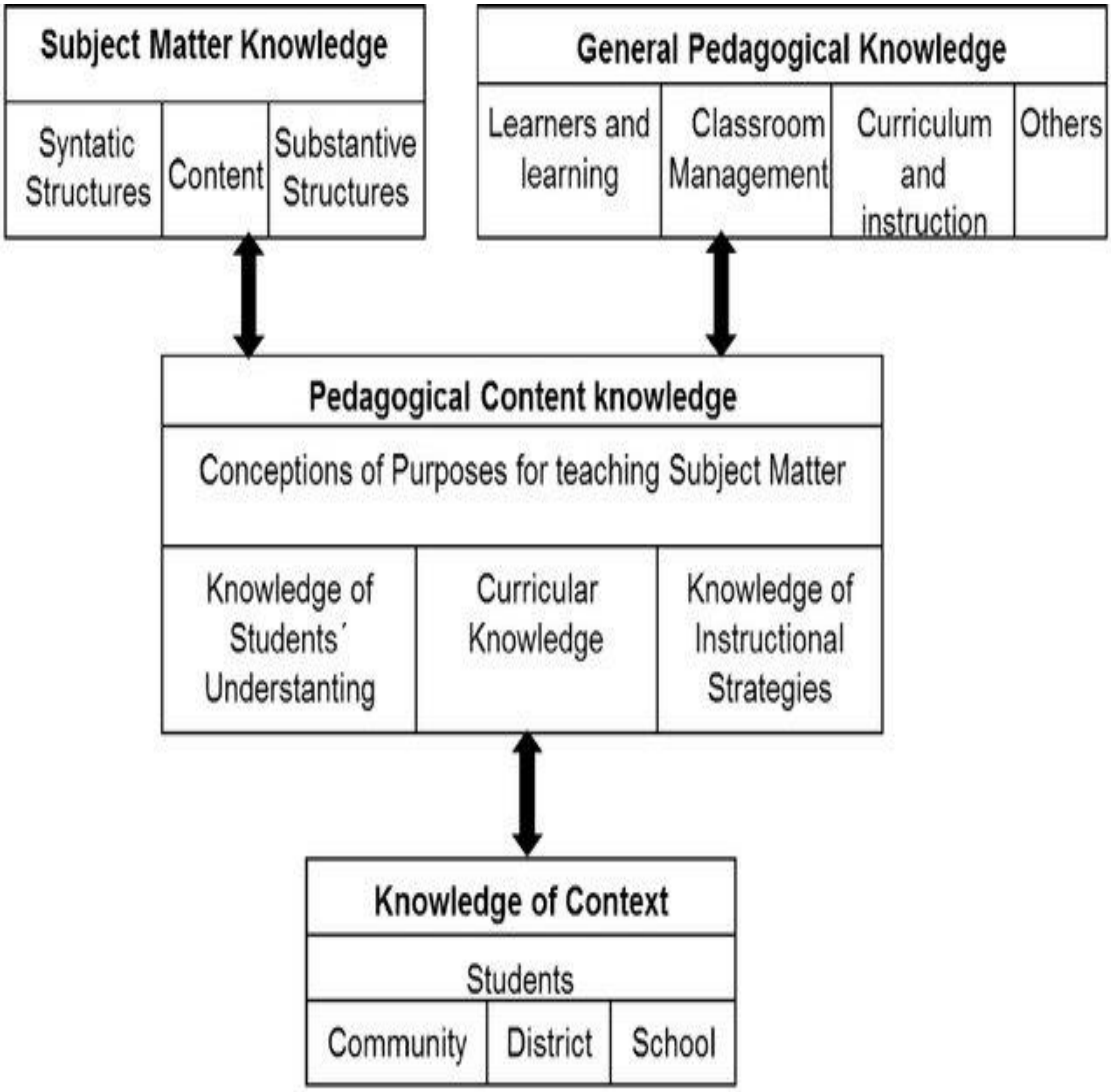


FIGURE 3.1: MODEL OF EDUCATOR KNOWLEDGE

SOURCE: Grossman (1990) in Fernandez (2014:85)

Figure 3.2 below represents the Model highlighting the components of pedagogical content knowledge for teaching science (Magnusson, Krajcik and Borko, 1999 in Fernandez, 2014:87). The model follows Grossman's model, but adds assessment knowledge as a component.

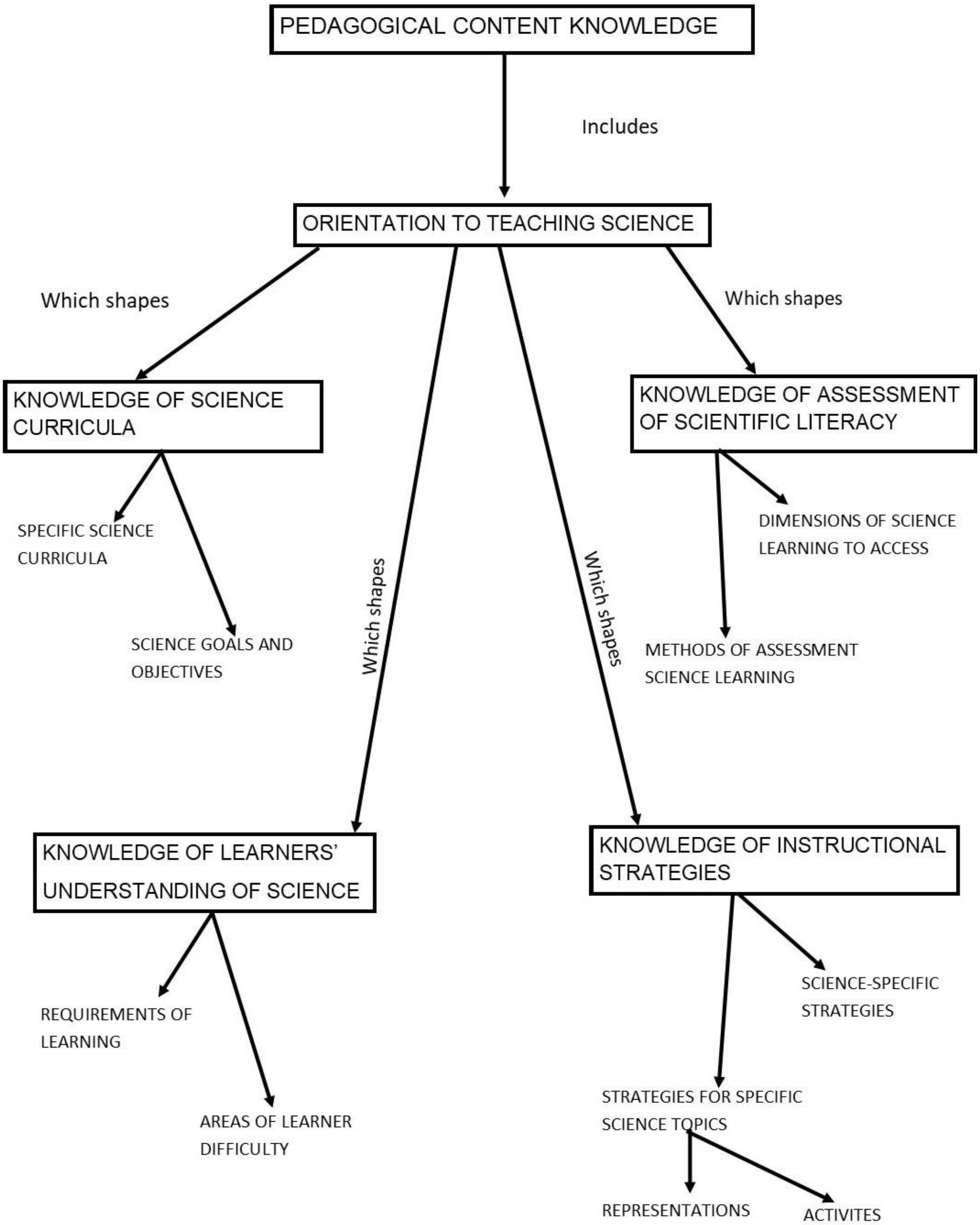


FIGURE 3.2: COMPONENTS OF PEDAGOGICAL CONTENT KNOWLEDGE FOR TEACHING SCIENCE

SOURCE: Magnusson, Krajcik and Borko (1999) in Fernandez (2014:87).adapted.

Technological pedagogical and content knowledge (TPACK) has been one of the guiding scientific concepts frequently used to analyse and improve the knowledge of educators on the incorporation of technology into teaching. The concept originated from the pedagogical content knowledge framework proposed by Shulman (1986) (Jang and Tsai, 2019:566). The authors explain that Instructional Technology has become an essential trend in educational reform. Educators are required to embrace various technical instruments and grow their knowledge of technology, content and pedagogy to boost professional growth and productivity in teaching.

Thus, Technological Content Awareness (TCK) is an awareness of how technology and content impact and limit each other. Educators need to comprehend more than the subject they are teaching. They also need to have a detailed understanding of how the subject matter (or the kinds of representations that can be constructed) can be altered through the use of specific technologies. Technological Pedagogical Knowledge (TPK) is an awareness of how teaching and learning can shift in specific ways as specific technologies are used. Technological Pedagogical Content Knowledge (TPACK) is an evolving type of information that goes beyond all three "core" elements (content, pedagogy and technology). It is an interpretation that arises from connections between knowledge of content, pedagogy and technology (Mishra, Koehler and Cain, 2013:16).

For over 5 years, Mishra and Koehler have been involved in conducting a design experiment to better clarify the growth of educators towards rich technical uses, while at the same time helping educators improve their technological teaching. A number of innovations are used by conventional schools, from textbooks to overhead projectors, referred to as 'transparent technologies'. Digital computers and computer applications, objects and mechanisms are the most common use of technology and are modern and not yet part of the collective. These emerging innovations have transformed or have the possibility to transform the essence of the classroom. (Mishra and Koehler, 2006:1018).

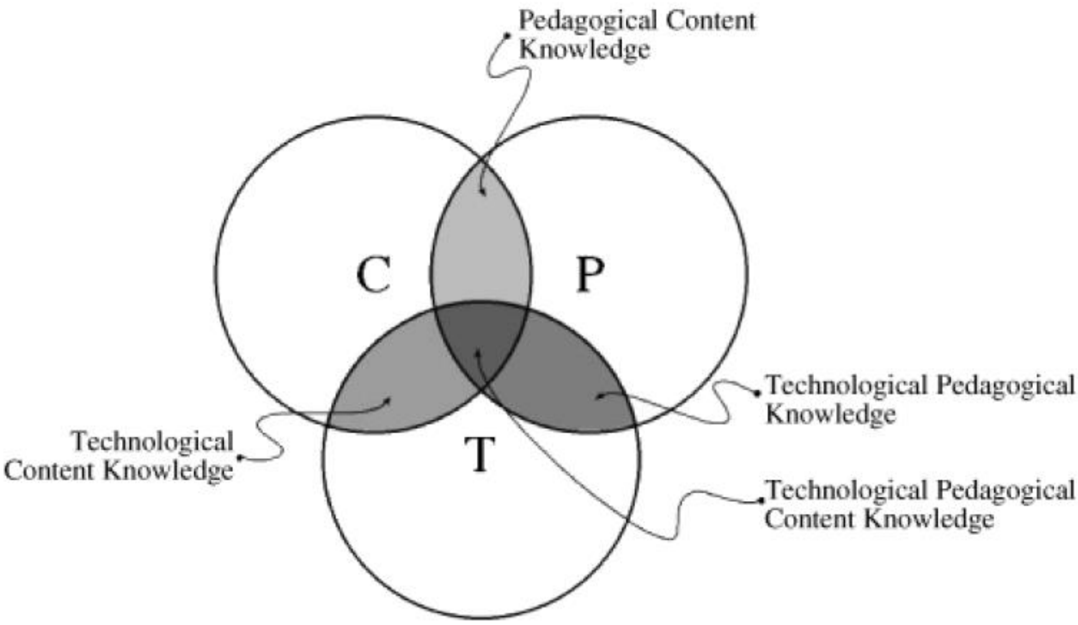


FIGURE 3.3: TPACK MODEL
SOURCE: Mishra and Koehler (2006:1025)

Mishra and Koehler (2006:1025) use a framework represented in Figure 3.3, which focuses on the interactions, affordances, and restrictions that exist between and among content, pedagogy, and technology. Knowledge of content (C), pedagogy (P), and technology (T) is important to producing effective teaching in this model. Instead of treating these as distinct bodies of information, this model stresses the dynamic interplay between these three sources of knowledge.

Mishra, Koehler and Cain, (2013:14) highlight that educators also have insufficient (or inappropriate) practice in using new technology for teaching and learning. The researchers explain that “many educators earned degrees at a time when educational technology was at a very different stage of development than it is today, not considering themselves sufficiently prepared to use technology in the classroom. An approach is required that considers teaching as an exchange between what educators know and how they apply this information within their classrooms in specific circumstances or contexts. There is no “one best way” to integrate technology into curriculum.

Simple changes to the traditional method of teaching and learning will impact on a learner's perception and interest in the subject. In a study conducted by Almasaeid (2014:139) it was found that blended learning strategy reflects on raising learner achievement and improving their attitudes towards learning. This is supported by recent experimental research conducted in Nigeria using multimedia innovation instead of the conventional lecture and direct instruction method by educators. It was found that this innovation was more effective in teaching biological concepts (Gambari, et al., 2014:87). These studies are evidence that an evolution in teaching strategies can impact on learners' performance and understanding. The selection of a content appropriate teaching strategy to promote the active constructive of learning can improve the performance and attitudes of learners.

In recent years, there has been much focus on improving learner achievement through improving the quality of educators. Guerriero (undated: 2) posits that The policy requirement for teaching and acquiring 21st century abilities including problem-solving, cooperation, communication, and creativity may need re-skilling current educators and improving the teaching profession's knowledge base. The Continuous Professional Teacher Development system has been devised to achieve this.

In order to re-skill educators, the focus of professional development programmes should centre on three kinds of knowledge. The first being content knowledge, the foundation on which the other types of knowledge were built; secondly, pedagogical content knowledge; which deals with the application of content knowledge; and lastly curriculum knowledge, which deals with the linking of concepts across the grades for a subject.

Luke (2003:398) states that People use a variety of sources of information, modes of communication, and community involvement in today's hybrid of "old" and "new" information settings. The new understanding of Knowledge Management and distribution as a method and design has been one of the possible consequences of the constructivist shift.

Keke (2014:18) cited Shulman (1986;1987) as describing educator knowledge as aspects of subject matter knowledge, content knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational aims, purposes and values.

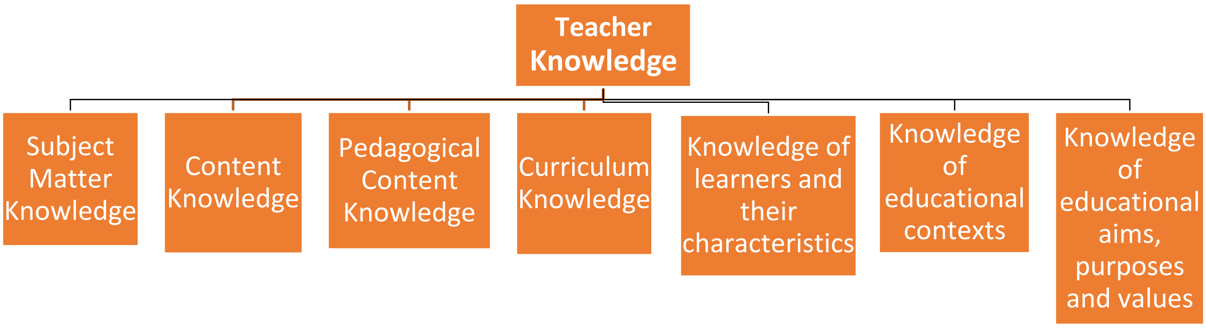


FIGURE 3.4: REPRESENTATION OF ASPECTS OF TEACHER (EDUCATOR) KNOWLEDGE

SOURCE: Researcher's own (2021) adapted from Keke (2014:18) cited Shulman (1986;1987)

Keke (2014:18-19) highlighted critical aspects of educator knowledge and in the work of Shulman 1986(6), he made reference to Father Walter Ong (1958), who presented an account of teaching in the Medieval University. Father Ong described a world of teaching and learning where no distinction was made between content (what is known) and pedagogy (how to teach it). However, today, professional development programmes need to focus on each aspect separately before moving towards a junction between both.

The educator is a crucial influencing factor in the implementation of the curriculum. Solomon (2019:1) explains that the method of executing the changes requires helping the learner gain expertise or experience.

Educators choosing effective strategies, arrange a classroom and make decisions when planning teaching involves pedagogical content knowledge. In a study carried out by Lee and Luft (2008:1351) into the perspectives of experienced secondary school Science educators on pedagogical content knowledge, their findings revealed that there are common components of pedagogical content knowledge that educators can identify with. The main components were knowledge of content, knowledge of goals and knowledge of students. Additionally, Khan, Khan and Khan (2016:1) posit that an educator who has good knowledge and awareness of the domain involved can easily facilitate academic success, which also depends on the educator's knowledge of the lesson delivery.

Pedagogical content knowledge is not an entity on its own. It is an aspect founded on content knowledge and aims to communicate the content using various strategies or methodologies. Keke (2014:55) states that the inadequate understanding of the knowledge structure of science by South African educators is the major factor inhibiting the successful teaching and learning of science subjects. An inadequately knowledgeable Life Sciences educator is unable to convey information and assist learners to construct meaning if they themselves do not understand it. This is supported by Shulman (1986:9), who highlights that a biology educator must understand the variety of ways in which the discipline is organised. Educators are considered as agents of information transfer. They are specialised as they possess knowledge obtained through years of experience in teaching and developmental programmes.

Atweh and Alsharif (2012:2) explain that decades of research on teaching from around the world have resulted in a comprehensive framework known as ‘Productive Pedagogies’ being developed in Queensland, Australia. This framework identifies important aspects of productive teaching. The primary rationale was to provide a tool for educators to use to increase their learners learning outcomes. The framework’s focus is on the improvement of learners’ intellectual reasoning and makes teaching and learning in schools more applicable.

3.5 POLICIES AND FRAMEWORKS BY THE DEPARTMENT OF EDUCATION TO IMPROVE THE QUALITY OF EDUCATORS

Educators require adequate content knowledge and an understanding of the appropriate teaching strategies to engage learners in an active process of scientific inquiry. The education department has been devising and revising frameworks and policies to improve the quality of educators so that the quality of teaching and learning improves.

One such document is the Integrated Strategic Planning Framework for Teacher Education and Development, which highlights its purpose to improve the quality of educator education and development (Department of Education 2011b:1). Dichaba and Mokhele (2017) posit that education structures are evolving around the world, providing opportunities for serious and promising changes in education. One of the main factors of these changes is the continuation of professional growth. Continuous educator qualification programmes at the Department of Education level and in partnership with DHET (Department of Higher Education and Training) institutes are being revised continuously to improve the quality of currently practicing educators. Mathematics and Science education are the main problem learning areas. It is therefore stated in a Mathematics and Science strategy document that educators without specialised qualifications in Mathematics and Science need "to be targeted for in-service training to address the lack of subject knowledge" (Department of Education 2001:12).

In-service training takes place in the form of short training workshops or seminars usually facilitated by subject advisors. Cronje (2011:8) explains that in-service workshops cover policy aspects and do not address the skills and knowledge needed by educators. Educators who attend the in-service training are thereafter expected to cascade the information gained to colleagues at school. There is usually no follow-up or monitoring process to evaluate the success of the in-service training, or to determine whether information was actually cascaded to other educators in a school.

This sentiment was re-iterated in a report by the Centre for Development and Enterprise (hereinafter referred to as CDE) (2015:2), which reported that government devised a policy that required initial educator education programs to be re-designed with a special focus on knowledge of the subject material and how to teach the knowledge of the content. According to the National Qualifications Framework Act 2008 (Department of Higher Education, 2015:9), teaching is considered to be a dynamic activity focused on the acquisition, incorporation and implementation of various forms of learning or knowledge practices. The National Qualifications Framework Act 2008 (Department of Higher Education, 2015:9) highlights the types of learning for teaching purposes as pedagogical learning refers to the study of the fundamentals, procedures, and ways of instruction, including awareness of learners, learning, curriculum, and general instructional and assessment strategies,discipline learning refers to subject matter knowledge, which can be the study of education and its foundations or specific specialized subject matter, as well as disciplinary learning refers to the study of the fundamentals, procedures, and ways of instruction, including awareness of learners, learning, curriculum, and general instructional and assessment strategies.

To meet the needs of the Life Sciences Curriculum and Assessment Policy (CAPS), it is imperative for South African educators to manage an adequate interpretation of the concepts related to Life Sciences. Although changes to the curriculum seem inevitable, Lizer (2013:2) highlighted that when it comes to teaching Sciences, South African educators generally oppose change and still use the old methods. Educators need to be competent in their profession. This level of competency allows them to achieve successful teaching and learning in the classroom. Figure 3.5 below illustrates the basic competencies of an educator. This is based on the types of learning and knowledge that must lead to the development of the educator (Department of Higher Education, 2015:64). Educators are expected to have sound subject knowledge, which will make them specialists in their subject fields. Educators must be able to identify the diversity of learners within the classroom in order to select the appropriate pedagogy for effective teaching. Figure 3.1 also highlights that educators should have Information Technology skills, which reinforces the move to the fourth industrial revolution. An educator who has up-to-date skills is able to use these skills in the classroom gainfully.

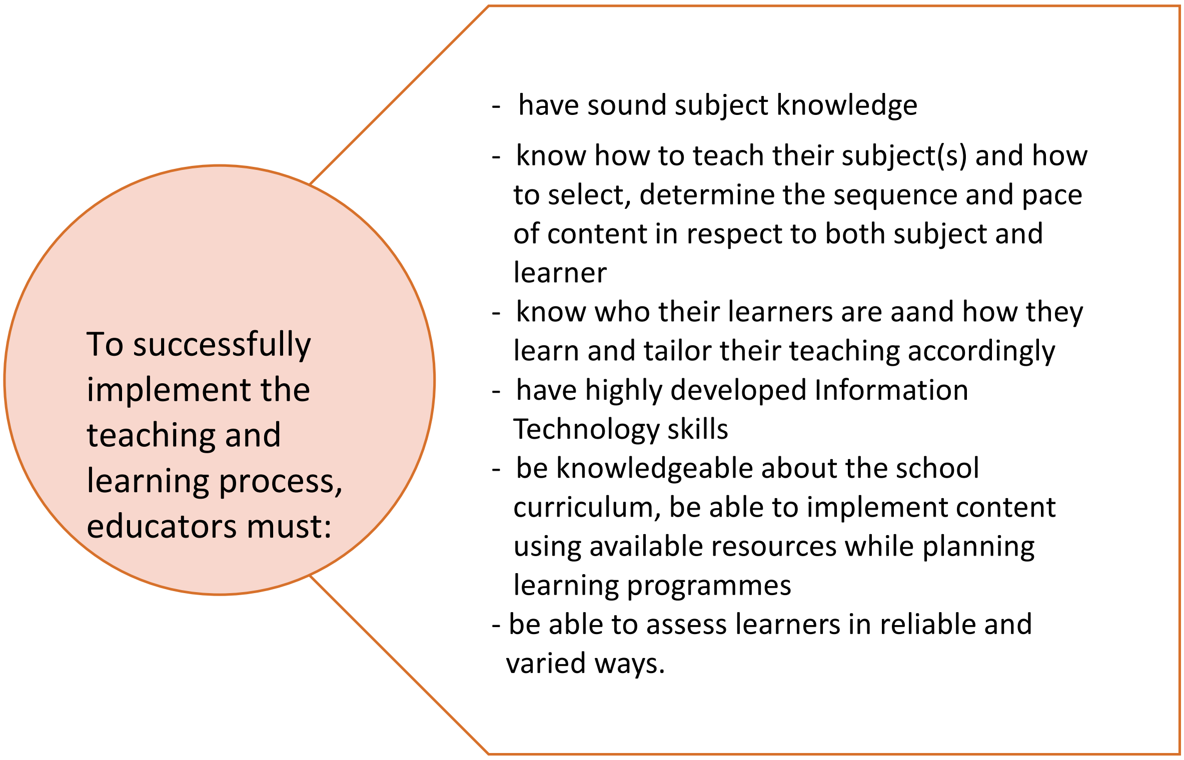


FIGURE 3.5: BASIC COMPETENCIES OF A TEACHER

SOURCE: Researcher's own adapted from Department of Higher Education (2015: 13 and 62). (2021)

According to the Department of Education Curriculum News (2013:5), although there are examples of excellent training programmes, a large majority have been ineffective. The National Education Evaluation and Development Unit recommended that training programmes receive urgent attention from the Department of Basic Education in view of identifying interventions that have a positive effect in the classroom. It is therefore evident that the evaluation and monitoring of professional development does not happen soon enough to remedy the shortfalls of the programmes. One may even question whether aims and objectives, have been established and whether they have been achieved for each of the professional development programmes.

The White Paper on Education and Training 1995 (Department of Education (1995:9) highlights that training and education are important components of the growth of human capital. This is an integrated approach to education and training. This approach to education allows for all learners to be included in the learning process. Educators adapt their pedagogical content knowledge to benefit the learner.

South Africans have undergone diverse histories of education, which is an important factor in the shift to a single national system of non-racial education. The overall purpose of the policy must be to allow all people to value, access and excel in lifelong education and high-quality training.

3.6. CONTINUOUS PROFESSIONAL TEACHER (EDUCATOR) DEVELOPMENT (CPTD)

Currently, the South African Council for Educators (SACE) and the Department of Basic Education (DBE) established the CPTD (Continuous Professional Teacher Development) system. The National Policy Framework for Teacher Education and Development in South Africa (2006:17) states that a large majority of educators need to reinforce aspects such as a subject knowledge base and pedagogical content knowledge, as well as teaching skills. The document highlights that the new CPTD system will "ensure that current initiatives devoted to the professional development of educators contribute effectively to the improvement of the quality of educators and provide educators with clear guidance regarding which activities will contribute to their professional growth".

SACE is the professional council for educators focusing on upskilling the level of the teaching occupation through managing the development of educators professionally. SACE is also tasked to oversee the implementation, management and quality assurance of the CPTD system (Booyse and Du Plessis, 2014:65).

New individuals to the teaching occupation are able to become part of the profession by one of the following two qualifications: "complete a BEd degree or by completing an appropriate first degree followed by a one-year Advanced Diploma in Education" (Department of Education, 2006:24).

Booyse and Du Plessis (2014:64) explain that a qualification is an accredited institution's formal declaration and certification of learning success, whereas learning programmes are structured learning experiences that lead to a certification.

To drive the success of educator development through the CPTD system, the quality of facilitators has the greatest impact. Life Science program advisors need to track the professional development process and its execution in the classroom. Lizer (2013:8) was of the notion that the standard of educators, principals and inspectors will guarantee results, including their experience and history.

Professional training and development activities are divided into four categories namely school-based programmes, employer-based programmes, qualification-based programmes, and other programmes offered by NGOs, educator unions, community-based and faith-based organizations, or private corporations. (Department of Education, 2006:18).

3.7. EDUCATOR PROFESSIONAL TRAINING AND DEVELOPMENT

With the reforms resulting from the education curriculum policy, there is a profound need for learning and adaptation on the part of educators. This can only be attained with the aid of professional development. The key driver of curriculum change success is the development of educators' knowledge, skills, attitudes and alignment of educator training methods (Lizer, 2013:1). Learner learning and success is impacted by the quality of educators and their approach to teaching.

The quality of the educator is improved by expanding the knowledge base, skills and competence (Keke, 2014:18). Therefore, educators should be developed continuously. Suzuki (2008) highlights that a large number of unqualified educators is a major impediment to enhancing educational quality, and in-service training is one strategy for improving the knowledge and abilities of unqualified educators who are currently working.

The professional development of educators may be understood as the upskilling of educators in different aspects of teaching through various activities. Meanwhile, Keke (2014:18) defines educator professional development is described as the process and practices that educators participate in to advance their professional careers. Bett (2016:2) indicates that developing countries in Africa and elsewhere are increasingly rising as a result of investing in their educators to achieve positive educational outcomes.

Keke (2014:26) augmented that successful educators' professional development:

- is aligned with learner learning needs;
- is intensive;
- is ongoing and connected to practice;
- focuses on the teaching and learning of specific content; and
- is continuously examined and assessed.

While professional training and development programmes are available for all educators to attend, in most cases only one educator per subject area per school may attend. Consequently, information received is meant to be conveyed to colleagues either through the cascade model whereby educators train their colleagues, or through educator clusters or communities where a network of educators share information (Keke, 2014:26).

When one thinks of professional training and development through whichever form, one should set a goal and achieve it. Therefore, the professional training and development of Life Sciences educators should aim to improve or to develop skills and knowledge. This should then impact on the methodology of instruction by educators in the classroom, which should result in improved learner learning (represented in Figure 3.6).

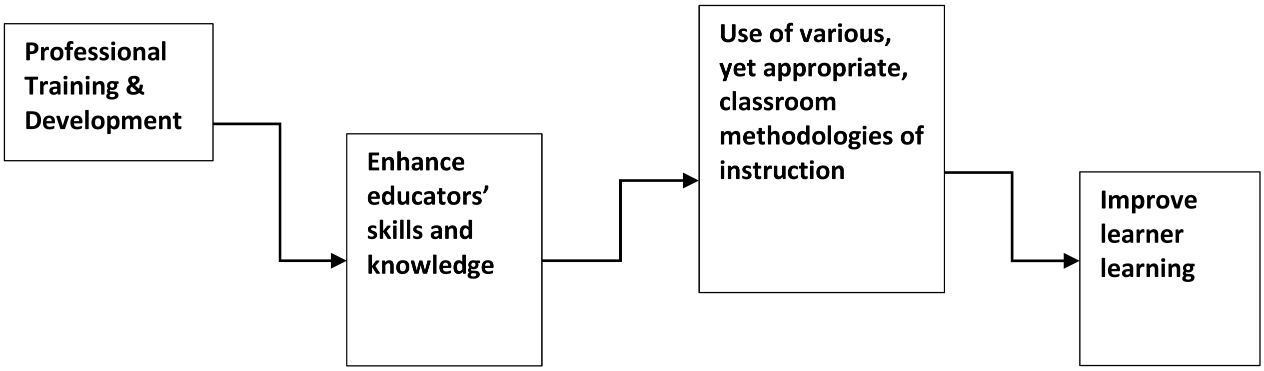


FIGURE 3.6: THE IMPACT OF PROFESSIONAL DEVELOPMENT PROGRAMMES ON EDUCATORS' AND LEARNERS' LEARNING
SOURCE: Researcher's own (2021)

Having an understanding of professional development and how it is regulated by SACE and DBE does not necessarily imply that the expected aims are met. Mokhele (2011:11) mentions in agreement that many continuous professional development initiatives really need to consider professional development from an educator's viewpoint, identifying what is the basis for educators to engage in these programs and how the programs will help them in the classroom.

As many studies are being currently undertaken regarding the professional development of educators, Karasira (2004:6) indicates that to address the new societal needs, educational system changes expect educators not only to upgrade their skills, but also to fully change their position as educators, resulting in a continuing need for professional development. As Life Sciences educators, it is imperative to have content knowledge about the subject matter to be taught. The lack of a Life Sciences content background may lead to selective content being taught to learners, while other aspects of the curriculum are ignored. Lizer (2013:15) highlights that many Biology (Life Sciences) educators do not have a sufficient understanding of the subjects they teach, restricting their ability to design and use higher-order thinking skills to assess learning comprehension through constructive learning.

Therefore, it must be clearly noted that content knowledge is impacted by the curriculum and it is imperative to ensure that the content is effectively conveyed to learners. This emphasises the need for professional development in the area of content knowledge. Lizer (2013:19) states that there must be a successful continuous professional development model which addresses the scientific literacy of the educator. Educators should be lifelong learners and the CPTD system should be designed to ensure that educators are continuously learning to improve themselves so that learning improves in the classroom.

Mokhele (2011:15) describes a study which shows that educators may be supported by rigorous professional development programs to enhance their skills and strengthen their teaching. Successful teaching of Life Sciences may be understood as Life Sciences educators mastering the content to be taught, the skills of teaching and method of how to teach it. Hudson (2013:771) believes that educators in schools are expected to enhance their skills through professional development, since it is understood that educator professional development is necessary for the transformation of education to take place. Kennedy (2005:236) highlights that it is possible to structure and coordinate ongoing professional development in a variety of ways and for a number of different purposes.

3.8 TYPES OF PROFESSIONAL TRAINING AND DEVELOPMENT

3.8.1 Cascade Model

The Cascade Model is also used by ministries of education to discuss strengthened curricula and more productive teaching-learning approaches in an attempt to to effect large-scale reform at the classroom level (Hayes,2000). Suzuki (2008:1) states that educator training is a specific means of improving the standard of teaching and the success of learners.

Using a qualitative approach, researchers Dichaba and Mokhele (2017: abstract) have concluded that in most in-service training courses, the cascade model has become the accepted method of delivering knowledge. However, it appears that it has neglected to significantly increase educator performance.

The Cascade Model, a system that delivers training messages across many layers from trainers at the central level to trainees at the local level, is primarily used for in-service training because it can deliver several qualified educators quickly and economically (Suzuki, 2008:1). Bett (2016) states that a variety of educators are also trained in specific content in this model and they go forward and train their colleagues in turn. While, Turner, Brownhill and Wilson (2016: abstract) highlight that close control of the knowledge of trainers and educators as it is conveyed via the system is important.

Ngeze, Khwaja and Iyer (2018:755) explain that the professional training cascade model is a top-down professional learning model where there is a flow of data from 'expert' educators or primary trainers to secondary trainers or multipliers at various levels. Here, the secondary trainers, undergo initial instruction and expertise from expert instructors through a workshop. These secondary trainers then educate other educators at the lower levels of the organization.

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Suzuki (2008:1) highlights that the drawback of the Cascade Model is that the messages sent during training are blurred. The intended messages are frequently altered and their implications are diluted by poor communication and the meaning of the same message. The Cascade Model is designed according to a central facility and top-down structure, but is difficult to adapt to grassroots needs.

Bett (2016:2) believes that ideally, the requirements on the ground should advise the framework and program of any good Educator Continuing Professional Development. Turner, Brown and Wilson (2016: abstract) explain that the professional development cascade model poses a hazard of diluting or distorting the information promoted in a curriculum as it moves from program creators to trainers and then to the target educators. Advantages of the cascade model have been reported as the use of existing teaching staff, cost-effectiveness and shorter time spans during training (Ngeze, Khwaja and Iyer, 2018:55)

Suzuki (2008:2), based on various researchers suggests ten conditional components to maintain the cascade mode's planning and implementation quality namely:

I. trainees and their requirements must be clearly established;
II. it is necessary to establish defined training objectives;
III. should be accompanied with consistent, high-quality training materials;
IV. trainers must be carefully chosen for their ability to train as well as their awareness;
V. of the specific knowledge and abilities to be taught;
VI. role and function of each person must be determined;
VII. each phase must allow enough time for trainers to organize and trainees to internalize the information;
VIII. each stage must be well-organized;
IX. any uncertainty must be eliminated;
X. a local support is expected; and
XI. the training process should be monitored.

3.8.2 Communities of Practice

Ngeze, Khwaja and Iyer (2018:7506) explain that the Communities of Practice model states that learning is a social activity including active engagement in the practice of social communities and the construction of activities in relation to these communities. Kennedy (2005:244) defines that communities of practice are typically made up of more than two persons and do not rely on confidentiality. According to the study, learning within such a community can be either a positive and proactive or a passive experience, depending on the individual's function as a member of the larger team. Wenger (2011:1) points out that people that participate in a process of collective learning on a shared domain constitute a community of practices.

The Community of Practice has been introduced as a new organisational form, which according to its proponents ensures that existing structures are reinforced (Ali, 2011:71). Members participate in joint activities and discussions, support each other and exchange data; while constantly interacting which allows them to learn from each other (Wenger,2011:2). Wenger (2011:2) believes that practitioners are members of a community of practice. They build a shared library of materials, experiences, stories, and tools.

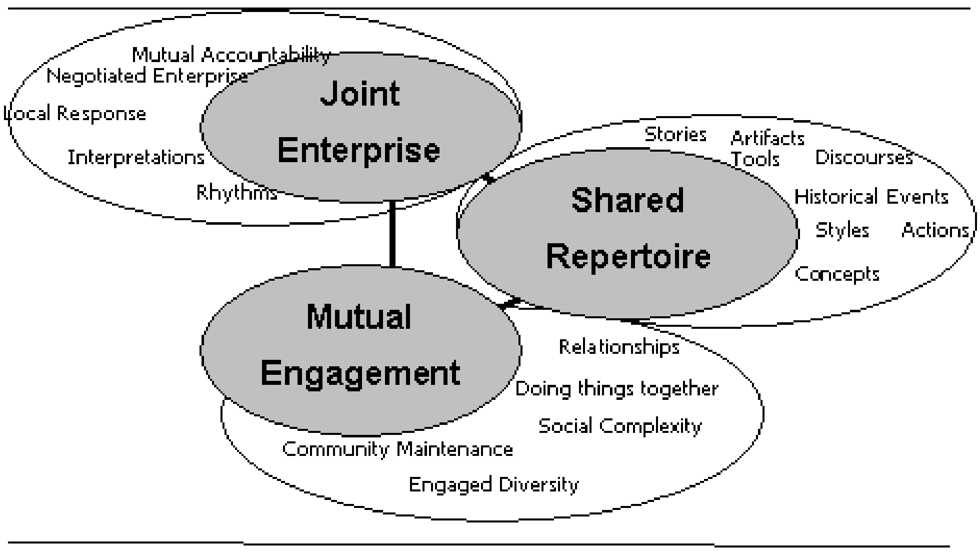


FIGURE 3.7: KEY COMPONENTS OF COMMUNITIES OF PRACTICE

SOURCE: Wilson, Ludwig-Hardman, Thornam and Dunlap (2004:np)

Figure 3.7 above illustrates Wenger's foundations of Communities of Practice, which presents that participants must be engaged in a joint enterprise whereby a joint project must draw them together. Participants must have shared access to a common resource portfolio and must establish relationships through reciprocal involvement in exercises to build trust.

Ali (2011:71) believes that a great deal of organisational learning occurs through the informal interaction of the individuals with similar interests in a social context. Communities of practice as a unique and informal organisational form exist along with formal organisational structures and hierarchies. Kennedy (2005:244) explains the added benefit of learning in societies that sees the presence of individual knowledge and the combinations of knowledge of many people through activity as a system aimed at knowledge generation.

3.8.3 Coaching/ Mentoring

The model of coaching/mentoring encompasses a number of professional development activities focused on a variety of methodological premises. The one-to-one partnership between two educators is generally necessary in order to promote continued professional growth (Kennedy, 2005:242). Ngeze, Khwaja and Iyer (2018:756) support the previous statement and cite Kennedy (2005) by stating that the coaching model involves one-to-one relationships between an experienced educator and novice educator. This model is more skills-based and encourages a diffusion view of professional development whereby educators obtain knowledge in the particular field by communicating with their more experienced peers.

Kennedy (2005:243) believes that this model "allows for the two educators involved to discuss possibilities, beliefs and hopes in a less hierarchically threatening manner". However, for the coaching/mentoring model of continuing professional development to be successful, the level of human interaction must be well established in this model. Mentoring in education is a dynamic multi-dimensional form of directing, teaching, shaping and promoting (Hudson, 2004:1).

Poplin (2003) explains that Project Venture in Phoenix (USA), a varied collaboration of urban, suburban, and rural school districts, has used coaching and mentoring extensively as a research-based, highly effective professional development strategy. Across the consortium, twenty-one technology mentor educators work with over 330 instructors. The technology mentor educators on assignment are highly trained, certified educators who employ coaching and modelling strategies to assist educators in effectively integrating technology into their classrooms.

Hudson (2013:772) explains that a variety of factors impact on an effective mentoring process, such as personal and professional traits of the mentor and mentee, as well as the mentor's attributes and practices; the setting or context in which it operates; and the employees involved in the relationship's selection and pairing.

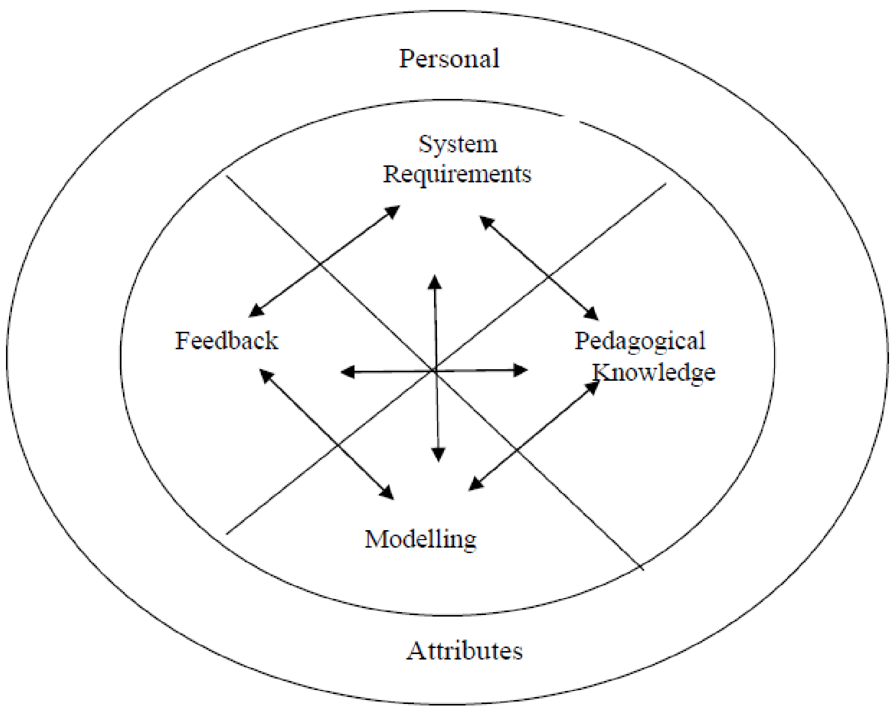


FIGURE 3.8: FIVE FACTOR MENTORING MODEL

SOURCE: Hudson (2004:3)

Figure 3.8 illustrates five factors in the mentoring model. Hudson (2004:3) describes the model as follows: Personal Attributes where the personal qualities of the mentor are central to the mentoring process. In relation to personal characteristics, mentors must also be supportive, attentive and able to instil confidence in their mentees (Hudson, 2004:3).

Moreover, the factor System Requirements provides guidance for quality control by offering a curriculum that focuses on achieving clear teaching objectives, while Pedagogical Knowledge is fundamental to the actual system of mentoring. Eleven qualities and methods of mentoring are correlated with pedagogical knowledge, namely planning for teaching, timetabling, preparation, teaching strategies, managing the classroom, critical skills, logical solving, knowledge of content, execution of lessons and evaluation of knowledge. The factor, 'Modelling' can relate to eight qualities and activities namely teaching, enthusiasm, a rapport with learners, classroom management, teaching effectively, practical lessons and well planned lessons (Hudson, 2004:4). The last factor, feedback, enables educators to reflect and strengthen teaching practices. Six attributes and practices are associated with feedback, articulate expectation, review, observe practice, provide oral feedback, assist mentee to evaluate teaching practices and provide written feedback (Hudson, 2004:5)

3.9 EVALUATION OF PROFESSIONAL TRAINING AND DEVELOPMENT

Training evaluation is a critical activity for the training and development function and it needs to be properly planned, framed and executed (Guha, Mukhopadyay and Patra, undated: abstract). Training and development assessment is an important part of assessing success after the completion of training and development programmes.

Srivastava, Dash and Walia (2018:1) explain that professional development is improved by training and growth in the learning of new skills, acquiring new experiences or attitudes. The authors state that evaluation is a method of judging something's value, quality, and relevance in relation to its goals. (Guha, Mukhopadhyay and Patra, undated:2) highlight depending on the type of training event and training goals, as well as the type of participants, this assessment can be conducted in a variety of ways.

Other purposes of training evaluation include: to assess if the goals set by the institution are being achieved by the training session; to account for the finances of the training session; determining the correct audience for the upcoming program; to gather information for productivity in future sessions, defining the efficacy of the various elements of training sessions; to assess the amount of teaching implemented by the trainees at work; and to ascertain whether training need analysis are met (Srivastava, Dash and Walia, (2018:3))

Ruskanda, Syharial and Suparman (2018:879) state that Education and training is a method of working to recruit more skilled workers and enhance facilities. The involvement of participants, the selection of materials and the delivery model is a representation of adult education, along with technological implementation.

3.9.1 Training and Development Evaluation Models

3.9.1.1. Kirkpatrick's Model

By far the most widely used evaluation model is laid out by Kirkpatrick, amongst other models. Although training and development programs may be carried out, these programs need to evaluated. Kirkpatrick and Kirkpatrick (2008:17) state that the purpose of reviewing training and development programs is to validate the training's existence and budget; to determine if the training should be continued; and to determine the training's efficiency and how it might be improved.

Srivastava, Dash and Walia, (2018:1) state that information gathered in the evaluation process helps the trainer and the organisation to modify and develop the training programme in order to become more constructive.

In order for the successful implementation of training and development programs, Kirkpatrick and Kirkpatrick (2008:9) highlight the following important aspects that need to be followed:

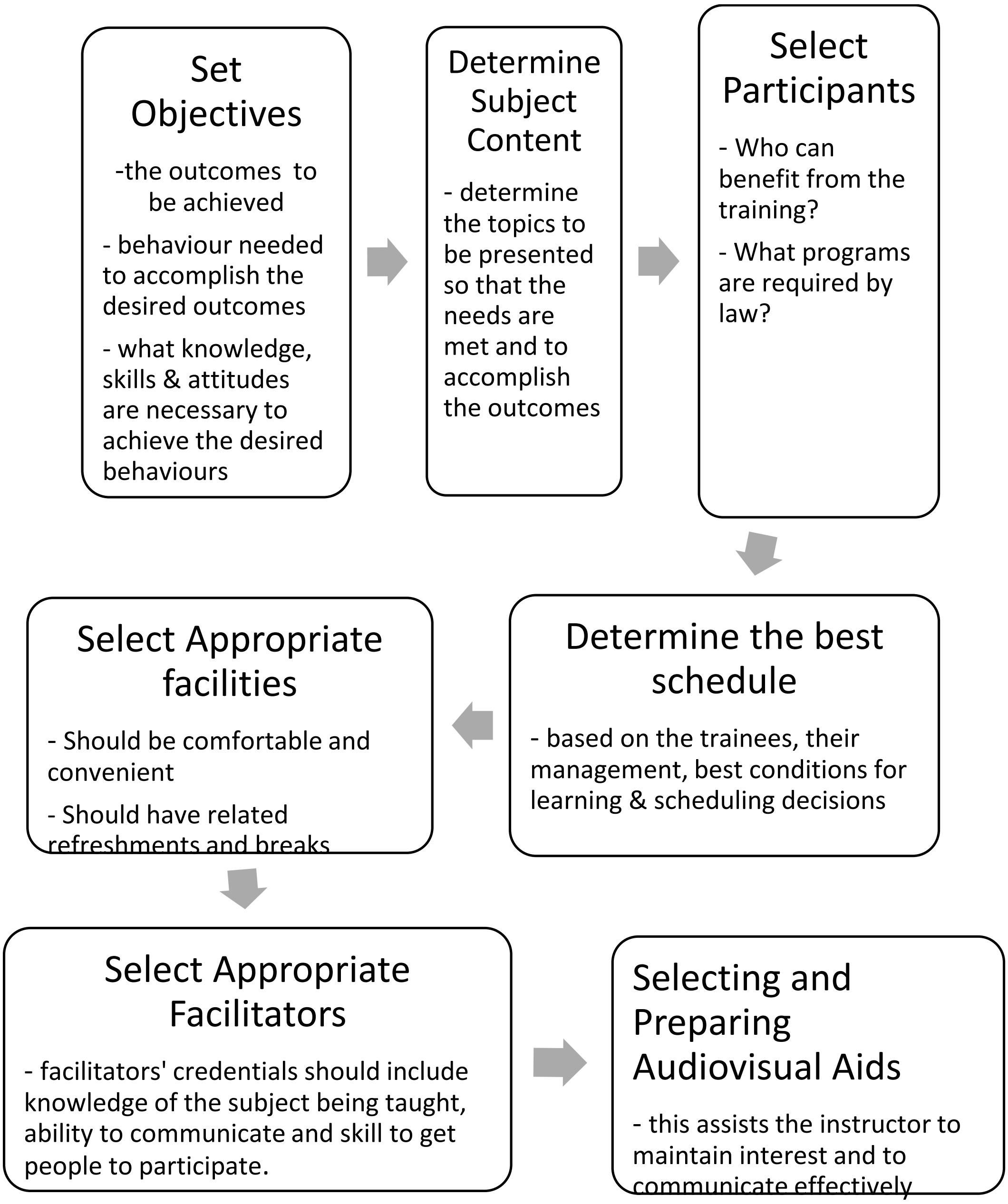


FIGURE 3.9 : ASPECTS FOR SUCCESSFUL IMPLEMENTATION OF TRAINING AND DEVELOPMENT PROGRAMMES.

SOURCE: Researcher's own adapted from Kirkpatrick and Kirkpatrick (2008:9)

Srivastava, Dash and Walia (2018:5) indicates that Kirkpatrick's model focuses on the training session only, that the model ignores effect of individual and organisational influences. To evaluate the training and development methods, proper criteria should be set. Kirkpatrick's model refers to four aspects.

FIGURE 3.10: KIRKPATRICK'S MODEL: FOUR LEVELS OF EVALUATING TRAINING AND DEVELOPMENT PROGRAMS
SOURCE: Kurt (2016:np)

Figure 3.10, highlights the four levels of evaluating training and development programs, where Level One (Reaction) refers to how participants react to the program, did they enjoy the program and did they find it beneficial or not? Level Two (Learning) refers to the degree to which individuals change behaviours, enhance comprehension and develop skills. Level Three (Behaviour) refers to change in the behaviour of participants because of attending the programs. Level Four (Results) refer to the final result of attending the program, which can be seen as an increase in productivity or improved quality (Kirkpatrick and Kirkpatrick, 2008:21).

3.9.1.2 CIRO Model

Kunene (2017:78) states that the CIRO (Context, Input, Reaction and Outcome) model emphasises trainee reaction as a source of information aimed at improving the training programme.

Warr, Bird and Rackham developed the model in 1970. The reaction assessment should track and measure the response of participants to the training session. Before and after the training session, this model aims at measuring all dimensions. (Srivastava, Dash and Walia, 2018:6). (Guha, Mukhopadhyay and Patra, undated:11) describes the CIRO model as:

Context	-	evaluation focused on factors like the objectives
Input	-	is concerned with the design and delivery of training programmes
Reaction	-	considers the quality of the training programme
Outcomes evaluation	-	focuses on the achievement gained from the training programme

3.9.1.3 BLOOM'S TAXONOMY

Bloom's Taxonomy was discussed previously with reference to knowledge creation. However, knowledge is created during training and development programmes. In the revised taxonomy shown in Figure 2.4, three of the initial groups were modified; two were exchanged in order; and the remaining group titles were modified to a verb form (Krathwohl, 2002:213). The purpose was to create a taxonomy that would assess learning at each stage.

The taxonomy table below (Table 3.1) shows the evolution or change from the original terms and aspects to the new terms and aspects. These can be used to describe the teaching and learning activities employed to meet the goals, as well as the evaluations used to assess how well the goals were accomplished (Krathwohl, 2002:217). The revised taxonomy shows a shift in emphasis from nouns to verbs. This re-inforces the construction of meaning through the learning process.

Structure of the Original Taxonomy	*Structure of the Cognitive Process Dimension of the Revised Taxonomy*
1. Knowledge 1.1 Knowledge specifics 1.11 Knowledge terminology 1.12 Knowledge of specific facts 1.2 Knowledge of ways and means of dealing with specifics 1.21 Knowledge of conventions 1.22 Knowledge of classification and Categories 1.23 Knowledge of criteria 1.24 Knowledge of methodology 1.3 Knowledge of universals and abstractions in a field 1.31 Knowledge of principles and generalisations 1.32 Knowledge of theories and structures	1. Remember- retrieving relevant knowledge from long term memory 1.1 Recognising 1.2 Recalling
2. Comprehension 2.1 Translation 2.2 Interpretation 2.3 Extrapolation	2. Understand –determine the meaning of instructional messages including oral, written and graphic communication 2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarising 2.5 Inferring 2.6 Comparing 2.7 Explaining
3. Application	3. Apply – carrying out or using a procedure in a given situation 3.1 Executing 3.2 Implementing
4. Analysis 4.1 Analysis of elements 4.2 Analysis of relationships 4.3 Analysis of organisational principles	4. Analyse – breaking material into it's constituent parts and detecting how the [arts relate to one another and to an overall structure or purpose. 4.1 Differentiating 4.2 Organising 4.3 Attributing
5. Synthesis 5.1 Production of unique communication 5.2 Production of a plan, or proposed set of operations 5.3 Derivation of a set of abstract relations	5. Evaluate – making judgements based on criteria and standards 5.1 Checking 5.2 Critiquing
6. Evaluation 6.1 Evaluation in terms of internal evidence 6.2 Judgements in terms of external criteria	6. Create – putting elements together to form a novel, coherent whole or make an original product 6.1 Generating 6.2 Planning 6.3 Producing

TABLE 3.1: COMPARISON OF THE FORM AND THE DESIGN OF THE ORIGINAL TAXONOMY TO THE AMENDED TAXONOMY

SOURCE: Krathwohl (2002:213)

An endeavour to acquire useful information on the impacts of a training program is referred to as ‘training evaluation’. The ability to evaluate, assess and improve the efficacy and efficiency of a training experience is regarded as crucial. By involving individuals in the formulation of training programs, the training assessment process can help measure training efficacy; improve overall job quality; and boost morale and motivation.

3.10 CONCLUSION

Despite policy and curriculum changes over time, very little has been done to impact the educator. An educator who does not have adequate content knowledge and is not confident to attempt various strategies of effecting teaching would not be able to successfully impart knowledge. As a result, unsuccessful learning takes place. The professional development of educators may be understood as the upskilling of educators in different aspects of teaching through various activities. The upskilling of educators is part of the learning process. During the learning process, knowledge is acquired by educators. The continuous professional development of educators results in the educator managing their knowledge and becoming a knowledge worker. Moreover, this has a ripple effect in the classroom. The more knowledge gained by the educator, the more knowledge can be imparted to the teaching and learning process. This ultimately adds to the sharing of knowledge in South Africa. A range of training and development methods may be used to professionally develop educators. Learners should be allowed to construct the meaning of the content during a lesson. The theory of constructivism should be a dominating factor in pedagogical content knowledge. Various teaching strategies to cater for the diverse learning styles of learners should be considered when planning lessons. The CPTD system created by SACE and the DBE need to monitor and evaluate programmes of teacher training in order to improve so that positive effects can be seen in the educators and subsequently in the classroom.

CHAPTER FOUR
PROFESSIONAL DEVELOPMENT FRAMEWORK

4.1 INTRODUCTION

The global education system has been continuously evolving. Educators are directly impacted by the curriculum and the changes that occur. The Curriculum reforms are aimed at improving the quality of teaching and learning. This can be effected by improving the quality of educators through forms of continuous professional training and development. The Department of Education (2001:12) has indicated that educators without specialised qualifications in Mathematics and Science need to be targeted for in-service training.

The terms development and training are synonymous with education and learning. Training involves learning in a mechanistic manner, while development involves learning by ‘thinking, doing and feeling’ (Garavan, Costine and Heraty, 1997:2). Fitzgerald (1992:81) defines training as the gathering of data and capabilities for current activities, an instrument to assist individuals in developing the organization and succeeding in their present role. The author defines development as the collection of information and techniques that can be applied now or in the future, as well as the equipping of personnel to contribute to the potential success of the organization.

Ndindeng (2019:5) highlights that training is a systematic procedure through a learning session to transmit or adjust knowledge, skills and behaviour. Saleem, Shahid and Naseem (2011:2) explain that development is a large, all rounded, ongoing sequence of activities to bring one to another level of success. The authors agree that training is a structured creation of the information, values and abilities needed by staff to perform effectively on a specific task or work.

4.2 PURPOSE OF PROFESSIONAL DEVELOPMENT

Fitzgerald (1992:81) believes that if they are to meet standards and add value to their organizations, individuals need some sort of preparation. The author considers training to be a short-term structure, while development is long-term allowing people to meet new challenges. Chaudary and Prasad (2011:16) states that training is a trainer-led, content-based method that progresses to an individual's desired shift in attitude.

Development and training are connected to the business objectives and performance, with the focus being to improve the knowledge and skills of the employees as necessary to achieve organisational and personal goals (Kapur, 2018:1). Saleem, Shahid and Naseem (2011:1) state that development and training increases organizations' work efficiency as workers realize what is required of them. They also highlight that frequently trained workers are well-driven and have increased trust and self-esteem. They agree that development and training develops and improves the knowledge and skills of workers to encourage them to respond to new technologies and transitions.

The learning objectives, size of the target population, learning styles, participant engagement, course content, period of the training courses, and training objectives and capabilities all influence the technique of development and training chosen (Kapur,2018:7). Chaudary and Prasad (2011:162) indicate that the first step is to define the problem, to distinguish the influence from the impact and to determine the cause. Ndindeng (2019:6) states that “strategies and training include discussion, dialogue, contextual research, demonstration and presentation”.

Kapur (2018:7-8) identifies two types of development and training methods: on-the-job training where learning/training takes place within the workplace, such as coaching or job rotation and off-the-job training where training is imparted at a distance from the workplace, which includes conferences, workshops and lectures. Saleem, Shahid and Naseem (2011:2) states that a strong system of training and development helps the workers understand what the organization is and its condition, and keep up-to-date with the skills required to do their daily work.

4.3 A CONCEPTUAL FRAMEWORK LINKING PROFESSIONAL DEVELOPMENT TO IMPROVED LIFE SCIENCES EDUCATION OUTPUT

In this study, there is development of a conceptual framework showing the links between aspects of the literature and the research question. Ravitch and Riggan (2017:4) states that the conceptual framework can be interpreted as a strictly graphic display of the organization of a study, or a way to connect all components of the research process together.

The ultimate purpose of a conceptual framework is to make the research outcomes more applicable and appropriate to the theoretical models (Adam, Hussein and Adu-Agyem, 2018:438). Ravitch and Riggan (2017:7) describe the conceptual framework as a combination of experiential knowledge and prior theory and research. Akintoye (2015:3) explains that A conceptual framework is made up of concepts that are organized in a meaningful, proper sequence. Meanwhile, Rocco and Plakhotnik (2009:122) believe that The purpose of a conceptual framework is to organize and categorize concepts that are pertinent to the study, as well as to draw relationships between them.

Akintoye (2015:3) explains that the goal of the conceptual framework is to explain concepts and to suggest links between the concepts in the analysis. The author states that concept maps pull together and make visible what an existing theory is, as well as helps one to see unexpected connections. Adam, et al., (2018:439) states that the conceptual framework is a system that the researcher believes best explains the natural course of the phenomenon being examined, and it is organized in a logical structure to help and demonstrate how ideas in a study are related to one another.

4.4 POSSIBLE FUTURE VALUE OF THE CONCEPTUAL FRAMEWORK LINKING PROFESSIONAL DEVELOPMENT TO IMPROVED LIFE SCIENCES EDUCATION OUTPUT FOR THE SOUTH AFRICAN DEPARTMENT OF EDUCATION

The challenge is to enhance the quality of education in all schools, considering that some schools may be deprived of resources, facilities and qualified educators (Ramdass, 2009:114). Moodley (2013:21) highlighted that the need to move from a conventional teacher-centred approach to a learner-centred approach has been troublesome.

Maarman and Lamont-Mbawuli (2017:272) highlights that it should also be taken into account that a teaching method that worked well in the previous South African Education System may not work as well in the current system. The authors suggest that educators need to change their style of teaching to a more inclusive strategy.

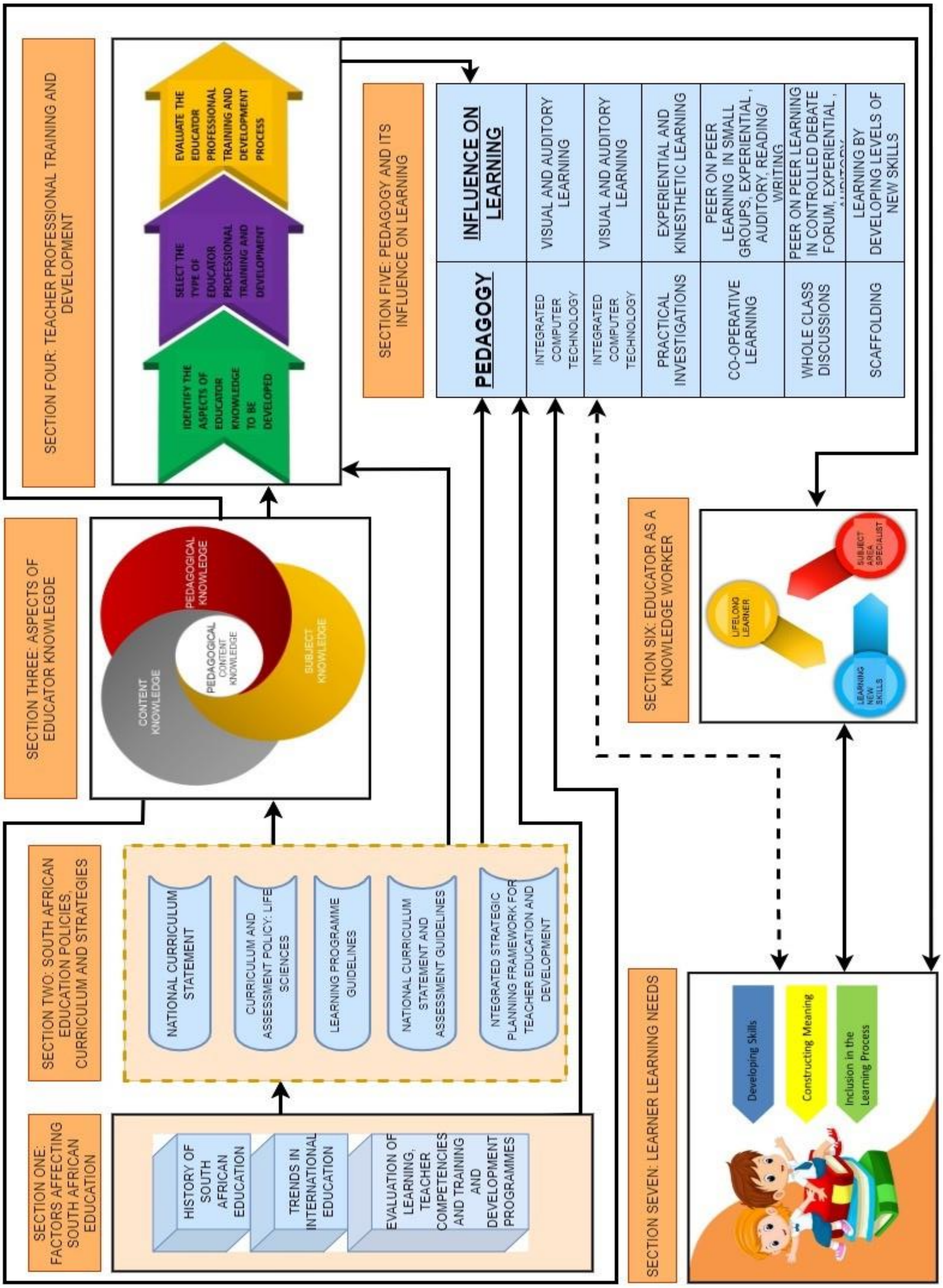
Inadequately developed and trained educators and inadequate support would directly contribute towards the failure of the curriculum (Mouton, Louw and Strydom, 2012:2). Moodley (2013:22) states that “the training and support provided to them are not adequately addressing their needs”. Mouton, Louw and Strydom (2012:40) stress that training programs need to be updated and continued and high-quality training, which is less theoretical and more realistic, needs to be delivered.

These challenges have shown that the Department of Education has to focus on the professional development of educators in order to improve on aspects such as educator quality, content knowledge and pedagogical knowledge.

4.5 FORMULATION OF THE CONCEPTUAL FRAMEWORK LINKING PROFESSIONAL DEVELOPMENT TO IMPROVED LIFE SCIENCES EDUCATION OUTPUT

With reference to the various models and ideals, as well as literature discussed in the prior chapters, this study offers the formulation of the conceptual framework linking professional training and development to improved Life Sciences education output to the South African Department of Education. The formulation of the Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output represented in Figure 4.1. places in context the research questions. The relationships represented in the conceptual framework linking professional development to improved Life Sciences education output acknowledges the challenges faced by the Department of Education regarding the quality of teaching, quality of teaching and education output. The researcher has tried to integrate key factors of professional development as well as pedagogy, thereby creating a contribution towards this study. Figure 4.1. is a graphical representation of relationships between aspects that subscribe to the formulation of the conceptual framework linking professional development to improved Life Sciences education output.

FIGURE 4.1.: CONCEPTUAL FRAMEWORK LINKING PROFESSIONAL DEVELOPMENT TO IMPROVED LIFE SCIENCES OUTPUT



4.5.1 An Account of the Sections of the Conceptual Framework Linking Professional Training and Development to Improved Life Sciences Education Output

Section One of the conceptual framework linking professional development to improved Life Sciences education output is the factors affecting South African education. This section is found at the top left hand side of Figure 4.1. It is crucial as it influences the creation of policies, curricula and strategies created by the South African Department of Education. The history of South African Education; trends in International Education reforms; and the evaluation of educator competencies, learning and training and development programmes are factors that impact on the South African education system.

Section Two of the conceptual framework linking professional development to improved Life Sciences education output is education policies, curriculum and strategies. This section is found at the top middle of Figure 4.1. This section represents the various education policies, curriculum and strategies that influences the expectations of a teacher. The curriculum (CAPS) provides that subject content to be known by the teacher. The assessment guidelines provide a guideline on how assessments are to be carried out at each phase of learning. This policy also highlights the various types of assessment techniques that may be employed. The CPTD strategy outlines the strategy to be implemented in order to improve educator professional development.

Section Three of the conceptual framework linking professional development to improved Life Sciences education output is the aspects of educator knowledge. This section is found on the top middle of Figure 4.1. This section is influenced by the education policies, curriculum and strategies in Section Two. Section Three encompasses the four aspects of educator knowledge namely subject knowledge, content knowledge and pedagogical knowledge which all contribute towards an educator's pedagogical content knowledge. Authors such as Shulman (1987) and Fernandez (2014) influence these aspects of educator knowledge.

Section Four of the conceptual framework linking professional development to improved Life Sciences education output represents the processes of educator professional development. This section is found on the top right of the framework in Figure 4.1. This section states that there is a need to identify the aspect of educator knowledge to be developed. This is followed by identifying the appropriate types of educator professional development that can be undertaken by an educator, which is influenced by the strategies and policies listed in Section Two. Professional development is also influenced by aspects of educator knowledge mentioned in Section Three. Various authors have contributed to the confirmation that these types of educator professional training and development are successful to the educator. Finally, the educator professional development must be evaluated. Results of the evaluation influence further professional development to be developed.

Section Five of the conceptual framework linking professional development to improved Life Sciences education output shows pedagogy and its influence on learning. This section is located at the bottom right of Figure 4.1. and is influenced by Section Three, the aspects of educator knowledge as pedagogical knowledge is one of the components listed. This section is also influenced by Section Two, on education policies and strategies, which outline strategies that may be used in teaching in order to achieve outcomes. Section One, factors affecting South African education, also influences Section Five as it refers to the ignorance of learner differences, which must be catered for in present day education. The fact that not all learners learn in the same way influences educators to develop their lessons to suit the learning styles of learners.

Section Five influenced by models of learning styles and lists various forms of pedagogy and their influence on the learning process. The development of Section Five is influenced by learning models namely the VARK Model, The three learning modalities of Barbe and Kolb's Model,

Section Six of the conceptual framework linking professional development to improved Life Sciences education output deals with the educator as a knowledge worker. This section is directly influenced by Section Four as attendance at the various types of teacher professional training and development allows for educators to continuously learn new aspects and develop themselves in order to improve their quality. This section which is found on the bottom middle of the framework of Figure 4.1., is also influenced by Section Seven, learner needs. The needs of the learner will determine the aspect of training and development needed by the educator. The SECI and the WIIG models influence how the knowledge worker is able to manage knowledge.

Section Seven of the conceptual framework represents the learning needs of the learner. These needs are identified in policy documents such as White Paper Six and is influenced by the works of Vygotsky and Piaget. The works of Shulman (1987) highlight the impact of pedagogical knowledge on learning. This implies the influence of Section Three on learner learning needs. The educator as a knowledge worker is a section influenced by learner learning needs and influences learners' learning needs. Section Seven is found in the bottom left of Figure 4.1.

4.5.2 A Description of the Sections of the Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output

From the detailed literature review, Figure 4.1. above brings together key aspects for the development of the conceptual framework linking professional development to improved Life Sciences education output for the South African Department of Education. The framework amalgamates the theoretical aspects linking aspects of educator knowledge, professional training and development, pedagogy and the educator as a knowledge worker to the needs of the learner. The conceptual framework linking professional development to improved Life Sciences education output, as shown in Figure 4.1 consists of the seven sections namely:

Section One:	Factors affecting South African Education
Section Two:	Education Policies, curriculum and strategies
Section Three:	Aspects of educator knowledge
Section Four:	Educator professional development
Section Five:	Pedagogy and its influence on teaching
Section Six:	Educator as a knowledge worker
Section Seven:	Learner needs

The main aspect to the framework (Figure 4.1.) is the learners' needs diagram, to which aspects of educator knowledge influences. The educator being a knowledge worker influences and is influenced by learner needs.

The procedure flow of the conceptual framework linking professional development to improved Life Sciences education output (Figure 4.1.) is represented by the use of solid arrows and dot line arrows. A solid line arrow begins at Section One, namely the Factors affecting South African Education Systems, which consists of the history of South African education, trends in international education reforms, evaluation of educator competencies, learning and training and development programmes. This one-way solid line arrow connects to Section Two, namely the Education policies, curriculum and strategies. A solid line arrow connects Section One to Section Five, namely pedagogy, and it influence learning, representing a suggested impact of Section One on Section five.

Section Two is depicted as a dot line block, which represents the reforming of policies, strategies and curriculum over time. A solid line arrow connects Section Two of the conceptual framework linking professional development to improved Life Sciences education output to Section Three, namely Aspects of Educator Knowledge. This section comprises content knowledge, subject knowledge, pedagogical knowledge and pedagogical content knowledge. A solid line arrow connects to Section Five, Pedagogy and its Influence on Learning, with examples provided. A solid line arrow connects Section Two to Section Four, namely Educator Professional Development. This section comprises identifying the aspect of educator knowledge to be developed, the type of educator professional development to be undertaken and the evaluation of educator professional training and development. This solid line arrows suggests that the policies, curriculum and strategies influences the educator professional training and development, as well as pedagogy.

A solid line arrow connects Section Three to Section Four namely the Educator Professional Development. The Aspects of educator knowledge that need to be developed are done so by attendance at the educator training and development programmes. Section Three is also connected to Section Five, namely Pedagogy and its Influence on Learning. Aspects of educator knowledge, subject knowledge, content knowledge, pedagogical knowledge and pedagogical content knowledge influence an educator’s pedagogy thereby impacting on the learning process. Section Three is connected to Section Seven, Learner Needs, by a solid line arrow. This implies that an educator’s knowledge impacts on the learner and the learning process.

Section Four is connected by a solid line arrow to Section Five, Pedagogy and its Influence on Learning, as the knowledge gained through attending educator professional development influences the pedagogical choices made by an educator. A solid line arrow also connects Section Four to Section Six, Educator as a Knowledge Worker and consists of the educator as a lifelong learner, educator and as a specialist in a subject area, as well as the educator learning new skills.

Section Five of the conceptual framework linking professional development to improved Life Sciences education output, Pedagogy and its Influence on Learning, is influenced by Sections Two, Three and Four. Section Five of Figure 4.1. is connected by a two-way dot line arrow to Section Seven, learner learning needs, which comprises inclusion in the learning process; the construction of meaning; and the development of skills. The two-way dot line arrow indicated evolving changes in pedagogy due to the needs of the learners. Section Five influences the success in the learning process while knowledge is being constructed.

A two-way solid line arrow connects Section Six, Educator as a Knowledge Worker, to Section Seven on learner learning needs. As these learner learning needs intensify the educator gains more knowledge, therefore evolving their knowledge base. The knowledge gained influences the success of learning by the learner. Section Seven was previously discussed.

4.5.2.1. Section one: Factors affecting South African Education

Section One located at the top left hand side of Figure 4.1., presents the following factors: the history of South African education; trends in international education reforms; and evaluation of educator competencies, learning and training and development programmes. These impact on the evolution of South African education policies, curricula and strategies.

South African Education pre-1994 was run under a general education policy by the Department of National Education and implemented by the other 18 departments of education. Educators were trained according to where schools were developed. For the purposes of this historical value, the South African education system was reviewed and reformed, not just once. The basis of the curricular shifts was towards pedagogical change and equal education for all.

The learning process is evaluated in the form of tests, exams and other forms of assessment in order to determine whether learners are achieving the set outcomes. The National Curriculum Statement Subject Assessment Guidelines (Department of Education, 2008b) highlights the type of assessments to be undertaken and the purpose of the assessments.

The evaluation of educator competencies is also needed in order to determine the output in the classroom. However, the evaluation of educator competencies leads to the development and revisions of policies and strategies to determine educator competencies and to upskill educator competencies by professional training and development.

The evaluation of training and development is crucial and should influence the revision of current professional training and development strategies. This is to ensure that subsequent professional training and development programmes are meeting the desired outcomes. This study has focused on education curricula in six different countries, namely Finland, Australia, Japan, China, Canada and Singapore. Each of these countries focuses on an aspect of education, such as pedagogy and inclusive practices. All of these countries have undergone education reforms in order to find the most suitable form of education for all. Meanwhile, most of these countries conduct research on the current curriculum and policies in order to evaluate and modify the curriculum and policies for more successful implementation.

These trends in international education practices influence the reform of South African education to one of ‘equal education for all’. This ideal influences the development of education policies, curriculum and strategies.

4.5.2.2 Section Two: Education Policies, Curricula and Strategies

Section One factors affecting the South African Education System of the conceptual framework linking professional development to improved Life Sciences education output flows to Section Two by a solid line arrow. Section Two is found on the top middle of Figure 4.1. and refers to the Education policies, curriculum and strategies. The focus of this study is on the Curriculum and Assessment Policy Statement: Life Sciences (Department of Education, 2011a). This document provides the educator with subject and curriculum knowledge outlining the topics to be taught and time guidelines of teaching, which assists with lesson planning.

This policy is the subject-specific policy of the National Curriculum Statement, which provides the general guidelines of education in South Africa. The National Curriculum Statement emphasised the move away from traditional autocratic teaching methods to a more constructive active-learning method. The National Curriculum Statement is based on the principles (Department of Education, 2011a:4-5) of “ensuring that educational imbalances of the past are redressed; active and critical learning rather than rote and uncritical learning; high knowledge and high skills; and providing a level of education that is comparable in quality to those of other countries”. The development of the National Curriculum Statement is influenced by the factors listed in Section One of the Framework (Figure 4.1.).

The Learning Programme Guidelines provides guidance to education stakeholders for introducing the National Curriculum Statement. This policy highlights stages such as the “development of a subject framework, development of a work schedule and development of lesson plans” (Department of Education, 2008a:3-4). The Learning Programme Guidelines are developed from the National Curriculum Statement and Curriculum and Assessment Policy.

The National Curriculum Statement Subject Assessment Guidelines for Life Sciences (Department of Education, 2008b:1) is built on the foundations of the National Curriculum Statement and Curriculum and Assessment Policy. The document highlights formal and informal assessment and the goal is to improve the knowledge, skills and values of learners; analyse the advantages and disadvantages of learners; provide adequate assistance for learners; review or update some parts of the curriculum; and inspire and motivate learners.

The Integrated Strategic Planning Framework was developed from the evaluation of educator competencies and learning performance. The purpose of this document is improvement in the quality of educator education and development (Department of Education, 2011b:1). The document describes that the issues affecting South Africa's Teacher Education and Development (TED) as important. Some challenges faced involve the deficiency of access to high calibre Teacher Education and Development opportunities for prospective and practising educators, as well as the negligence of the structure significantly in improving the quality of teaching and learning in schools. This strategy also makes reference to SACE, which is responsible for quality management in identifying and addressing teacher development needs and to ensuring that professional development programmes are available for educators.

4.5.2.3 Section Three: Aspects of Educator Knowledge

Section Three, on the aspects of educator knowledge is influenced by the Education policies, curriculum and strategies (Section Two) of Figure 4.1. The aspects of educator knowledge mentioned in Section Three are subject knowledge, content knowledge and pedagogical knowledge and these aspects overlap as **pedagogical content knowledge.**

The Model of Educator Knowledge in Fernandez (2014:85) places **pedagogical content knowledge** at a central point. This model, shown as Figure 3.4. in Chapter Three, illustrates that subject knowledge, pedagogical knowledge and context knowledge transform towards pedagogical content knowledge. Meanwhile, Figure 3.5. of Chapter Three represents the components of **pedagogical content knowledge** for teaching science in Fernandez (2014:87). It depicts aspects of the knowledge of a science educator such as understanding science (representing content knowledge), knowledge of instructional strategies (representing pedagogical knowledge) and knowledge of science curricula (representing subject knowledge). Models of learning styles can assist educators when planning lessons to ensure effectiveness, such as the VARK Model, Barbe's Model and Kolb's Model.

Content Knowledge deals with knowing the content to be taught. Khan, Khan and Khan (2016:1-2) state that an educator possessing good knowledge about a concerned field can easily promote academic performance. Content knowledge alone cannot provide educational success. The educator must know how to effectively communicate this Content Knowledge (the aspect known as Pedagogical Knowledge). Pedagogical knowledge focuses on the strategies or pedagogies of communicating the content knowledge to learners. Shulman (1986) states that a Biology (Life Sciences) educator must understand the variety of ways in which the discipline is organised. As learning styles vary from one learner to another, so should the teaching pedagogies or strategies. Tanner and Allen (2004:19) state that Science educators need to broaden their own styles of teaching and pedagogical methods in lessons in order to meet the various groups of learners.

Subject Knowledge focuses on knowledge of the curriculum. The educator must understand what the curriculum states and have a knowledge of policies and strategies associated with the curriculum. Subject Knowledge requires the educator to be familiar with the content and topics to be taught and the time-frame within which it is to be taught. Subject Knowledge provides educators with the information to create their own lesson plans. However, for effective lesson planning, Subject Knowledge is linked with Content Knowledge and Pedagogical Knowledge.

4.5.2.4. Section Four: Educator Professional Development

Section Four of the conceptual framework linking professional development to improved Life Sciences education output (seen in Figure 4.1.) is connected by a solid line arrow from Section Two and Section Three. Section Two consists of policies, curriculum and strategies such as the Integrated Strategic Planning Framework, which makes reference to the development of educators along with SACE. Section three depicts the aspects of educator knowledge that need to be developed through educator professional training and development. The Department of Education (2001:12) states that "educators without specialised qualifications in Mathematics and Science need to be targeted for in-service training to address the lack of knowledge". In the educator professional development section, the first feature is to identify the aspect of Educator Knowledge to be developed.

Hudson (2013:771) highlights that educators are expected to enhance their abilities through a form of professional growth. However, Karasira (2004:6) explains that in order to address societal needs, educational reform requires educators to attend ongoing professional development. Educator professional development activities must be designed to meet the outcomes set. In Keke (2014:26), it is augmented that the active professional development of educators is compatible with the needs of learners; is comprehensive, continuous and related to practice; focuses on teaching and learning relevant content; and is regularly monitored and evaluated. According to Department of Education Curriculum News (2013:5), there have been a number of excellent professional training programmes, but a large majority have been ineffective.

Professional Development serves to enhance educators' skills and knowledge thereby allowing the educator to make use of various yet appropriate pedagogies, which improves learner learning. The South African Council for Educators (SACE) and the Department of Basic Education (DBE) established the CPTD (Continuous Professional Teacher Development) system. The National Policy Framework for Teacher Education and Development in South Africa (2006:17) states that "a large majority of educators need to reinforce their subject knowledge base and pedagogical content knowledge as well as teaching skills". The Department of Education (2006:18) states that “professional development may be classified as school-driven programmes, employee-driven programmes and qualification-driven programmes”.

The researcher has selected the most common types or designs of professional development experienced by educators. Kirkpatrick and Kirkpatrick (2008:9-13) advise that the following aspects be followed when designing a professional training and development programme, namely “setting objectives, determining subject content, selecting participants, determining the best schedule, selecting appropriate facilities, selecting appropriate facilitators and selecting and preparing audio-visual aids”.

Suzuki (2008:1) explains that the cascade model is a multi-layer system for getting training messages from central trainers to local trainees. is commonly used for in-service training because it can swiftly and cost-effectively offer a large number of qualified instructors. Suzuki (2008:1) highlights the weakness of this model as the distortion of the messages transferred. This is supported by Turner, Brown and Wilson (2016: abstract) stating that the knowledge promoted will be distorted as it passes from originators to target educators. Advantages of the cascade model have been reported as the use of existing teaching staff, cost-effectiveness and shorter time spans during training (Ngeze, Khwaja and Iyer,2018:755).

People that participate in a process of collaborative learning on a shared domain form communities of practice (Wenger,2011:1). This is based on a concept of learning as social interaction, where all participants are actively involved and there is construction of knowledge happening. Kennedy (2005:242) explains that the coaching/mentoring approach is a one-on-one connection between two educators that is intended to help them continue their professional growth.

In the coaching/mentoring design of educator professional development, educators gain expertise in a specific area by associating themselves with more experienced colleagues. Other types of educator professional training and development designs or programmes may be used, such as workshops and seminars. Selecting the appropriate design or programme is dependent on the aspect of educator knowledge to be developed. Educator professional development designs or programmes must be evaluated.

The evaluation of educator professional development designs or programmes is crucial and should influence the adjustment or adaptation of current educator professional training and development designs or programmes in order to ensure that subsequent designs or programmes meet the desired outcomes. Various models of evaluation of training and development are in existence. Kirkpatrick's model is the most widely used evaluation model. Srivastava, Dash and Walia (2018:1) highlight that information gathered in the evaluation process helps the trainer and organisations to modify and develop the training programme in order to become more constructive. The CIRO model places emphasis on trainee reaction as part of the evaluation process.

4.5.2.5 Section Five: Pedagogy and its Influence on Learning

Section Five, Pedagogy and its Influence on Learning of the conceptual framework linking professional development to improved Life Sciences education output is linked by a two-way dotted line arrow to Section Seven, Learner Learning Needs. This type of line represents the evolution of pedagogy, which influences the learner needs but is also determined by the changing inclusive learning needs of the learner. Section One, Two, Three and Four flow into Section Five by solid line arrows depicting the influence of these sections onto Section Five.

Pedagogical content knowledge is a combination of an educator's content knowledge, subject knowledge and pedagogical knowledge. **Pedagogical content knowledge** is the link of these three aspects of **educator knowledge** to promote successful teaching and learning in the classroom. The use of technology when selecting an appropriate pedagogy is referred to as Technological Pedagogical and Content Knowledge (TPACK). The TPACK model formulated by Mishra and Koehler (2006:1025) is built on the foundation of **pedagogical content knowledge** by Shulman (1986). It emphasises the interactions between and amongst content, pedagogy and technology.

However, the selection of the appropriate pedagogy for a lesson must take into consideration the diversity of learners' learning. This is explained by reference to models of learning styles. The VARK model developed by Fleming in 1989 focuses on four sensory modalities of learning, namely: visual, auditory, reading and kinaesthetic. Very similar is the three learning modalities of Barbe (Baig and Ahmed, 2016) which emphasise the visual, auditory and kinaesthetic learning strengths of learners. Kolb's model (1984) focuses on experiential learning and is founded on the basis of cognitive learning by Dewy, Lewin and Piaget.

According to the researchers, Integrated Computer Technology (ICT) is a pedagogy which appeals to a learner's visual and auditory learning skills. Practical investigations allow for hands-on learning focusing on the kinaesthetic, reading / writing and experiential learning styles. Co-operative learning usually takes place in small groups where learning is experiential to the environment, with listening and speaking skills along with reading and writing. Whole-class discussions are similar to co-operative learning. However, it involves a whole-class discussion in a controlled debate forum. This promotes experiential, auditory, reading and writing, and sometimes visual learning styles. Scaffolding is a pedagogy which strives to enable a learner to attempt a level of skills which has not yet been engaged in typical classroom tasks. The aim is to determine a learner's level of capability and be able to adjust future pedagogies accordingly.

4.5.2.6 Section Six: Educator as a Knowledge Worker

Section Four, Educator Professional Development, flows into Section Six by a solid line arrow. This indicates that teacher professional development influences Section Six. Section Six is found at the bottom middle of Figure 4.1. This section is represented as a cycle, showing a continuous cycle of knowledge gaining. Van Staden (2009:11) highlights that the "knowledge worker is an educated individual in a specialist knowledge area". The professional development of educators leads to the development of knowledge workers. Ludwikowska (2018:179) points out that training is effective for developing workers with certain abilities as one of the methods of production. The continuous professional development of educators ensures that educators are lifelong learners. This continuous gain of knowledge impacts their **pedagogical content knowledge** in the classroom. The acquisition of new knowledge and skills makes the educator a specialist in a subject area, whilst being a life-long learner.

A two-way solid line arrow between Section Six and Section Seven indicates that as the learning needs of the learner changes over time, it determines the knowledge to be gained by the educator. This knowledge gained by the educator in turn influences the learning process of the learner.

4.5.2.7 Section Seven: Learner Learning Needs

Section Seven is the focal point of the conceptual framework linking professional development to improved Life Sciences education output (Figure 4.1.) This section influences Sections Five and Six, and is influenced by Sections Five and Six. Sections in this framework follow a process flow which ultimately impacts on Section Seven: the Learner Learning Needs.

The models of learning styles discussed earlier indicate that learners learn differently. Some may rely on visual, auditory, reading or kinaesthetic learning styles. The learning environment also influences the learning. Some learners may benefit from a mix of learning styles as time goes by. The educator needs to acknowledge the diversity in learning and select appropriate pedagogies to impact successfully on the learners' learning needs. Carey and Smith (1993:236) believe that it is important to introduce a constructivist epistemology of Science to learners, where learners gain an understanding.

Learners must be able to construct meaning from lessons. Booyse and Du Plessis (2014:96) state that as claimed by both Piaget and Vygotsky, knowledge must be built through the learner's tasks. Section Five influences the construction of meaning and the development of skills by choice of pedagogy of the educator. The White Paper 6 (2001:6) emphasises "acknowledging that all children and youth can learn and that they need support" and learning methodologies to meet their diverse needs. Learners must be included in the learning process.

4.6 CONCLUSION

In this chapter, the formulation of the conceptual framework linking professional development to improved Life Sciences education output (Figure 4.1.) was developed and is an original compilation by the researcher. The researcher describes the seven sections and the components of the conceptual framework linking professional training and development to improved Life Sciences education output, shown in Figure 4.1. The framework will provide the South African Department of Education with a clearer understanding of the necessity of educator professional development to education output. The formulation of the conceptual framework linking professional development to improved Life Sciences education output (Figure 4.1.) is derived from aspects of in depth literature review. This framework highlights factors that affect South African Education reform and the policies, strategies and curriculum devised thereof. The framework also looks at the influence of these policies, strategies and curriculum on the aspects of educator knowledge and educator professional training and development. The influence of these aspects on the educator being a knowledge worker is also pointed out as knowledge workers are crucial to South African becoming a knowledge-based economy and the influence this has on learning. A focus on pedagogy and its influence on the learner and learning was also included. Chapter Five deals with the Research Methodology of this study.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 INTRODUCTION

The previous chapter explains how training and development are connected to the business objectives and performance, with the focus being to improve the knowledge and skills of the employees which is necessary to achieve organisational and personal goals (Kapur,2018:1). Paterson (2002:np) explains that training and development may be off-the-job or on-the-job.

This study, includes the development of a conceptual framework showing the links between aspects of the literature and the research question. Akintoye (2015:3,6) explains that the goal of a conceptual framework is to explain concepts and to suggest links between the concepts in the analysis. With reference to the various models and ideals as well as literature discussed in the preceding chapters, this study offers the formulation of the conceptual framework linking professional training and development to improved Life Sciences education output to the South African Department of Education.

Chapter Five outlines the research design of this study. This chapter provides details of the target population and the simple sampling methods used to select subjects from the sampling frame. The procedure of data collection, as well administering the data collection instrument and methods of analysis of the data, are introduced. This chapter also offers details on the need for and how ethical considerations have been preserved.

5.2 THE RESEARCH PROBLEM CONTEXTUALISED

The post-apartheid era saw a restructuring of the South African education system. DuPlessis (2013:1) states that many curricula that were tried and tested and revised until the present day education policy Curriculum and Assessment Policy Statement (CAPS).

An article in Times Live (Savides, 2017) highlights the current plight of South African schools regarding the qualification status of educators. The reporter further stated that crucial subjects such as Mathematics and Sciences were the hardest hit. The quality of education is derived from the quality of educators who are knowledgeable on the content. Denson (2012:7) describes "knowledge workers as those who are highly educated, having superior interpersonal communication skills and are able to digest and process information better than most".

Education, training and advancement are part of every information worker's development cycle (Van Staden, 2009:35). Ludwikowska (2018:180) states that the best solution for educating educators with certain skills, or giving them the opportunity to fill the holes in their effectiveness, is preparation as one form of employee growth. In order for educators to effectively communicate knowledge in the classroom, they must possess pedagogical content knowledge. The appropriate pedagogy according to the teacher's pedagogical content knowledge allows for the construction of knowledge during the learning process.

5.3 KEY RESEARCH OBJECTIVES

The key objectives of this study were the following:

- To explore literature on aspects of teacher knowledge and training and development models that may influence the teaching and learning process;

- To explore the variety of teaching methodologies / pedagogies that may be used when teaching the Human Nervous System and the Endocrine System;

- To research the attitudes of Life Sciences educators towards the training and development programmes offered by the Department of Education which they have attended; and

- To develop a Conceptual Framework Linking Professional Training and Development to Improved Life Sciences Education Output developed from reviewed literature.

5.4 RESEARCH DESIGN CONCEPTUALISED

The research design selected for this study was quantitative and descriptive. The researcher employed a highly structured research methodology involving the administration of questionnaires and the analysis of data thereof.

The aim of the research is to find answers to questions by applying scientific procedures. The arranging of settings for data collection and analysis in a way that tries to combine relevance to the research purpose with procedural economy is known as research design. The study design is necessary because it allows the research to go as smoothly as possible in order to generate the most information. The design reduces biases and increases the consistency of the data collected and analysed (Kothari, 2004:1;31-32). Thakur (2021:53) explains that the general vision employed to carry out research is referred to as research design, which defines a rational method to address defined research questions through data collection, interpretation, analysis and discussion.

5.4.1 Quantitative Research Design vs Qualitative Research Design

Williams (2007: 67) explains that the qualitative research approach entails the utilization of data for the purpose of describing, explaining, and interpreting it. While, Kothari (2004:5) explains that the subjective evaluation of attitudes, beliefs, and behaviours is the focus of qualitative research. The techniques of focus groups interviews and in-depth interviews are used. Thakur (2021:57) states that the open-ended survey question and descriptive responses are key to the qualitative research method. It is a fascinating approach to use in order to learn about other people's perspectives. Williams (2007:69) describes Researchers use a mixed methods strategy in which they combine qualitative and quantitative data collection and analysis methodologies in a single study. The researcher in this study collects and analyses numerical data as well as narrative data.

The general measurement of variables, or correlation between subjects, is a component of quantitative research methodology. In reporting results, this strategy mainly relies on numbers. The data used in this form of research lead to findings since they give researchers a tool to comprehend and critique professional papers as well as improve student learning evaluation (McMillan & Schumacher 2006:149). Kothari (2004:3,5) states that quantitative analysis requires the quantitative generation of data. The inferential approach is used to construct a database from which to infer population characteristics or relationships. This type of research is based on the measurement of quantity. Williams (2007:66) describes the quantitative research method is defined as the collecting of data in order to quantify information. In response to relationship questions, quantitative research can be used. This research method might be descriptive, in which the situation is examined in its current state and attributes of a particular occurrence are identified.

Correlational development design, observational studies, and survey research are employed in descriptive research (Williams,2007:67). Nassaji (2015:129) states that the goal of descriptive research is to describe a phenomenon and its characteristics. Survey tools are amongst the instruments used to gather data. Kothari (2004:2-3) explains that descriptive research, which is commonly employed in the Social Sciences, includes surveys and fact-finding inquiries of various kinds with the goal of describing the current state of events. The variables are beyond the researcher's control. Only what has happened or is happening can be reported by the researcher Creswell (2009:101) explains that by investigating a sample of a population, a survey design can provide a quantitative or statistical account of that population's patterns. This study makes use of the quantitative research method.

5.5 TARGET POPULATION

In this study, the sample population is identified as educators who are currently teaching Life Sciences to learners in mainstream government secondary schools.
The population in this study was determined by a sampling list of approximately 210 Life Sciences educators, teach in the Umlazi District of the KZN Department of Education.

5.6 SAMPLING PROCEDURE

A sample is a group of people chosen from a wider population to participate in a survey (Mugo, 2002:1). Kothari (2004:15) highlights that, known as probability sampling, simple random sampling is where each sample in a population has an equal chance of being included in the sample. The researcher employed probability sampling, namely the purposeful sampling technique. The technique enables for the selection of representative samples from the population to function as information-rich samples for the topic. (McMillan and Schumacher, 2006:126). Mugo (2002:1) explains that sampling is a process for identifying a representative sample of a population for the goal of ascertaining population parameters or traits.

Simple random sampling is described as a technique where the researcher assigns numbers to the subjects and selects samples by a random method (Struwig and Stead 2004:116). This method of sampling means that all members of the population have a fair probability of being chosen for the survey (Graziano and Raulin 1997:214). Berndt (2020:225) explains that simple random sampling is a simple technique to perform, but it requires a thorough and up-to-date database of all people in the population. Acharya, Prakash, Saxena & Nigam (2013:331) highlights that in simple random sampling, random number tables or computer-generated lists of random numbers are used to select data.

For the purpose of this research, the researcher has made use of digitally generated random numbers. Sekaran (2003:294) provides a scientific guideline of selecting a sample size (n) based on a population size (N). In this study the population size (N) is 210. Ten samples of the target population will be used in the pre-test. Therefore, population size is 200. According to the computed table in Sekaran (2003:294) (Annexure E), the researcher will randomly select 132 samples for the purpose of this study.

5.7 MEASURING INSTRUMENT

The researcher will make use of structured survey questions. Sekaran (2003:236) states that “a questionnaire is a pre-formulated written set of questions to which respondents record their answers, usually within rather closely defined alternatives. Questionnaires are an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest. Questionnaires can be administered personally, mailed to the respondents, or electronically distributed”.

5.7.1 Overview on the Use of Questionnaires

Questionnaires provide an unbiased method of gathering data about people's knowledge, opinions, attitudes, and actions (Boynton and Greenhalg, 2004:1312).
Yaddanapudi and Yaddanapudi (2019:335) states that because questionnaires are non-interventional, they pose little ethical considerations. The survey's results are influenced by the language used in the questions, the style of questions used, the order in which they are organized, and many other factors.

Yaddanapudi and Yaddanapudi (2019:335) further highlights that closed-ended questions, in which participants select one or more of the prepared responses, are simpler and faster to respond to, but they only provide restricted information. Open-ended inquiries that require respondents to react in their own words take longer to complete but yield more information. A questionnaire must be validated after it has been created.

Ruel, Wagner and Gillespie (2016a:2) explains that creating a questionnaire is a multi-step process that entails much more than just writing questions. The variables (characteristics or features about the population that vary from person to person) are linked to the theoretical underpinnings of interest through survey questions. The survey instrument's types of measurements should ideally yield useful, unbiased, and error-free results. Sekaran (2003: 249-250) states that several systems are structured to electronically execute questionnaires. One may expect electronic questionnaire administration to take a growing role in the future with the rise of computer literacy. In this study, the questionnaire is in the format of scaled questions, namely the Linkert scale, ratio type questions and nominal type questions. The questionnaire is comprised of biographic details, educational history and professional development. Ruel, Wagner and Gillespie (2016a:15) highlight that when measuring respondents' attitudes and opinions about certain topics, individuals, ideas, or experiences, Likert scales are very useful.

5.7.2 Design of the Questionnaires

For this study, the questionnaire was designed to include closed- ended statements and questions on the Likert scale. The questions were written in such a way that they focused on a specific order of data collection. Questions aimed to determine the background information of respondents leading to levels of agreement or disagreement to questions or statements using the Likert scale.

The questionnaire in this study comprises 17 statements and the following sections:

1) Consent
2) Biographical details
3) Educational History
4) Professional Development

The questionnaire was sent to Life Sciences educators selected by random sampling from a target population of 200 in the Umlazi District of the KZN Department of Education. The global pandemic Covid-19 prevented the researcher from administering the questionnaires in person. The measuring instrument namely the questionnaire (Annexure A) was administered electronically to samples. The online Google Forms programmes was used to design the questionnaire. Respondents were emailed a covering letter (Annexure B), along with the link address which would allow them to access and complete the questionnaire. 132 questionnaires were sent out with a time frame of one month to return them. 127 completed questionnaires were returned.

5.8 VALIDITY AND RELIABILITY OF THE QUESTIONNAIRE

Validity is explained as the extent to which participants and researchers share a common interpretation of and analysis of data (McMillan & Schumacher, 2006:324-326), whilst Makhado (2002:116) describes validity as the extent to which scientific phenomena correspond to world reality. To ensure validity, the researcher administered the same questionnaire to all samples. The questionnaires were data analysed using the same data analysis technique. However, reliability, is described by Gall et al (1996:338-339) as the researcher has a good idea of what needs to be evaluated and is using appropriate recording tools, whilst Silverman in Makhado (2002:118) describes reliability is defined as the absence of any unintentional circumstances in the research outcomes. Reliability has been ensured as the questionnaire has been administered to a large number of samples.

5.8.1 Validity of the Questionnaire

The researcher must check that the items on the questionnaire were straightforward and appropriate for uniform interpretation to ensure the validity of the quantitative study design. The researcher would also ensure that respondents were capable of completing the questionnaire and that the questionnaire items were bias free (McMillan and Schumacher, 2006:194-195). The questions structured such that they do not pose any influence to sample respondents to show themselves off. Tuckman (1999:237) highlights that structured response questions help reduce the amount of diversity in responses.

Yaddanapudi and Yaddanapudi (2019 :336) explains that face, content, criteria, and concept validity are some of the components of validity. In the viewpoint of experts and respondents, face validity is the degree to which the questionnaire 'appears' to assess what it is supposed to measure. It is frequently measured ad hoc rather than quantitatively. A questionnaire's content validity is checked to see if it has all of the necessary items to answer the research question. The degree to which the exam genuinely measures what it claims to assess is known as construct validity. It is the most important aspect of validity, but it is also the most difficult to assess.

5.8.2 Reliability of the Questionnaire

The researcher must have a comprehensive concept of what is being studied and must make use of proper documentation techniques to ensure the reliability of the analysis (Gall, Borg et al 1996:338-339). Taherdoost (2016:33) state that “reliability concerns the extent to which a measurement of a phenomenon provides stable and consist result”.

Yaddanapudi and Yaddanapudi (2019:336) highlight that reliability of a system is typically assessed over time (test-retest reliability or repeatability), across things (internal consistency), and between researchers (inter-rater reliability). Reliability testing is important since it relates to the accuracy across the sections of a measuring device (Taherdoost, 2016:33).

5.9 PRE-TESTING / PILOT STUDY

Pre-tests or pilot tests are very valuable tools for academics since they allow them to discover potential issues with survey items and/or data gathering. They're necessary for any study that uses computer-assisted data collection. A pre-test entails gathering data from a limited number of respondents using the study's data collection procedures. The pre-test sample should ideally be drawn from the study's sampling frame. (Lewis-Beck, Bryman and Liao, 2004:854).

Ornstein (2014:2) posit that prior to data collection, survey pre-tests and pilot surveys are used to identify and correct problematic questions. The researcher further explains that pre-testing is not primarily exploratory, because the idea is to improve existing questions, rather than to develop new measures of a concept or decide between alternative questions.

To ensure that the questions are understood by the respondents and that there are no issues with the terminology or measurement, it is important to pre-test the instrument to ensure that there is no ambiguity in the questions. Pre-testing means using a limited number of respondents to assess the appropriateness and interpretation of the questions. This helps to fix any deficiencies in time until the instrument is administered orally or via a questionnaire to respondents, thus minimizing prejudices (Sekaran 2003:249). Willis (2016:7) highlights that it appears that there has been a shift to usability by the respondent, as questionnaires increasingly require self-administration (e.g., Web surveys).

For the purpose of pre-testing the questionnaire, ten randomly selected sample Life Sciences educators were emailed the link address to complete the questionnaire. The ten respondents were excluded from the target population (N=200) and were not part of the random sampling procedure to determine the 132 samples.

Taherdoost (2016:33) states that “the most commonly used internal consistency measure is the Cronbach’s Alpha coefficient” and cites Whitley (2002) and Robinson (2009), stating that when using Likert scales, Cronbach's Alpha is considered the most acceptable metric of reliability. Shamsuddin, Mubin, Zain, Akil and Aziz (2015:34) state that the most popular measure of internal consistency and reliability is Cronbach's alpha. When the range is between 0 and 1, it is considered a measure of scale dependability since it can be correlation efficient. Researchers make reference to this Rule of Thumb in their research. Table 5.1 illustrates the Rule of Thumb (Shamsuddin, Abdullah and Yaamat, 2015:34).

TABLE 5.1 : RULE OF THUMB ON CRONBACH'S ALPHA

SOURCE: Shamsuddin, Abdullah and Yaamat (2015:34)

Alpha Coefficient Range	**Strength of Association**
< 0.6	Poor
0.6 to < 0.7	Moderate
0.7 to < 0.8	Good
0.8 to < 0.9	Very Good
0.9	Excellent

While this provides a guideline, Taherdoost (2016:33) highlights that Excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50-0.70), and low reliability (0.50 and below) are four suggested reliability cut-off points. Although values along each guideline may differ slightly, there is a margin of understanding of what the calculated values of Cronbach's Alpha refer to.

TABLE 5.2: CRONBACH'S ALPHA FOR THE PRE-TEST

Aspect	Cronbach's Alpha Biographical Details	Cronbach's Alpha Educational History	Cronbach's Alpha Professional Development
Alpha	0.721	0.72	0.68

Yaddanapudi and Yaddanapudi (2019: 336) indicate that Cronbach's alpha is a correlation coefficient determined from pair-wise correlations between different items. The degree of agreement between different raters is determined using kappa statistics in inter-rater reliability. Based on the validation, the questionnaire should be adjusted. At this point, the amended questionnaire must be examined to ensure that it continues to address the survey's objectives. McMillan & Schumacher (2006:186) explain that for survey research and other surveys, the Cronbach Alpha is the most acceptable kind of reliability.

Table 5.2 illustrated the computed values of Cronbach's Alpha for Section Two, Section Three and the questions of Section Four, which are designed using the Likert scale measuring instrument, namely the questionnaire (Annexure A). These values have been generated from responses from the pre-test. With reference to Table 5.1 on the RULE OF THUMB ON CRONBACH'S ALPHA (Shamsuddin, Abdullah and Yaamat, (2015:34)) and information provided by Taherdoost (2016:33), the researcher calculated the average Cronbach's Alpha for the pre-test to be 0.67. This is considered to be moderate according to the RULE OF THUMB ON CRONBACH'S ALPHA (Shamsuddin, Abdullah and Yaamat, 2015:34) and moderately reliable according to Taherdoost (2016:33). Overall, the questionnaire is deemed to be moderately reliable as per Cronbach's Alpha values. This questionnaire is therefore reliable for administration to the sample respondents for this study.

5.10 DATA COLLECTION

Pawar (2016:2) states that data collection that is planned and methodical is an important and necessary activity. Data collected can be used effectively to inform or educate people and organisations about new trends that are relevant to them.

There are different means of data collections. Ruel, Wagner and Gillespie (2016b:10) describe three different methods of administering questionnaires, also known as surveys.This information is summarised in Table 5.3 below.

TABLE 5.3: SUMMARY OF DATA COLLECTION METHODS

Method of survey collection	Strategy
Mailed Surveys	Is low technology. Requires that a self-addressed, postage paid return envelope is sent along with the survey questionnaire to the respondent.
Interviews	Interviewer can administer the survey questions by phone, in person one on one groups or in person one on group. Interviewers must be trained to ask questions consistently.
Self-administered Web Surveys	Require few resources. Cost of contact attempts is cheap to make, allowing researcher to make multiple attempts. Software programme allows for responses by respondents to be automatically saved to the server.

SOURCE: Ruel, Wagner and Gillespie (2016b:10).(adapted)

The researcher was unable to deliver the questionnaire in person due of the widespread Covid-19 pandemic. The measuring instrument, namely the questionnaire, (Annexure A) was administered electronically to samples. The online program, Google Forms was used to design the questionnaire. Samples were emailed with a covering letter (Annexure B), along with the link address, allowing respondents to access and complete the questionnaire.

5.11 ETHICAL CONSIDERATIONS

Researchers must collect data, according to the collection of ethical guidelines that are often focused on informed consent, privacy and confidentiality, voluntary participation, zero physical and psychological damage (Pawar, 2007:5). Coffelt (2017:2-3) highlights that anonymity and confidentiality are legal standards intended to protect human subjects' privacy during data collection, analysis and reporting. The researcher differentiates between anonymity and confidentiality as follows:

- In an anonymous study, participants' demographic data may be collected, and researchers may summarize their attributes in aggregate. As a result, readers have a basic idea of who took part in the study and may assess how representative a sample is of a larger community.
- In a confidential study, the researcher knows the participant, which is a normal occurrence during an interview.

Survey research is commonly used in Social Science methods, enabling the researcher to gather knowledge on a range of mental, thinking and opinion topics (Buchanan and Hvizdak, 2009:37). Joe, Raben and Phillips (2016:3) mention that since the 1990s, there has been an increasing use of digital data collection methods and it has become apparent that research participants entrust researchers with a staggering amount of personal information. Therefore, researchers must be very aware and mindful of the responsibilities that they have to their research participants.

Buchanan and Hvizdak (2009:37) explain that Web 2.0 services include online survey tools, and so research ethics 2.0 emerges, compelling researchers and research regulators to reconsider and re-evaluate core research ethical issues. Coffelt (2017:6) posits that anonymity and confidentiality are particularly difficult to maintain in internet-based research. The researcher's ability to protect himself or herself from cyber-hacking or keylogging is unusual.

Ogden (2008:61) states that when a researcher picks one topic over another, the possibility of bias enters the study process. Bias can be introduced by decisions about study methods, population sampling, and other design flaws. Researchers can avoid bias by being conscious of their own values and preconceptions, seeking for data that contradicts their assumptions, and being open to different interpretations of data. Joe, Raben and Phillips (2016:80) highlight that a key principle of social research is that respondents' cooperation is voluntary. Appropriate information about what they will be asked for the reason for which it is obtained, and assurance that their privacy will be protected must be given to them. This information is supported by Buchanan and Hvizdak (2009:38), that in order to improve response rates and information quality; researchers must develop credibility with respondents by explaining the study's goal; how respondents are chosen; how data will be utilized; and who will have access to it.

All data obtained from respondents will be disposed of once the study has been approved. The study does not discriminate against any sample subject from the population. All samples have an equal chance of being selected as a result of random sampling. Strict confidentiality is maintained as no names are required for the purpose of this study, moreover respondents are made aware of the purpose of the study and that completing the questionnaire is voluntary.

5.12 DATA ANALYSIS

The data will be analysed using the appropriate statistical and inferential techniques. Descriptive statistics was used to analyse the fundamental elements of the data in a study. The use of descriptive statistics allows for the display of quantitative data (Sarmento and Costa, 2019:3). Loeb, et al., (2017:1) explain that quantitative descriptive statistical analysis is about recognizing patterns in data to specifically address who, the "benchmark" for what, where, when and to what extent information can be used in causal research. Sarmento and Costa (2019:3) highlight that the measure of central tendency is a value that attempts to represent data collection by providing a "central" or "typical" value. This method allows one to establish population-wide generalizations based on sample data.

5.13 CONCLUSION

This chapter detailed the research design of the study. Insight was provided on the target population and how sample subjects were chosen by random selection against a sampling list. In this chapter, aspects of validity and reliability were discussed in detail. The pre-test conformed to the scientific value of Cronbach's Alpha, rendering the questionnaire moderately reliable. This chapter also highlighted that descriptive statistics was used to analyse data of this study. The representation of graphs and tables to recognise patterns is crucial is interpreting data. The next chapter provides an analysis of data and discussion of the findings thereof.

CHAPTER SIX

STATEMENT OF FINDINGS, INTERPRETATION AND DISCUSSION OF THE DATA

6.1 INTRODUCTION

This chapter discusses the conclusions and addresses the outcomes of the questionnaires in this report. The primary instrument used to collect data was the questionnaire (Annexure A), which was distributed to 132 survey respondents. SPSS version 26.0.0. was used to evaluate the data obtained from the responses. The results show the descriptive statistics of the quantitative data obtained in the form of graphs, cross-tabulations and other figures. The use of correlations and chi square test values interpreted using the p-values are inferential techniques. A statement of statistical significance is needed in the conventional approach to reporting a result. A p-value is generated from a test statistic. A significant result is indicated with "$p < 0.05$".

The target population of 210 Life Sciences educators was provided on a sampling list. The researcher made use of digitally generated random numbers for selecting the sample. From this list, 10 Life Sciences educators were randomly selected for the pre-test. The 10 pre-test samples were removed from the sampling list (N=210) making the target population 200 (N=200). According to a computer generated table in Sekaran (2002:294), the researcher randomly selected 132 samples for research purposes. In total, 132 questionnaires were despatched via a digital email platform and 127 were returned. Therefore, the final questionnaires for this study was n=127. This represented a high response rate of 96%, which was due to the researcher repeatedly sending out the emails to the sample respondents.

The measuring instrument, namely the questionnaire (Annexure A), was administered to Life Sciences educators within the Umlazi District of the Kwa-Zulu Natal Department of Education. Section A gives the sample respondent the opportunity to consent to completing the questionnaire. A letter of approved ethical clearance (Annexure C) was provided by the DUT Research Ethics Committee once the initial research proposal and measuring instrument, namely the questionnaire (Annexure A), was reviewed and assessed. A letter providing permission to conduct the research within the Umlazi

District of the Kwa-Zulu Natal Department of Education was provided by the Kwa-Zulu Natal Department of Education (Annexure D).

Reliability Statistics

Reliability and validity are the two most critical elements of accuracy. By taking multiple measurements on the same subjects, reliability is determined. A reliability coefficient of 0.60 or higher is considered as “acceptable” for a newly developed construct.

The Table 6.1 below reflects the Cronbach’s alpha score for all the items that constituted the questionnaire.

TABLE 6.1 CRONBACH’S ALPHA SCORE FOR ALL ITEMS OF THE QUESTIONNAIRE

	Section	Number of Items	Cronbach's Alpha
Q11	Professional Qualification impact on Development	7	0.805
Q12	Study Programme Non-Registration	4	0.776
Q15	Teacher Training Workshops	3	0.949
Q16	Use of Teaching Strategies	7	0.717
Q17	Need for Professional Development	6	0.944

The reliability scores of all parts surpass the alpha value of the suggested Cronbach. Taherdoost (2016:33) highlights that Excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50-0.70), and low reliability (0.50 and below) are four suggested reliability cut-off points. For these parts of the study, this implies a degree of appropriate, reliable scoring.

The researcher provided a valuable analysis of data for all questions in the form of summarised tabular format and graphs as frequencies and percentages, as reported in this chapter. The analysis of results is presented in sequential order of the questionnaire (Annexure A):

6.2 SECTION A: ANALYSIS OF RESULTS PERTAINING TO BIOGRAPHICAL DATA

This section summarises the biographical characteristics of the respondents.

6.2.1 Analysis of Gender Distribution by Age

The Table 6.2 below describes the overall gender distribution by age. The ratio of males to females is approximately 1:2 (37.0% : 63.0%) ($p = 0.003$).

TABLE 6.2: OVERALL GENDER DISTRIBUTION BY AGE

		What is your gender?		Total
Age (years)		Female	Male	
20 – 25	Count	3	1	4
	% within What is your age range?	75.0%	25.0%	100.0%
	% within What is your gender?	3.8%	2.1%	3.1%
	% of Total	2.4%	0.8%	3.1%
26 – 30	Count	7	9	16
	% within What is your age range?	43.8%	56.3%	100.0%
	% within What is your gender?	8.8%	19.1%	12.6%
	% of Total	5.5%	7.1%	12.6%
31 - 35	Count	19	9	28
	% within What is your age range?	67.9%	32.1%	100.0%
	% within What is your gender?	23.8%	19.1%	22.0%
	% of Total	15.0%	7.1%	22.0%
36 - 40	Count	17	14	31
	% within What is your age range?	54.8%	45.2%	100.0%
	% within What is your gender?	21.3%	29.8%	24.4%
	% of Total	13.4%	11.0%	24.4%
> 40	Count	34	14	48
	% within What is your age range?	70.8%	29.2%	100.0%
	% within What is your gender?	42.5%	29.8%	37.8%
	% of Total	26.8%	11.0%	37.8%
Total	Count	80	47	127
	% within What is your age range?	63.0%	37.0%	100.0%
	% within What is your gender?	100.0%	100.0%	100.0%
	% of Total	63.0%	37.0%	100.0%

Within the age category of 20 to 25 years, 75% were female. Within the category of females (only), 3.8% were between the ages of 20 to 25 years. This category of females between the ages of 20 to 25 years formed 2.4% of the total sample. Within the same age category of 20 to 25 years, 25% were male. Within the category of males (only), 2.1% were between the ages of 20 to 25 years. This category of females between the ages of 20 to 25 years formed 0.8% of the total sample.

Within the age category of 26 to 30 years, 43.8% were female. Within the category of females (only), 8.8% were between the ages of 26 to 30 years. This category of females between the ages of 26 to 30 years formed 5.5% of the total sample. Within the same age category of 26 to 30 years, 56.3% were male. Within the category of males (only), 19.1% were between the ages of 26 to 30 years. This category of females between the ages of 26 to 30 years formed 7.1% of the total sample.

Within the age category of 31 to 35 years, 67.9% were female. Within the category of females (only), 23.8% were between the ages of 31 to 35 years. This category of females between the ages of 31 to 35 years formed 15.0% of the total sample. Within the same age category of 31 to 35 years, 32.1% were males. Within the category of males (only), 19.1% were between the ages of 31 to 35 years. This category of males between the ages of 31 to 35 years formed 7.1% of the total sample.

Within the age category of 36 to 40 years, 54.8% were female. Within the category of females (only), 21.3% were between the ages of 36 to 40 years. This category of females between the ages of 36 to 40 years formed 13.4% of the total sample. Within the same age category of 36 to 40 years, 45.2% were male. Within the category of males (only), 29.8% were between the ages of 36 to 40 years. This category of males between the ages of 36 to 40 years formed 11% of the total sample.

Within the age category of greater than 40 years, 70.8% were female. Within the category of females (only), 42.5% were in the ages of greater than 40 years. This category of females of greater than 40 years formed 26.8% of the total sample. While, within the same age category of greater than 40 years, 29.2% were male.

Within the category of males (only), 29.8% were in the ages of greater than 40 years. This category of males of greater than 40 years formed 11% of the total sample. The age distributions are not similar as there are more respondents younger than 40 years old ($p < 0.001$).

Table 6.3 below represents that the majority of respondents (94.5%) were currently teaching Life Sciences ($p < 0.001$), with the remainder having taught the subject previously.

6.2.2 Analysis of Respondents Currently Teaching Life Sciences

TABLE 6.3: NUMBER OF RESPONDENTS CURRENTLY TEACHING LIFE SCIENCES

	Frequency	Percent
No	7	5.5
Yes	120	94.5
/Total	127	100.0

Figure 6.1 below indicates the time-frames for the variables specified. The variables represent the number of years that educators are currently teaching Life Sciences.

FIGURE 6.1: NUMBER OF YEARS EDUCATORS ARE CURRENTLY TEACHING LIFE SCIENCES

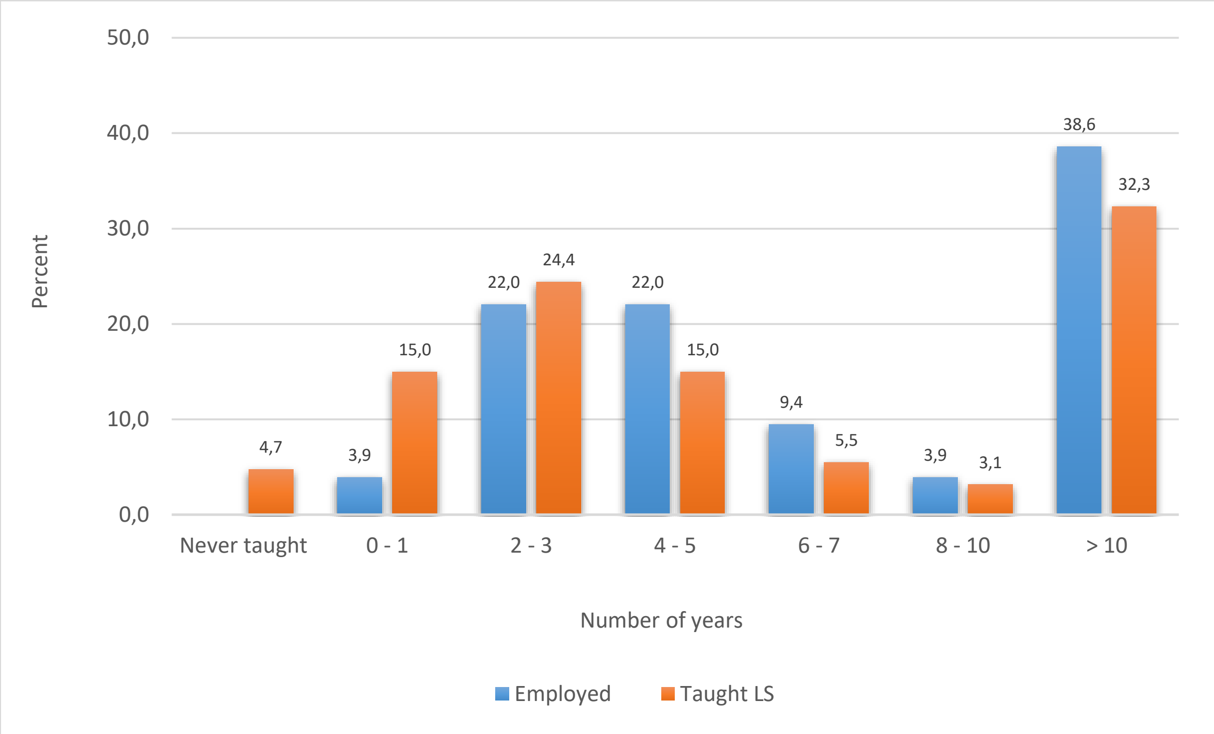


Figure 6.1 shows that significantly more respondents are employed as educators and taught Life Sciences for more than 10 years ($p < 0.001$).
It is also noticed that there is a relationship between the two time-frames, implying that Life Science educators had taught their specialist subject being Life Sciences since first employed ($p < 0.001$).

Three-quarters of the respondents (74.0%) had been in employ for more than 4 years. A little less than 60% (56%) had also taught Life Sciences during this time.
This implies that respondents had been in employ for a while, which is also a useful fact as it indicates responses from experienced workers.

6.2.3 Analysis of Highest Qualification of Respondents which includes a Study in Biological Sciences

The Figure 6.2 below indicates the highest academic qualification, which includes a study in Biological Sciences of the respondents.

FIGURE 6.2: HIGHEST ACADEMIC QUALIFICATION WHICH INCLUDES A STUDY IN BIOLOGICAL SCIENCES OF RESPONDENTS

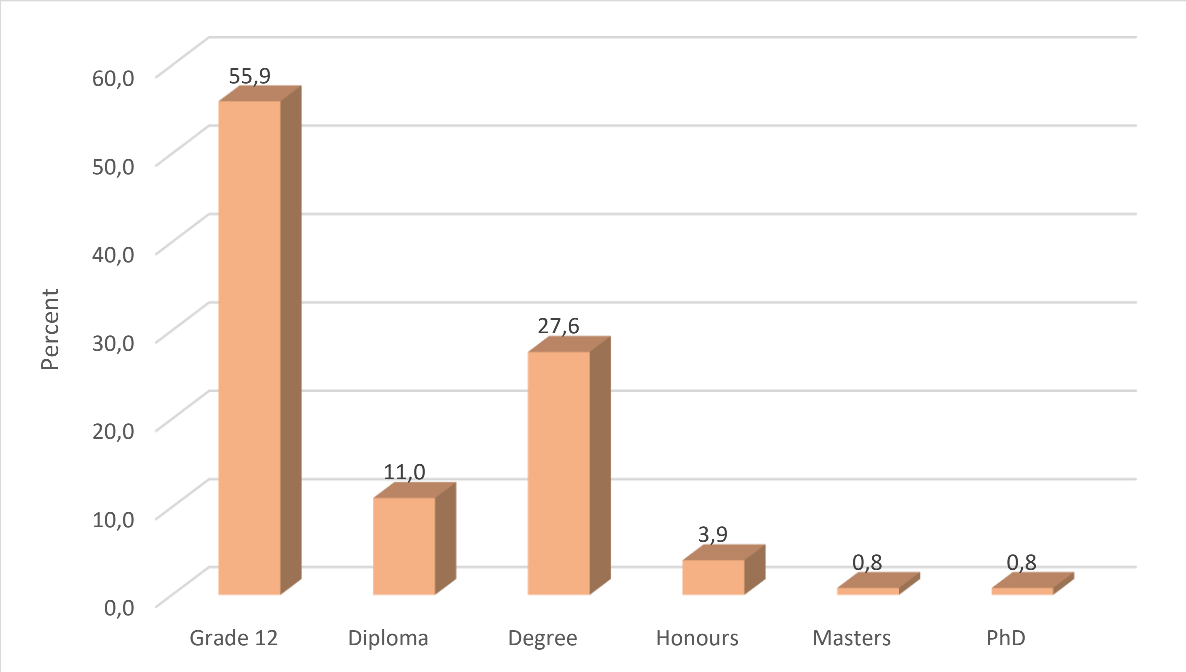


Figure 6.2 indicates that the majority of respondents (55.9%) had a study qualification in Biological Sciences with a Grade 12 qualification. The remaining respondents (44.1%) had a study in Biological Sciences at varying levels of qualifications ($p < 0.001$). It is evident that many respondents pursued a study course in Life Sciences (previously known as Biology) at a high level, therefore completing this study course with a Grade 12 Matric Certificate. Being a current Life Sciences teacher would imply that the respondents pursued a teaching qualification. Other respondents have pursued a study in Biological Sciences at levels such as Diploma, Degree, Honours, Masters and PhD, indicating a level of specialisation in the subject area.

6.2.4 Analysis of Professional Teaching Qualification of Respondents

Table 6.4 below indicates the professional teaching qualification/s of the respondents.

TABLE 6.4: PROFESSIONAL TEACHING QUALIFICATION OF RESPONDENTS

	Frequency	Percent
Bachelor of Education	69	54.3
Advanced Certificate in Education	3	2.4
Postgraduate Certification in Education	17	13.4
National Diploma in Education	9	7.1
Bachelor of Education (Honours)	9	7.1
Master of Education	4	3.1
Other	16	12.6
Total	127	100.0

All of the respondents had some form of qualification, with approximately half (54.3%) having a Bachelor of Education ($p < 0.001$). This shows a level of correlation between data represented in Figure 6.2 that approximately half (55.9%) of the respondents have a Biological Sciences study at Grade 12, then pursued a Bachelor of Education qualification. Table 6.6 shows that only 2.4% of respondents have an Advanced Certificate in Education, while 13.4% have a Postgraduate Certificate in Education. To pursue study towards an Advanced Certificate in Education, educators must have at least a 3-year qualification; while in order to pursue the Postgraduate Certificate in Education, one must have a relevant Bachelor degree. There are 7.1% of respondents with a National Diploma in Education, which is a study course pursued to upgrade current teacher qualifications; 7.1% of respondents have a Bachelor of Education (Honours); 3.1% of respondents have a Masters of Education and 12,6% of respondents possess some other type of professional teaching qualification.

6.2.5 Analysis of the Number of Respondents Currently Registered for a Life Sciences/ Biological Studies Course

Table 6.5 below indicates the number of respondents currently registered for a Life Sciences / Biological Sciences studies course.

TABLE 6.5: NUMBER OF RESPONDENTS CURRENTLY REGISTERED FOR A LIFE SCIENCES / BIOLOGICAL SCIENCES STUDIES COURSE

Are you currently registered for Life Sciences / Biological Sciences studies?

	Frequency	Percent
No	122	96.1
Yes	5	3.9
Total	127	100.0

Approximately 4% of the respondents were currently enrolled to improve their Life Sciences qualification.

6.3 FACTOR ANALYSIS

Factor analysis is a statistical technique whose main goal is data reduction. A typical use of factor analysis is in survey research, where a researcher wishes to represent a number of questions with a small number of hypothetical factors. Factor techniques are applicable to a variety of situations. One need not believe that factors actually exist in order to perform a factor analysis, but in practice, the factors are usually interpreted, given names and spoken of as real things.

The matrix tables are preceded by a summarised table, Table 6.6, that reflects the results of the Kaiser-Meyer-Olkin and Bartlett's Test. The requirement is that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy should be greater than 0.50 and Bartlett's Test of Sphericity less than 0.05. In all instances, the conditions are satisfied which allows for the factor analysis procedure.

Factor analysis is done only for the Likert scale items. Certain components divided into finer components. This is explained below in the rotated component matrix.

TABLE 6.6: RESULTS OF THE KASIER-MEYER-OLKIN TEST AND BARTLETT'S TEST

Kaiser-Meyer-Olkin and Bartlett's Test

		Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
	Section		Approx. Chi-Square	df	Sig.
Q11	Professional Qualification impact on Development	0.720	504.652	21	0.000
Q12	Study Programme Non-Registration	0.744	249.923	6	0.000
Q15	Teacher Training Workshops	0.763	380.663	3	0.000
Q16	Use of Teaching Strategies	0.848	420.676	36	0.000
Q17	Need for Professional Development	0.907	787.945	15	0.000

All of the conditions are satisfied for factor analysis.
That is, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value is greater than 0.500 and the Bartlett's Test of Sphericity sig. value is less than 0.05.

TABLE 6.7.1: Rotated Component Matrix: QUESTION 11

Q11	Component	
	1	2
Subject matter knowledge has improved (content according to the prescribed work schedules)	0.027	0.932
Content knowledge has improved (content beyond the parameters of the prescribed work schedules)	0.074	0.941
Knowledge of various teaching and learning strategies have increased	0.858	-0.083
Knowledge of the curriculum has improved	0.762	0.310
Knowledge of assessment techniques to accommodate the learner has improved	0.842	-0.196
Has developed your confidence to teach and facilitate learning	0.771	0.315
Ability to link subject matter knowledge/content knowledge to the appropriate teaching and learning strategies have improved	0.619	0.484

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

TABLE 6.7.2: Rotated Component Matrix: QUESTION 12

Q12	Component
	1
I believe I am qualified and confident to handle the expectations outlined in the Life Sciences CAPS document	0.922
I am competent in content knowledge therefore I do not need to study further	0.913
I have the financial mean to study further	0.489
My lessons are learner centred, meeting the outcomes of constructive learning	0.845

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

TABLE 6.7.3: Rotated Component Matrix: QUESTION 15

Q15	Component
	1
The workshop enriched my knowledge of the subject matter	0.960
The workshop enriched my content knowledge	0.961
The facilitator informed me of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning	0.937

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

TABLE 6.7.4: Rotated Component Matrix: QUESTION 16

Q16	Component	
	1	2
Teacher speaks, learners listen	-0.142	0.801
Learners copy notes from the blackboard into their notebooks	-0.231	0.774
Teacher, makes use of inquiry-based learning (learners hypothesis, select apparatus, identify variables and draw conclusions	0.751	-0.175
Teacher tells learners the answers to questions from past exam papers	0.647	0.462
Teacher makes use of Integrated Computer Technology	0.620	-0.404
Learners copy notes from a textbook into their notebooks	-0.110	0.743
Learners practice questions during collaborative learning	0.721	-0.331
Teacher encourages whole class discussions to construct meaning of topics	0.748	-0.456
Teacher encourages scaffolding (assisting learners to move towards new skills, concepts and levels of understanding)	0.730	-0.023

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

TABLE 6.7.5: Rotated Component Matrix: QUESTION 17

Q17	Component
	1
Enhance content knowledge	0.863
Update knowledge of effective teaching strategies	0.897
Ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning	0.887
Understanding how to integrate different cognitive levels into teaching	0.937
Make use of various strategies of assessments	0.918
Select appropriate resources to improve teaching and learning	0.912

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

The principle component analysis was used as the extraction method, and the rotation method was Varimax with Kaiser Normalization. This is an orthogonal rotation method that minimizes the number of variables that have high loadings on each factor. It simplifies the interpretation of the factors. Factor analysis/loading shows inter-correlations between variables. Items of questions that loaded similarly imply measurement along a similar factor.

An examination of the content of items loading at or above 0.5 (and using the higher or highest loading in instances where items cross-loaded at greater than this value) effectively measured along the various components.

The statements that constituted questions 12, 15 and 17 loaded perfectly along a single component. This implies that the statements that constituted these sections perfectly measured what they set out to measure.

It is noted that the variables that constituted questions 11 and 16 loaded along 2 components (sub-themes), namely pedagogical content knowledge and traditional teaching strategies respectively. This means that respondents identified different trends within the section. Within the section, the splits are colour-coded.

The Pearson Chi Square test was done for Questions 11, 12, 15, 16 and 17. This is referred to as a goodness of fit test and is a univariate test. It is used to test whether any of the response options are selected significantly more or less often that the others. If the p-values are less than 0.05 (the level of significance), it implies that the distributions were not similar. That is, the differences between the way respondents scored (agree, disagree) were significant. If the p-values were higher than 0.05 (the level of significance), it implies that the distributions were similar. The differences between the way respondents scored (agree, disagree) were not significant.

6.4 CORRELATIONS BETWEEN VARIABLES OF THE QUESTIONNAIRE

- Bivariate correlation was also performed on the (ordinal) data. The results are found in Annexure E. The results indicate the following patterns and all significant relationships are indicated by a * or ** on Annexure E:
- Positive values indicate a directly proportional relationship between the variables
- Negative value indicates an inversely proportional relationship between the variables.

The researcher has identified the following relationships according to the results of Bivariate Correlation:

TABLE 6.8: CORRELATION VALUES OF IMPROVEMENT OF CONTENT KNOWLEDGE AND THE USE OF AN INQUIRY BASED TEACHING STRATEGY

CORRELATION VALUE BETWEEN	"Content knowledge has improved (beyond the parameters of the prescribed work schedules)"
"Teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)"	+0.216

The correlation value between "Content knowledge has improved (beyond the parameters of the prescribed work schedules)' and "Teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)" represented in Table 6.8 above is 0.216. This represents a directly proportional relationship. Respondents indicate that as content knowledge is improved, the teacher makes use of inquiry-based learning more often, which is a form of constructive learning.

TABLE 6.9: CORRELATION VALUES OF LESSONS ARE LEARNER-CENTRED AND CONSTRUCTIVE TEACHING METHODS

CORRELATION VALUE BETWEEN	"My lessons are learner centred meeting the outcomes of constructive learning"
"teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)" and "need to enhance content knowledge"	+0.397
"Teacher makes use of Integrated Computer Technology"	+0.388
"Learners practice questions during collaborative learning"	+0.188
"Teacher encourages whole class discussions to construct meaning of topics	+0.278
"Teacher encourages scaffolding (assists learners to move towards new skills, concepts and level of understanding)	+0.238

Table 6.9 shows that the correlation value between "My lessons are learner-centred meeting the outcomes of constructive learning" and
"teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)" is 0.397 ;
"teacher makes use of Integrated Computer Technology" is 0.388;
"learners practice questions during collaborative learning" is 0.188
"teacher encourages whole class discussions to construct meaning of topics" is 0.278; and "teacher encourages scaffolding (assisting learners to move towards new skills, concepts and levels of understanding) is 0.238.

This implies that there is direct proportionality between the respondent educators developing their lessons as learner-centred and the use of the constructive teaching strategies as inquiry-based, use of integrated computer technology, whole class discussions and scaffolding.

TABLE 6.10: CORRELATION VALUES OF FACILITATOR INFORMED THE RESPONDENT HOW TO LINK VARIOUS TEACHING AND LEARNING STRATEGIES TO SUBJECT MATTER/ CONTENT KNOWLEDGE TO IMPROVE TEACHING AND LEARNING AND TRADITIONAL TEACHING METHODS

CORRELATION VALUE BETWEEN	“the facilitator informed me of how to link various teaching strategies with subject matter/ content knowledge to improve teaching and learning”
“teacher speaks, learner listens”	-0.388
“learners copy notes from the blackboard into their notebooks”	-0.215
“learners copy notes from the textbook into their notebooks”	-0.335

Table 6.10 shows the correlation value between “the facilitator informed me of how to link various teaching strategies with subject matter/ content knowledge to improve teaching and learning” and
“teacher speaks, learner listens” is -0.338;
“learners copy notes from the blackboard into their notebooks” is -0.215; and
“learners copy notes from the textbook into their notebooks” is -0.335.
There is an inversely proportional relationship between “the facilitator informed me of how to link various teaching strategies with subject matter/ content knowledge to improve teaching and learning” and the other three variables. This indicates that if there is more information provided by facilitators during professional development workshops to educators on how to link various teaching strategies with subject matter / content knowledge, then there would be less use of traditional teaching methods such as “teacher speaks, learner listens”, ”learners copy notes from the blackboard into their notebooks” and “learners copy notes from the textbook into their notebooks” This would allow for learners to become more involved in the construction of meaning in work to be learnt.

TABLE 6.11: CORRELATION VALUES OF TEACHER SPEAKS, LEARNER LISTENS AND CONSTRUCTIVE TEACHING METHODS

CORRELATION VALUE BETWEEN	“teacher speaks, learner listens”
“teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)” and “need to enhance content knowledge”	-0.190
“Teacher makes use of Integrated Computer Technology”	-0.350
“Learners practice questions during collaborative learning”	-0.410
“Teacher encourages whole class discussions to construct meaning of topics”	-0.438
“Teacher encourages scaffolding (assists learners to move towards new skills, concepts and level of understanding)	-0.181

Table 6.11 shows that the correlation value between “teacher speaks, learner listens” and “teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)” is -0.190;
“teacher makes use of Integrated Computer Technology” is -0.350;
“learners practice questions during collaborative learning” is -0.410;
“teacher encourages whole class discussions to construct meaning of topics” is -0.438; and “teacher encourages scaffolding (assisting learners to move towards new skills, concepts and levels of understanding) is -0.181.
These values imply an inversely proportional relationship between the traditional teaching method “teacher speaks, learner listens” and the five variables that represent constructive teaching and learning methods. Respondents indicate that the more traditional teaching methods such as “teacher speaks, learner listens” are used in the classroom, the less constructive teaching methods are used in the classroom, therefore inhibiting the opportunity for learners to construct their own meaning during lessons.

TABLE 6.12: CORRELATION VALUES OF TEACHER SPEAKS, LEARNER LISTENS AND ASPECTS OF PROFFESSIONAL DEVELOPMENT

CORRELATION VALUE BETWEEN	“teacher speaks, learner listens”
“need to enhance content knowledge”	+0.334
“need for the ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning”	+0.197
“need to select appropriate resources to improve teaching and learning”	+0.188

Table 6.12 shows that the correlation value between “teacher speaks, learner listens” and “need to enhance content knowledge” is 0.334;
“need for the ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning” is 0.197; and
“need to select appropriate resources to improve teaching and learning” is 0.188.
The value indicates a direct proportionality between “teacher speaks, learner listens” and the variables representing a need for professional development in the above aspects. Respondents indicate that the more that traditional teaching methods such as “teacher speaks, learner listens” is used in the classroom, there is a greater need for professional development with respect to developing content knowledge; linking subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning; and selecting appropriate resources to improve teaching and learning.

TABLE 6.13: CORRELATION VALUES OF CONSTRUCTIVE TEACHING METHODS AND ASPECTS OF PROFESSIONAL DEVELOPMENT

CORRELATION VALUE BETWEEN	"teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)" and "need to enhance content knowledge"	"Teacher makes use of Integrated Computer Technology"	"Learners practice questions during collaborative learning"	"Teacher encourages whole class discussions to construct meaning of topics"
"need to enhance content knowledge"	-0.345	-0.390	-0.256	-0.416
"need for the ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning"	-0.404	-0.346	-0.239	-0.348
'need to understand how to integrate different cognitive levels into teaching'	-0.387	-0.316	-0.252	-0.313
'need to know how to make use of various strategies of assessment"	-0.378	-0.275	-0.240	-0.330
"need to select appropriate resources to improve teaching and learning"	-0.371	-0.367	-0.251	-0.404

Table 6.13 shows the correlation value between the use of constructive teaching methods, namely “teacher makes use of inquiry-based learning (learners hypothesise, select apparatus, identify variables and draw conclusions)”; ”teacher makes use of Integrated Computer Technology” ; “learners practice questions during collaborative learning” ; “teacher encourages whole class discussion to construct meaning of topics” and aspects of professional development, namely “need to enhance content knowledge”; “need for the ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning”; “need to understand how to integrate different cognitive levels into teaching’ ; “need to know how to make use of various strategies of assessment” and “need to select appropriate resources to improve teaching and learning”. The correlation values are all negative, indicating inversely proportional relationships between the use of constructive teaching methods and aspects of professional development. The overall implication is that respondents applying constructive teaching methods in the classroom more often require less professional development in the areas of content knowledge; linking subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning; understanding how to integrate different cognitive levels into teaching; knowing how to make use of various strategies of assessment and selecting appropriate resources to improve teaching and learning.

These correlations inform the researcher that professional development is important in developing educators towards constructive teaching and learning so that a move away from teacher-centred or traditional teaching methods can be made.

6.5 SECTION ANALYSIS

The section that follows analyses the scoring patterns of the respondents per variable per section. The results are first presented using summarised percentages for the variables that constitute each section. Results are then further analysed according to the importance of the statements.

6.5.1 Question Eleven: Aspects of Knowledge developed from Professional Qualification

This question deals with understanding the extent to which a teacher's professional qualification has helped develop them as a teacher with respect to teaching the relationship between the Human Nervous System and the Endocrine System. The aim of this question, was to better understand whether the teacher's subject matter knowledge and content knowledge have improved, whilst establishing whether the teacher has gained knowledge of various teaching and learning strategies. This question also helped to determine whether the professional qualification has allowed the teacher to improve their knowledge of the curriculum, knowledge of assessment techniques and has given the teacher the ability to link subject matter knowledge/content knowledge to the appropriate teaching and learning strategies. Table 6.8 below summarises the scoring patterns of Question 11.

6.5.1.1 SUMMARY OF RESPONSES BY RESPONDENTS IN RELATION TO STATEMENTS IN QUESTION ELEVEN

The following patterns are observed in Figure 6.3 below:

- Some statements show (significantly) higher levels of agreement, whilst other levels of agreement are lower (but still greater than levels of disagreement); and
- 1 statement (Q11.2) indicates a higher level of disagreement

The overall levels of agreement and disagreement are similar across the sub-questions as more respondents scored Agree or Disagree, compared to the stronger options. The remaining statements have patterns that show significantly higher levels of agreement, which are discussed as follows:

Figure 6.3 shows that for Question 11.1, 11.8% of respondents selected “Strongly Agree” and 39.4% selected “Agree”. Therefore in total, 51.2% of respondents were in agreement that their professional qualification helped develop them in the area of subject knowledge (content according to the prescribed work schedule), while a total of 48.8% were in disagreement.

Figure 6.3 shows that for Question 11.2, 9.4% of respondents selected “Strongly Agree” and 37.0% selected “Agree”. Therefore in total, 46.4% of respondents were in agreement that their professional qualification helped develop them in the area of content knowledge (content according to the prescribed work schedule), while a total of 53.5% were in disagreement. Factor analysis for this question indicated that a significantly higher percentage of respondents selected “Disagree” (49.6%). This possibly indicates that professional qualifications do not focus on content-specific learning.

Figure 6.3 shows that for Question 11.3, 26.8% of respondents selected “Strongly Agree” and 68.5% selected “Agree”. Therefore in total, 95.3% of respondents were in agreement that their professional qualification helped develop them in the area of knowledge of various teaching and learning strategies, while a total of 14.2% were in disagreement.

Figure 6.3 shows that for Question 11.4, 17.3% of respondents selected “Strongly Agree” and 68.5% of respondents selected “Agree”. Therefore in total, 85.8% of respondents were in agreement that their professional qualification helped develop them in the area of knowledge of the curriculum, while a total of 14.2% were in disagreement.

Figure 6.3 shows that for Question 11.5, 26.8% of respondents selected “Strongly Agree” and 66.1% of respondents selected “Agree”. Therefore in total, 92.9% of respondents were in agreement that their professional qualification helped develop them in the area of knowledge of assessment techniques to accommodate the learner, while a total of 7% were in disagreement.

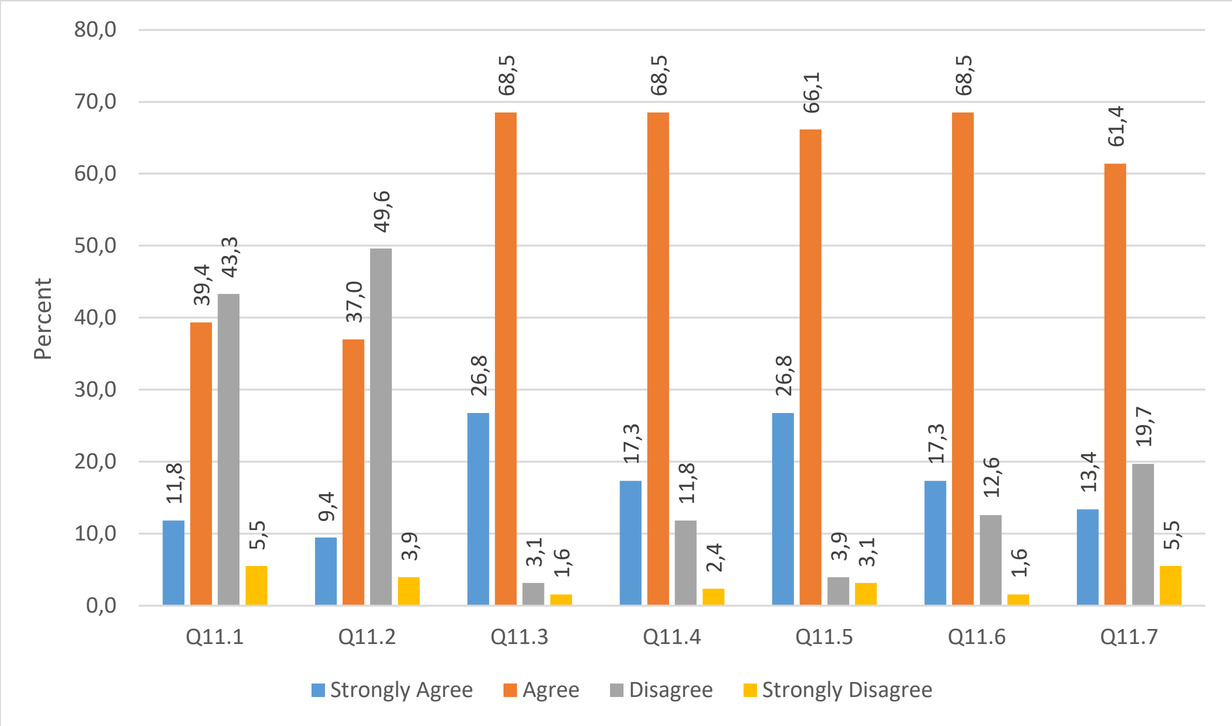
Figure 6.3 shows that for Question 11.6, 17.3% of respondents selected “Strongly Agree” and 68.5% of respondents selected “Agree”. Therefore in total, 85.8% of respondents were in agreement that their professional qualification helped develop them in the area of developing their confidence to teach and facilitate learning, while a total of 14.2% were in disagreement.

Figure 6.3 shows that for Question 11.7, 13.4% of respondents selected “Strongly Agree” and 61.4% of respondents selected “Agree”. Therefore in total, 74.8% of respondents were in agreement that their professional qualification helped develop them in the area of being able to link subject matter knowledge/content knowledge to the appropriate teaching and learning strategies while a total of 25.2% of respondents were in disagreement. Table 6.14 represents a summary of the data collected and analysed for Question 11.

TABLE 6.14: SUMMARY OF THE SCORING PATTERNS FOR QUESTION 11

		Strongly Agree		Agree		Disagree		Strongly Disagree	
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
Subject matter knowledge has improved (content according to the prescribed work schedules)	Q11.1	15	11.8%	50	39.4%	55	43.3%	7	5.5%
Content knowledge has improved (content beyond the parameters of the prescribed work schedules)	Q11.2	12	9.4%	47	37.0%	63	49.6%	5	3.9%
Knowledge of various teaching and learning strategies have increased	Q11.3	34	26.8%	87	68.5%	4	3.1%	2	1.6%
Knowledge of the curriculum has improved	Q11.4	22	17.3%	87	68.5%	15	11.8%	3	2.4%
Knowledge of assessment techniques to accommodate the learner has improved	Q11.5	34	26.8%	84	66.1%	5	3.9%	4	3.1%
Has developed your confidence to teach and facilitate learning	Q11.6	22	17.3%	87	68.5%	16	12.6%	2	1.6%
Ability to link subject matter knowledge/content knowledge to the appropriate teaching and learning strategies have improved	Q11.7	17	13.4%	78	61.4%	25	19.7%	7	5.5%

FIGURE 6.3: RESPONSES TO QUESTION 11



6.5.2 Question Twelve: Reasons for Not Registering for a Study Programme

This question deals aimed to understand why a teacher would not register for any study programme with respect to teaching the Nervous System and the Endocrine System. The aim of this question was to better understand whether the teacher believes that he or she is qualified and confident enough to meet the expectations outlined in the Life Sciences CAPS document, as well as to determine whether the teacher feels that he or she is competent in content knowledge and has no need to study further. This question also determined whether finances are a limiting factor to studying further and whether educators believe that their lessons are learner-centred, meeting the criteria of constructive learning. Table 6.15 shows a summary of the overall scoring for Question 12.

6.5.2.1 Summary of Responses in Relation to Statements of Question Twelve

Figure 6.4 and Table 6.15 show that for Question 12.1, 26.8% of respondents selected “Strongly Agree” and 49.6% selected “Agree”. Therefore in total, 76.4% of respondents were in agreement that they would not register for a study programme with respect to teaching the Human Nervous System and Endocrine System as they believed that they were qualified and confident enough to handle the expectations outlined in the Life Sciences CAPS document. A total of 23.6% of respondents were in disagreement and believed that they were not qualified and confident to meet the expectations as per the Life Sciences CAPS document.

Figure 6.4 and Table 6.15 show that for Question 12.2, 23.6% of respondents selected “Strongly Agree” and 48.8% selected “Agree”. Therefore in total, 72.4% of respondents were in agreement that they would not register for a study programme with respect to teaching the Human Nervous System and Endocrine System as they believed that they were competent in the content knowledge. A total of 27.6% of respondents were in disagreement and believed that they were not competent in the content knowledge of this topic of teaching.

TABLE 6.15 OVERALL SCORING FOR QUESTION 12

		Strongly Agree		Agree		Disagree		Strongly Disagree	
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
I believe I am qualified and confident to handle the expectations outlined in the Life Sciences CAPS document	Q12.1	34	26.8%	63	49.6%	30	23.6%	0	0.0%
I am competent in content knowledge therefore I do not need to study further	Q12.2	30	23.6%	62	48.8%	34	26.8%	1	0.8%
I have the financial mean to study further	Q12.3	6	4.7%	26	20.5%	20	15.7%	75	59.1%
My lessons are learner centred, meeting the outcomes of constructive learning	Q12.4	25	19.7%	84	66.1%	18	14.2%	0	0.0%

FIGURE 6.4: RESPONSES TO QUESTION 12

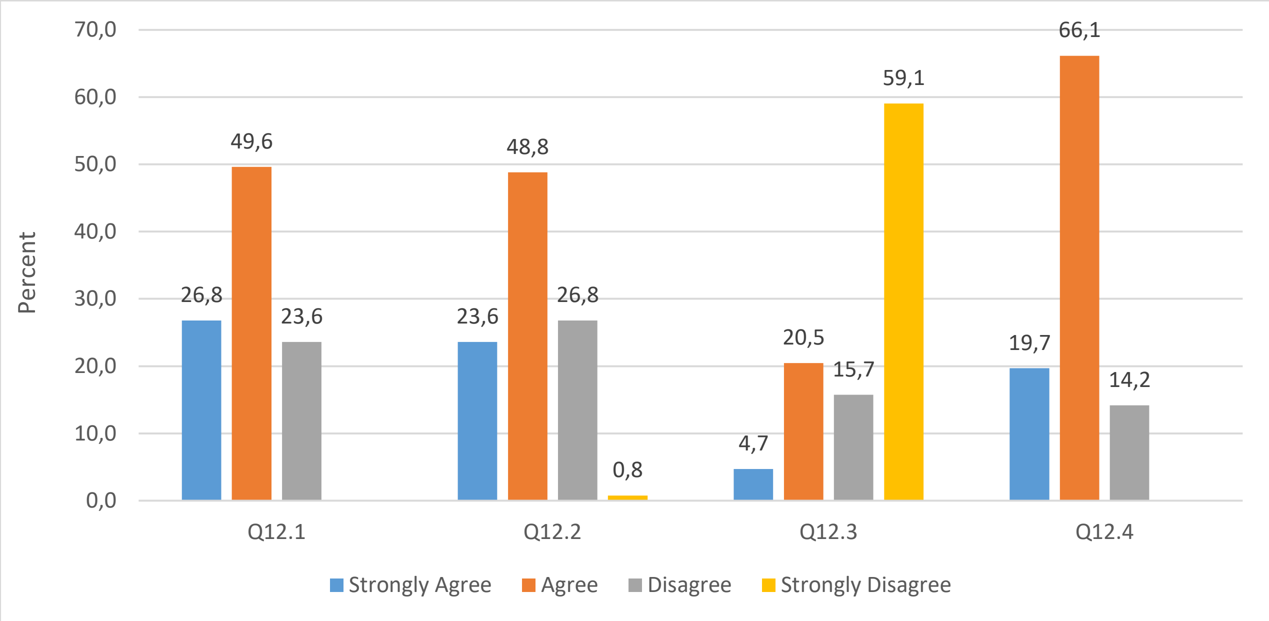


Figure 6.4 and Table 6.15 show that for Question 12.3, 15.47% of respondents selected “Strongly Disagree” and 59.1% selected “Disagree”. Therefore in total, 74.8% of respondents were in disagreement that they would not register for a study programme with respect to teaching the Human Nervous System and Endocrine System as they did not have the financial means to do so. A total of 25.2% of respondents were in agreement and believed that they did have the financial means to study further.

Figure 6.4 and Table 6.15 show that for Question 12.4, 19.7% of respondents selected “Strongly Agree” and 66.1% of respondents selected “Agree”. Therefore in total, 85.8% of respondents were in agreement that they would not register for a study programme with respect to teaching the Human Nervous System and Endocrine System as their lessons were learner-centred, meeting the outcomes of constructive learning. A total of 14.2% of respondents were in disagreement and believed that they did not meet the outcome of constructive learning by having learner-centred lessons.

6.5.3 Question Thirteen: attendance of respondents at Teacher Training Workshops

The aim of these questions was to determine whether respondents have attended teacher training workshops as a form of professional development and lifelong learning. Table 6.16 shows the summary of the scores for Question 13.

TABLE 6.16: SUMMARY OF SCORES FOR QUESTION 13

	Frequency	Percent
No	26	20,5
Yes	101	79,5
Total	127	100,0

Significantly more respondents (79.5%) had attended teacher training workshops.

6.5.4 Question Fifteen : Opinions of Respondents on Teacher Training Workshops

Question 15 aims to gather the opinions (of teacher training workshops) of respondents. The questions serve to determine whether the teacher training workshops enrich their knowledge of the subject and content matter. It also aims to determine whether the facilitator informs the trainee of how to link various teaching strategies with subject matter / content knowledge in order to improve teaching and learning. Table 6.17 summarises the scoring of responses and Figure 6.5 represents the scores graphically.

6.5.4.1 Summary of Responses in Respect to Statements of Question Fifteen

Figure 6.5 and Table 6.17 show that for Question 15.1, 3.9 % of respondents selected “Strongly Disagree” and 58.3% selected “Disgree”. Therefore in total, 62.2% of respondents were in disagreement that the teacher training workshops had enriched their knowledge of the subject matter. A total of 37.8% of respondents were in agreement and believed that the teacher training workshops enriched their knowledge of the subject matter.

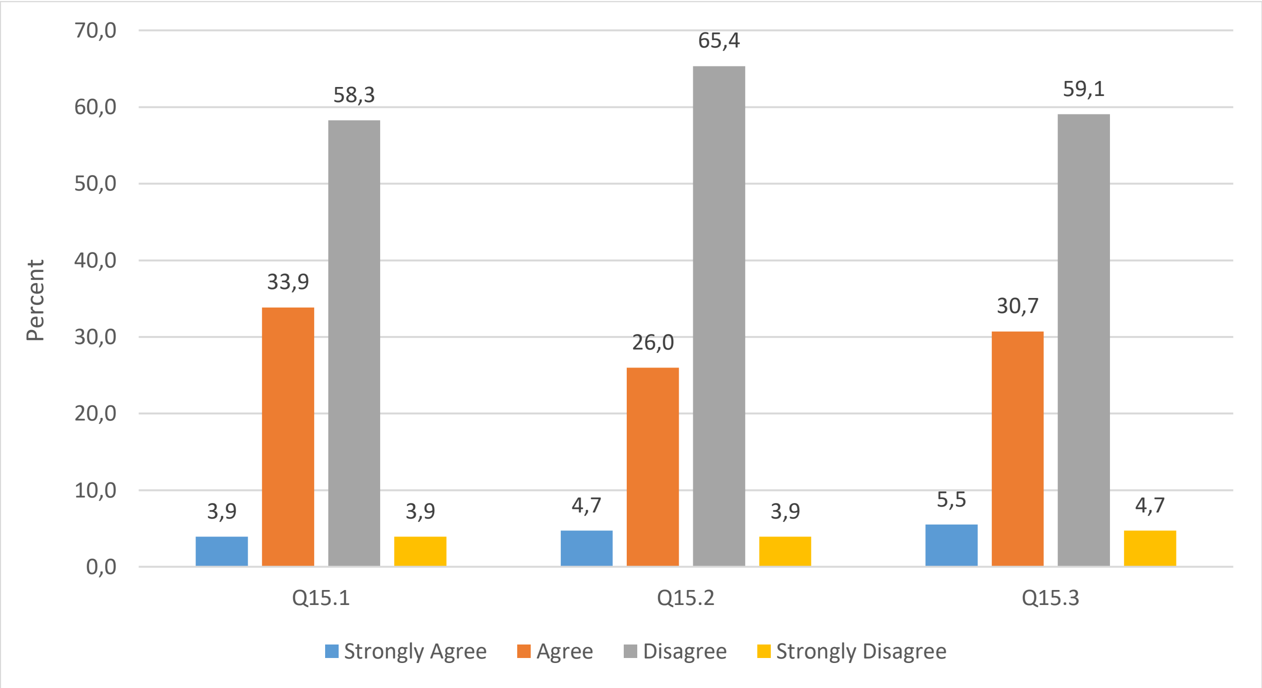
Figure 6.5 and Table 6.17 show that for Question 15.2, 3.9 % of respondents selected “Strongly Disagree” and 65.4% selected “Disgree”. Therefore in total, 69.3% of respondents were in disagreement that the teacher training workshops had enriched their content knowledge. A total 30.7% of respondents were in agreement and believed that the teacher training workshops enriched their content knowledge.

Figure 6.5 and Table 6.17 show that for Question 15.3, 4.7% of respondents selected “Strongly Disagree” and 59.1% selected “Disgree”. Therefore in total, 63.8% of respondents were in disagreement that the faciltator informed trainees of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning. A total of 36.2% of respondents were in agreement and believed that the faciltator informed trainees of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning.

TABLE 6.17: SUMMARY OF SCORES FOR QUESTION 15

		Strongly Agree		Agree		Disagree		Strongly Disagree	
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
The workshop enriched my knowledge of the subject matter	Q15.1	5	3.9%	43	33.9%	74	58.3%	5	3.9%
The workshop enriched my content knowledge	Q15.2	6	4.7%	33	26.0%	83	65.4%	5	3.9%
The facilitator informed me of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning	Q15.3	7	5.5%	39	30.7%	75	59.1%	6	4.7%

FIGURE 6.5: RESPONSES TO QUESTION 15



There are similar scoring patterns across Questions 15.1 and 15.3. Here, the scoring of agreement is 37,8% and 36.2% respectively, where most of these respondents selected "Agree". However, 62.2% and 63.8% of respondents respectively were in disagreement with the aspects discussed.

6.5.5 Question Sixteen : Teaching Strategies during Life Sciences Lessons

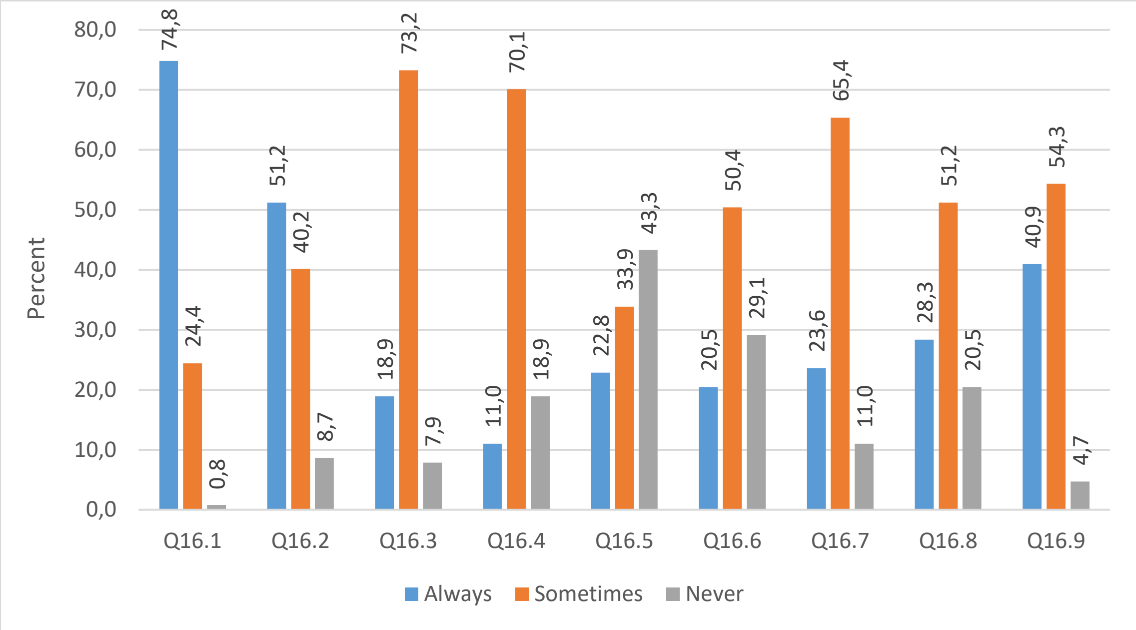
This question aimed to determine the type of teaching strategies used by educators during lessons. The teaching strategies range from traditional teaching strategies such as teacher speaks and learners listen; learners copy notes from the blackboard into their notebooks to the more modern techniques of using Integrated Computer Technology during lessons. Other listed strategies include inquiry-based techniques which are applied during investigations, through to collaborative learning and scaffolding, which is a technique where learners are assisted to move towards new skills, concepts and levels of understanding. Table 6.18 summarises the scoring. The graph in Figure 6.6 represents the scoring data graphically and is analysed below.

6.5.5.1 SUMMARY OF RESPONSES IN RELATION TO STATEMENTS IN QUESTION SIXTEEN

TABLE 6.18: SUMMARY OF SCORES FOR QUESTION 16

		Always		Sometimes		Never	
		Count	Row N %	Count	Row N %	Count	Row N %
Teacher speaks, learners listen	Q16.1	95	74.8%	31	24.4%	1	0.8%
Learners copy notes from the blackboard into their notebooks	Q16.2	65	51.2%	51	40.2%	11	8.7%
Teacher, makes use of inquiry-based learning (learners' hypothesis, select apparatus, identify variables, and draw conclusions	Q16.3	24	18.9%	93	73.2%	10	7.9%
Teacher tells learners the answers to questions from past exam papers	Q16.4	14	11.0%	89	70.1%	24	18.9%
Teacher makes use of Integrated Computer Technology	Q16.5	29	22.8%	43	33.9%	55	43.3%
Learners copy notes from a textbook into their notebooks	Q16.6	26	20.5%	64	50.4%	37	29.1%
Learners practice questions during collaborative learning	Q16.7	30	23.6%	83	65.4%	14	11.0%
Teacher encourages whole class discussions to construct meaning of topics	Q16.8	36	28.3%	65	51.2%	26	20.5%
Teacher encourages scaffolding (assisting learners to move towards new skills, concepts, and levels of understanding)	Q16.9	52	40.9%	69	54.3%	6	4.7%

FIGURE 6.6: RESPONSES TO QUESTION 16



Factor analysis of the graph indicates that many respondents, representative of the population, still make use of the traditional teaching method of teacher talks and learner listens; 74.8% of respondents always make use of this teaching strategy during Life Sciences lessons, while less than 1% of respondents stated that they never use this teaching strategy. Other teaching strategies that show fairly higher levels of always being used compared to others is 'learners copying notes from the blackboard into their notebooks' (another traditional teaching method), and is represented as 51.2%. Scaffolding is represented as 40.9% as always being used and a 54.3% response was that it is sometimes used as a teaching strategy.

Higher levels of teaching strategies that are sometimes used include the teacher making use of inquiry-based learning (73.2% response); teacher tells learners the answers to questions from past exam papers (70.1% response); learners practice questions during collaborative learning (65.4% response); and learners copy notes from a textbook into their notebooks (50.4% response). A similar scoring pattern is observed for Questions 16.3 and 16.4.

However, the higher response rate of a teaching strategy never being used is observed in the use of Integrated Computer Technology (43.3%). This could be due to the lack of computer facilities at the school; a lack of technology competency of the teacher, or a lack of support to use the resource effectively.

6.5.6 Question Seventeen: Aspects of Professional Development Required by Respondents

This question aimed at determining the needs of the respondent educators in respect of aspects of professional development. The aspects provided need statements that are similar aspects posed to educators across the questionnaire (Annexure A). The areas of focus are the enhancement of content knowledge; update knowledge of effective teaching strategies; ability to link subject matter / content knowledge with the appropriate teaching strategies; to understand how to integrate different cognitive levels into teaching; making use of various strategies of assessment and selecting appropriate resources to improve teaching and learning. Table 6.19 summarises the scoring responses. Figure 6.7 provides a graphical representation of the data, which is analysed below.

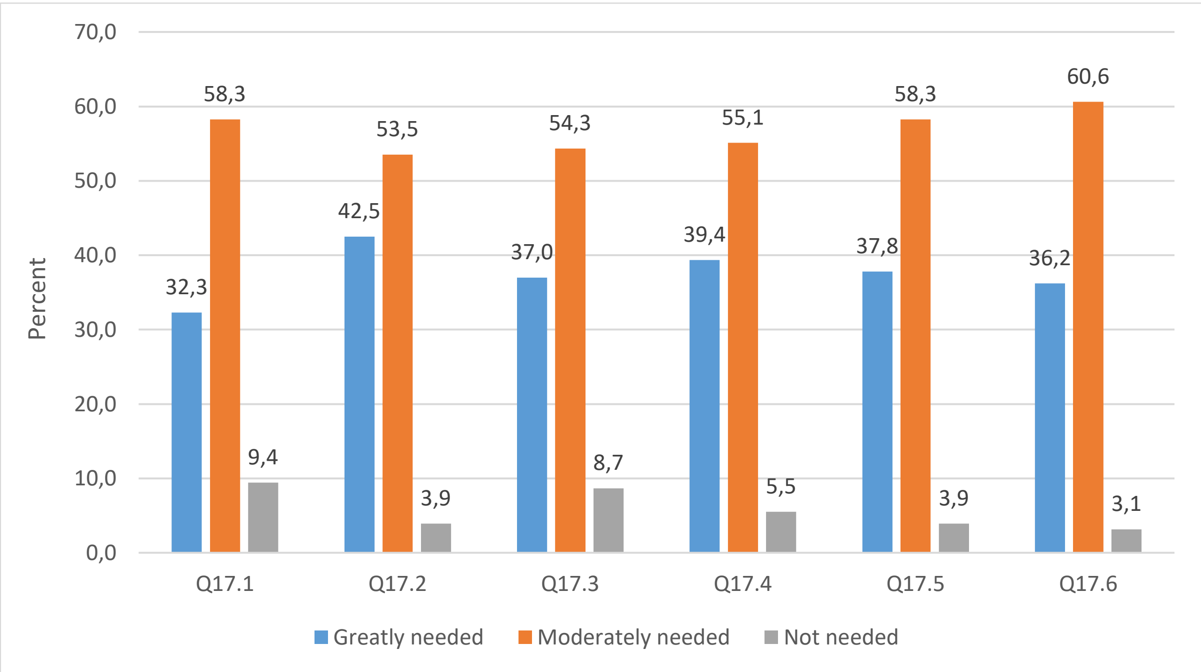
6.5.6.1 Summary of Responses by Respondents in regard to Statements of Question Seventeen

Figure 6.7 and Table 6.19 below indicate that all statements show significantly higher levels of moderately needed responses ranging from 53% to 60%. Similar patterns for this response are observed across all statements. Moreover, a 60% response is observed in the need to develop respondents in selecting appropriate resources to improve teaching and learning. There was no instance where the response was 0% for any of the aspects not being needed. However, the response for this scale across all statements was less than 10%. Although not as significantly high as moderately needed, the responses for aspects being greatly needed across all statements range from 32% to 42%. A 42% response is observed in the need to develop respondents in updating their knowledge of effective teaching strategies.

TABLE 6.19: THE SUMMARY OF SCORES FOR QUESTION 17

		Greatly needed		Moderately needed		Not needed	
		Count	Row N %	Count	Row N %	Count	Row N %
Enhance content knowledge	Q17.1	41	32.3%	74	58.3%	12	9.4%
Update knowledge of effective teaching strategies	Q17.2	54	42.5%	68	53.5%	5	3.9%
Ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning	Q17.3	47	37.0%	69	54.3%	11	8.7%
Understanding how to integrate different cognitive levels into teaching	Q17.4	50	39.4%	70	55.1%	7	5.5%
Make use of various strategies of assessments	Q17.5	48	37.8%	74	58.3%	5	3.9%
Select appropriate resources to improve teaching and learning	Q17.6	46	36.2%	77	60.6%	4	3.1%

FIGURE 6.7: RESPONSES TO QUESTION 17



6.6 STATISTICAL RELATIONSHIPS BETWEEN VARIABLES

A second Pearson's Chi square test was performed to determine whether there was a statistically significant relationship between the variables. The Pearson's Chi square test is a test of independence which is used on cross-tabulations to determine whether a significant relationship exists between the two variables represented in the cross-tabulation. All p-values (Asymptotic Significance 2-sided) < 0.05 have a significant relationship and the null hypothesis is rejected. All p-values > 0.05 do not signify a significant relationship and the null hypothesis is accepted. A second test was performed, known as the Fisher's Exact test. This test was used to determine whether there was a statistical relationship between variables. All p-values (Exact Significance 2-sided) < 0.05 have a significant relationship and the null hypothesis is rejected. All p-values > 0.05 do not have a significant relationship and the null hypothesis is accepted. The tables below summarise the results of the Pearson's Chi square tests and the Fisher's Exact test.

6.6.1 Statistical Relationships between Question 11 Statements and Attendance at Teacher Training Workshops.

The results of the Pearson's Chi square test and the Fisher's Exact test are shown on the tables below. Table 6.20 , Table 6.21, Table 6.22, Table 6.23, Table 6.24 and Table 6.25 represent the computerised data. Data was computerised using SPSS version 26.0. for Windows. A null hypothesis is formulated for each statement of Question 11 and their attendance at teacher training workshops. The statistical parameters state that if the p-values of both tests are < 0.05 then the null hypothesis is rejected and there is a significant relationship between the variables. If the p-values of both tests are > 0.05 then the null hypothesis is accepted and there is no significant relationship between the variables. Question 11 deals with aspects of teacher knowledge. The aim of testing these variables was to establish whether aspects of teacher knowledge do improve as a result of attending teacher training workshops. The discussion is provided below based on the computerised data in each table.

H_0^1 There is no significant relationship between “Subject matter knowledge has improved (content according to the prescribed work schedules)” and “Have you attended any teacher training workshops?”

TABLE 6.20: SUBJECT MATTER KNOWLEDGE HAS IMPROVED (CONTENT ACCORDING TO THE PRESCRIBED WORK SCHEDULES) AND HAVE YOU ATTENDED ANY TEACHER TRAINING WORKSHOPS? (n=127)

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	5.893[a]	3	0,117	0,116
Likelihood Ratio	8,778	3	0,032	0,043
Fisher's Exact Test	6,490			0,079
Linear-by-Linear Association	5.126[b]	1	0,024	0,031
N of Valid Cases	127			

Pearson’s Chi-Square = 5.893, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$);
Fisher’s Exact Test= 6.490, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.20 shows that the Pearson’s Chi square test result p-value is 0.117 and the Fisher’s Exact test result p-value is 0.079. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The improvement in subject matter knowledge (content according to the prescribed work schedules) is not related to attendance at teacher training workshops.

H_0^2 There is no significant relationship between “Content knowledge has improved (content beyond the parameter of the prescribed work schedules)” and “Have you attended any teacher training workshops?”

TABLE 6.21: CONTENT KNOWLEDGE HAS IMPROVED (CONTENT BEYOND THE PARAMETERS OF THE PRESCRIBED WORK SCHEDULES) AND HAVE YOU ATTENDED ANY TEACHER TRAINING WORKSHOPS? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	5.542[a]	3	0,136	0,128
Likelihood Ratio	7,735	3	0,052	0,070
Fisher's Exact Test	5,756			0,097
Linear-by-Linear Association	5.234[b]	1	0,022	0,022
N of Valid Cases	127			

Pearson’s Chi-Square = 5.542, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$); Fisher’s Exact Test= 5.756, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.21 shows that the Pearson’s Chi square test result p-value is 0.136 and the Fisher’s Exact test result p-value is 0.097. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The improvement in content knowledge (content beyond the parameters of the prescribed work schedules) is not related to attendance at teacher training workshops.

$H_0{}^3$ There is no significant relationship between, “Knowledge of various teaching and learning strategies have increased” and “Have you attended any teacher training workshops?”

TABLE 6.22: KNOWLEDGE OF VARIOUS TEACHING AND LEARNING STRATEGIES HAVE INCREASED AND HAVE YOU ATTENDED ANY TEACHER TRAINING WORKSHOPS? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	.832[a]	3	0,842	0,902
Likelihood Ratio	1,235	3	0,745	0,849
Fisher's Exact Test	0,802			0,948
Linear-by-Linear Association	.016[b]	1	0,901	1,000
N of Valid Cases	127			

Pearson’s Chi-Square = 0.832, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$);
Fisher’s Exact Test= 0.802, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.22 shows that the Pearson’s Chi square test result p-value is 0.842 and the Fisher’s Exact test result p-value is 0.948. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The increase in knowledge of various teaching and learning strategies is not related to attendance at teacher training workshops.

H_0^4 There is no significant relationship between “Knowledge of the curriculum has improved” and “Have you attended teacher training workshops?”

TABLE 6.23: KNOWLEDGE OF THE CURRICULUM HAS IMPROVED AND HAVE YOU ATTENDED TEACHER TRAINING WORKSHOPS? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.930[a]	3	0,403	0,401
Likelihood Ratio	3,419	3	0,331	0,380
Fisher's Exact Test	2,391			0,488
Linear-by-Linear Association	.605[b]	1	0,437	0,481
N of Valid Cases	127			

Pearson’s Chi-Square = 2.930, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$);
Fisher’s Exact Test= 2.391, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.23 shows that the Pearson’s Chi square test result p-value is 0.403 and the Fisher’s Exact test result p-value is 0.488. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The improvement in knowledge of the curriculum is not related to attendance at teacher training workshops.

H_0^5 There is no significant relationship between "Knowledge of assessment techniques to accommodate the learner has improved" and "Have you attended teacher training workshops?"

TABLE 6.24: KNOWLEDGE OF ASSESSMENT TECHNIQUES TO ACCOMMODATE THE LEARNER HAS IMPROVED AND HAVE YOU ATTENDED ANY TEACHER TRAINING WORKSHOPS? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.299[a]	3	0,513	0,557
Likelihood Ratio	3,138	3	0,371	0,471
Fisher's Exact Test	1,766			0,634
Linear-by-Linear Association	.011[b]	1	0,918	1,000
N of Valid Cases	127			

Pearson's Chi-Square = 2.299, df =3, Cut-off parameter: Pearson's Significance ($p < 0.05$);
Fisher's Exact Test= 1.766, Cut-off parameter: Fisher's Exact Test Significance ($p < 0.05$)

Table 6.24 shows that the Pearson's Chi square test result p-value is 0.513 and the Fisher's Exact test result p-value is 0.634. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The improvement in knowledge of assessment techniques to accommodate the learner is not related to attendance at teacher training workshops.

$H_0$6 There is no significant relationship between "Ability to link subject matter knowledge/ content knowledge to the appropriate teaching and learning strategies have improved" and "Have you attended any teacher training workshops?"

TABLE 6.25: ABILITY TO LINK SUBJECT MATTER KNOWLEDGE / CONTENT KNOWLEDGE TO THE APPROPRIATE TEACHING AND LEARNING STRATEGIES HAVE IMPROVED AND HAVE YOU ATTENDED ANY TEACHER TRAINING WORKSHOPS? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	7.727[a]	3	0,052	0,052
Likelihood Ratio	9,312	3	0,025	0,033
Fisher's Exact Test	6,802			0,065
Linear-by-Linear Association	1.125[b]	1	0,289	0,363
N of Valid Cases	127			

Pearson's Chi-Square = 7.727, df =3, Cut-off parameter: Pearson's Significance ($p < 0.05$); Fisher's Exact Test= 9.312, Cut-off parameter: Fisher's Exact Test Significance ($p < 0.05$)

Table 6.25 shows that the Pearson's Chi square test result p-value is 0.052 and the Fisher's Exact test result p-value is 0.065. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The null hypothesis is therefore accepted. The improvement in the ability to link subject matter knowledge / content knowledge to appropriate teaching and learning strategies is not related to attendance at teacher training workshops, which are a form of professional development for educators.

The professional development of educators is a critical step in improving the quality of educators and their impact in the classroom. Mokhele (2011:16) referred to information from the National Research Council (2007), which showed that many educators expressed dissatisfaction with the professional development opportunities made available to them in schools and insisted that the most effective development programmes have been self-initiated. Cronje (2011:8) explains that in-service workshops cover policy aspects and do not address the skills and knowledge needed by educators.

Keke (2014:18) indicated that the quality of the educator is improved by expanding their knowledge base, skills and competence. Fernandez (2014:80) makes reference to Shulman (1987), who outlines the categories of educator knowledge to promote understanding amongst learners, and that educators should possess and states that pedagogical content knowledge is that special amalgam of content and pedagogy, namely content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge and knowledge of learners and their characteristics.

Meanwhile, Keke (2014:18) defines educator professional development as processes and activities engaged in by educators which enhance professional career growth. Mokhele (2011:11) states that there is consensus that many continuous professional development programmes have yet to understand professional development from a teacher's perspective; to acknowledge what drives educators to enlist in these programmes; and how the programmes can benefit them in the classroom. According to the Department of Education Curriculum News (2013:5), although there have been examples of excellent training programmes, a large majority have been ineffective.

Moodley (2013:22) highlighhts that the training and support provided to educators are not adequately addressing their needs.

6.6.2 Statistical Relationship between Improvement of Content Knowledge and being Registered for a Life Sciences / Biological Sciences Studies.

The results of the Pearson's Chi square test and the Fisher's Exact test are shown in the tables below. Table 6.26, represent the computerised data. Data was computerised using SPSS version 26.0. A null hypothesis is formulated to measure the relationship between the aspects. The statistical parameters state that if the p-values of both tests are < 0.05, then the null hypothesis is rejected and there is a significant relationship between the variables. If the p-values of both tests are > 0.05 then the null hypothesis is accepted and there is no significant relationship between the variables. The aim of testing these variables, "content knowledge has improved (beyond the parameters of the prescribed work schedules)" and "Are you currently registered for Life Sciences / Biological Sciences studies?", is to establish whether educators who register to study further in Life Sciences or Biological Sciences courses benefit by improving their content knowledge in Life Sciences. The discussion is provided below based on the computerised data in each table.

H_0^7 There is no significant relationship between "content knowledge has improved (beyond the parameters of the prescribed work schedules)" and "Are you currently registered for Life Sciences / Biological Sciences studies?"

TABLE 6.26: CONTENT KNOWLEDGE HAS IMPROVED (BEYOND THE PARAMETERS OF THE PRESCRIBED WORK SCHEDULES) AND ARE YOU CURRENTLY REGISTERED FOR LIFE SCIENCES/ BIOLOGICAL SCIENCES STUDIES? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	16.876[a]	3	0,001	0,014
Likelihood Ratio	12,110	3	0,007	0,003
Fisher's Exact Test	11,017			0,004
Linear-by-Linear Association	11.650[b]	1	0,001	0,001
N of Valid Cases	127			

Pearson's Chi-Square = 16.876, df =3, Cut-off parameter: Pearson's Significance ($p < 0.05$);
Fisher's Exact Test= 11.017, Cut-off parameter: Fisher's Exact Test Significance ($p < 0.05$)

Table 6.26 shows that the Pearson's Chi square test result p-value is 0.001 and the Fisher's Exact test result p-value is 0.004. Both test result p-values are < 0.05. This indicates a significant relationship between the variables. The improvement in content knowledge (beyond the parameters of the prescribed work schedules) is influenced by educators registering for Life Sciences / Biological Sciences studies. The null hypothesis is therefore rejected. Professional development whether through workshops or study courses, is a means of improving an aspect of knowledge for the teacher. Govender (2015:492) indicates that educators engage in different ways of improving their qualifications and developing themselves as professionals.

Educators are knowledge workers as they gain knowledge over time and this knowledge is imparted to colleagues and more so to learners where content is gained by educators. Van Staden (2009:35) states that education, training and learning is part of the development process of any knowledge worker and that formal and informal training is a lifelong process.

6.6.3 Statistical Relationship between Improvement of Knowledge of the Curriculum and Whether the Respondent is Currently Teaching Life Sciences and the Number of Years that the Respondent has been Employed as a Teacher

The results of the Pearson's Chi square test and the Fisher's Exact test are shown on Table 6.27 and Table 6.28 below, which represents the computerised data. Data was computerised using SPSS version 26.0. A null hypothesis is formulated to measure the relationship between the aspects. The statistical parameters state that if the p-values of both tests are < 0.05, then the null hypothesis is rejected and there is a significant relationship between the variables. If the p-values of both tests are > 0.05, then the null hypothesis is accepted and there is no significant relationship between the variables. The aim of testing these variables, "Knowledge of curriculum has improved" and " Are you currently teaching Life Sciences?" ; "Knowledge of curriculum has improved" and " How many years have you been employed as a teacher?", is to establish whether educators become more familiar and knowledgeable with the expectations of the curriculum if they are currently teaching the subject as well as determine whether educators who are employed for a longer period of time have a better understanding of the curriculum. The better the understanding of the curriculum the more effective it is to implement the curriculum. The discussion is provided below based on the computerised data in each table.

$H_0 8$ There is no significant relationship between "Knowledge of curriculum has improved" and "Are you currently teaching Life Sciences?"

TABLE 6.27: KNOWLEDGE OF CURRICULUM HAS IMPROVED AND ARE YOU CURRENTLY TEACHING LIFE SCIENCES? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.600[a]	3	0,659	0,653
Likelihood Ratio	2,507	3	0,474	0,571
Fisher's Exact Test	1,529			0,739
Linear-by-Linear Association	1.471[b]	1	0,225	0,338
N of Valid Cases	127			

Pearson's Chi-Square = 1.660, df =3, Cut-off parameter: Pearson's Significance ($p < 0.05$);
Fisher's Exact Test= 1.529, Cut-off parameter: Fisher's Exact Test Significance ($p < 0.05$)

Table 6.27 shows that the Pearson's Chi square test result p-value is 0.659 and the Fisher's Exact test result p-value is 0.739. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The improvement in curriculum knowledge is not influenced by whether a teacher is teaching Life Sciences. The null hypotheses are therefore accepted.

H_0^9 There is no significant relationship between “Knowledge of curriculum has improved” and “How many years have you been employed as a teacher?”

TABLE 6.28: KNOWLEDGE OF CURRICULUM HAS IMPROVED AND HOW MANY YEARS HAVE YOU BEEN TEACHING LIFE SCIENCES? (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	11.148[a]	15	0,742	0,729
Likelihood Ratio	12,066	15	0,674	0,771
Fisher's Exact Test	11,853			0,658
Linear-by-Linear Association	1.121[b]	1	0,290	0,310
N of Valid Cases	127			

Pearson’s Chi-Square = 11.148, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$);
Fisher’s Exact Test= 11.853, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.28 shows that the Pearson’s Chi square test result p-value is 0.742 and the Fisher’s Exact test result p-value is 0.658. Both test result p-values are > 0.05. This indicates that there is no significant relationship between the variables. The improvement in curriculum knowledge is not related to the number of years that educators have been teaching. The null hypothesis is therefore accepted.

In both Table 6.27 and Table 6.28, the results indicate that the null hypothesis is accepted and that there is no significant relationship between knowledge of the curriculum and whether an educator teaches the subject, or for how long the educator has been teaching. This implies that there is no enforcing of curriculum knowledge taking place.

The curriculum is central to the education process as it refers to the teaching and learning activities and experiences provided by schools, namely the aims and objectives: the selection of content to be taught; ways of teaching and learning; and forms of assessment (NEPI,1993:102). Therefore, knowledge of the curriculum impacts on the quality of teaching and aspects of teacher knowledge in the classroom. To meet the requirements of the Life Sciences Curriculum and Assessment Policy (CAPS), it has become important for South African educators to develop adequate understanding of the concepts related to Life Sciences. Although changes to the curriculum seem inevitable. According to DeMonte (2013:1), it takes a sustained investment of time into educator professional development to change instruction and improve classroom outcomes. Experience does not necessarily lead to better instruction, while enhancing skills, knowing strategies and understanding content and pedagogy so learners understand. It is therefore vital that knowledge of the curriculum be enforced in order to deliver improved quality teaching and learning in the classroom.

6.6.4 Statistical Relationship between Educators' Belief of being Competent in Content knowledge and not Needing to Study Further to Listing Educators' Completed Academic Qualification which Includes a Study in Biological Sciences

The results of the Pearson's Chi square test and the Fisher's Exact test is shown on Table 6.29 below, which represents the computerised data. Data was computerised using SPSS version 26.0. A null hypothesis is formulated to measure the relationship between the aspects. The statistical parameters state that if the p-values of both tests are < 0.05, then the null hypothesis is rejected and there is a significant relationship between the variables. If the p-values of both tests are > 0.05, then the null hypothesis is accepted and there is no significant relationship between the variables. The aim of testing these variables, “I am competent in content knowledge therefore I do not need to study further” and “List your completed academic qualification which includes a study in Biological Studies” is to establish whether educators who have completed academic qualification with a study course in Biological Studies are actually more likely to feel competent in content knowledge when teaching that they do not feel the need to study further. The discussion provided below based on the computerised data in each table.

H_0^{10} There is no significant relationship between “I am competent in content knowledge therefore I do not need to study further” and “List your completed academic qualification which includes a study in Biological Studies”

TABLE 6.29: I AM COMPETENT IN CONTENT KNOWLEDGE THEREFORE I DO NOT NEED TO STUDY FURTHER AND LIST YOUR COMPLETED ACADEMIC QUALIFICATION WHICH INCLUDES A STUDY IN BIOLOGICAL STUDIES. (n=127)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	60.946[a]	36	0,006	.[b]
Likelihood Ratio	43,004	36	0,196	0,023
Fisher's Exact Test	60,810			0,025
Linear-by-Linear Association	5.700[c]	1	0,017	0,016
N of Valid Cases	127			

Pearson’s Chi-Square = 60.946, df =3, Cut-off parameter: Pearson’s Significance ($p < 0.05$);
Fisher’s Exact Test= 60.810, Cut-off parameter: Fisher’s Exact Test Significance ($p < 0.05$)

Table 6.29 shows that the Pearson's Chi square test result p-value is 0.006 and the Fisher's Exact test result p-value is 0.025. Both test result p-values are < 0.05. This indicates that there is a significant relationship between the variables. An educator's belief and level of competence in content knowledge in Life Sciences is significantly influenced by the teacher completing an academic qualification which includes a study in Biological Studies. The null hypothesis is therefore rejected. Coetzee (2015:np) indicates that quality teaching is directly affected by underqualified or unqualified educators teaching a subject. Findings by Scott (2013) indicate that educators having a BSc degree might be beneficial in their conceptual understanding in the profession.

6.7 LIMITATIONS OF THE RESEARCH

The researcher highlighted the following as limitations to the study:

- The global pandemic of COVID-19 prevented the researcher from having contact with the sample respondents to administer the questionnaires for completion and collection. The questionnaire was administered to sample respondents through a digital online platform which took a quite long to retrieve the completed questionnaires. Although cost effective, the researcher had to send out numerous reminders to sample respondents to complete and return the questionnaire.

- Five questionnaires were not returned by sample respondents. The researcher had to complete data analysis based on 127 respondents instead of 132.

- Literature which was applicable to this study was very limited. Many of the referenced works were older than 2010 but indeed pertinent.

- There was limited literature available through both digital and walk-in library resources for research on aspects such as:
  - Professional training and development of South African educators
  - Professional training and development Models in the South Africa Education Sector
  - Pedagogical content knowledge in teaching Life Sciences
  - Training of Life Sciences educators
  - Knowledge workers in the South African Education Sector

- The study was limited to one district of the Kwa-Zulu Natal Department of Education. The researcher selected sample respondent educators from the population of the sampling frame for Life Sciences educators of the Umlazi district. However, given the nature of aspects in the discussions, the researcher should have extended the research to include another district of the Kwa-Zulu Natal Department of Education. This would have resulted in the researcher's concluding generalisation being representative of a larger sample population.

6.8 CONCLUSION

This chapter presented an analysis of data collected through questionnaires (Annexure A) administered to 132 sample respondents. A total of 127 questionnaires were completed and the was data analysed. A detailed discussion of the findings from the analysis of responses was presented. The data was presented in the form of graphs and tables. Aspects of the data were analysed using statistical tests, using SPSS Version 26.0. The statistical results were represented in the form of tables and graphs, from which the researcher has presented a detailed description. A total of 10 hypotheses testing significant relationships between variables were tested. The researcher highlighted aspects as limitations to the study with limited literature being the most crucial.

The next chapter presents the conclusions and recommendations as a result of the analysis of data.

CHAPTER SEVEN
CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

In this chapter, the researcher presents the conclusion and recommendations to the study. The conclusions and recommendations of this study are drawn from the results and findings discussed in Chapter Six.

This study aims to determine whether current Life Sciences educators possess the necessary content knowledge to successfully facilitate knowledge construction, and whether they are equipped to choose the appropriate strategies of conveying this knowledge to learners by means of a quantitative study in the form of a questionnaire. This study made use of a quantitative research design. The researcher employed a highly structured research methodology involving the administration of questionnaires and the analysis of the data thereof. Data was collected through a pre-coded, structured questionnaire using a Likert scale (Annexure A). The questionnaire in this study comprised 17 statements and four sections, namely Consent, Biographical Details, Educational History and Professional Development.

In total, 132 questionnaires were despatched via a digital email platform and 127 were returned. Therefore, the final responses for this study were n=127. SPSS version 26.0.0. for Windows was used to evaluate the data obtained from the responses. The results were described as descriptive statistics, in the form of graphs, cross tabulations and other figures for the quantitative data obtained. It should be highlighted that the completed thesis was language edited by a competent Language Editor. After completion of the thesis, the researched conducted a TURNITIN exercise for any form of plagiarism. The TURNITIN program produced a highly significant value of a minimal 16%. This could have been further reduced as the TURNITIN program identified secondary authors for similar theoretical viewpoints.

7.2 CONCLUSION

The main aim of the study was to determine whether current Life Sciences educators gain aspects of pedagogical content knowledge through educator professional development programmes and to determine the type of pedagogy most commonly used in present day Life Sciences lessons. Many important conclusions have resulted from the study of data collected. Tests were used for the formulated hypotheses. The questionnaire (Annexure A) that was developed for this study proved to provide scientific worth to the study. The researcher cited information from other authors who endorse similar findings to the results of this study.

The development of the conceptual framework shows the links between aspects of the literature and the research question. The aim of the Conceptual Framework Linking Professional Training and Development to Improved Life Sciences Education Output (Figure 4.1) is to propose relationships between concepts or aspects of this study. The framework amalgamates the theoretical aspects linking aspects of educator knowledge, professional training and development, pedagogy and the educator as a knowledge worker to the needs of the learner. The main aspect to the framework (Figure 4.1.) is the learner needs diagram which aspects of educator knowledge influence. The educator being a knowledge worker influences and is influenced by learner needs.

7.3 REFLECTIONS AND EVALUATION

7.3.1 Educator Professional Qualification

An average of 66.6% of respondents show agreement that their professional qualification has improved their knowledge of various teaching and learning strategies; improved knowledge of the curriculum; improved knowledge of assessment techniques to accommodate the learner; developed confidence to teach and facilitate learning; and improved their ability to link subject matter knowledge / content knowledge to the appropriate teaching and learning strategies. However, only an average of 20.3% of respondents strongly agree to the aspects listed above. This indicates that the majority of respondents show a lack of certainty and confidence in the development of themselves under these aspects upon completion of their professional qualification.

An average of 46.5% of respondents indicated that they “disagree’ that their professional qualification has improved subject matter knowledge (content according to the prescribed work schedules) and improved content knowledge (content beyond the parameters of the prescribed work schedules). This reveals that respondents would require a form of professional development to focus on and improve subject matter knowledge and content knowledge, which play an integral part in the teaching process.

7.3.2 Teaching Strategies (pedagogies) used in Life Sciences Lessons

The findings reveal that 74.8% of respondents indicated ‘always’ to making use of the teaching strategy ‘teacher talks and learners listen’, while results also reveal that 51.2% of respondents indicated ‘always’ to using the teaching strategy ‘learners copy notes from the blackboard into their notebooks’. High percentages of respondents indicated that they ‘sometimes’ make use of ‘teacher tells learners the answers to questions from past papers’ (70.1% of respondents) and ‘learners copy notes from a textbook into their notebooks’ (50.4% of respondents).

These teaching strategies are termed as ‘traditional teaching strategies’. The learner is not given the opportunity to construct his or her own understanding of the concepts. These findings reveal that traditional teaching strategies are still prevalent in the South African millennial classroom.

A significant 73.2% of respondents indicated that they ‘sometimes’ make use of ‘inquiry-based learning’ while, 7.9% indicated ‘never’ for this strategy. This could be a direct implication of whether the teacher has himself or herself acquired and has knowledge of these inquiry-based skills, such as stating a hypothesis, selecting apparatus, identifying variables and drawing conclusions. This factor also impacts on the educators’ level of confidence to impart these skills to learners. Acquiring knowledge of these skills and practicing the skills would be a result of being professionally developed through workshops or subject-related courses, or having gained experienced and knowledge through professional qualifications.

7.3.3 Educator Development Workshops

Data analysis reveals that 58.3% of respondents selected ‘disagree’ that educator training workshops enrich their knowledge of subject matter. Another high percentage of respondents selecting ‘disagree’ is observed as 65.4% of respondents disagreed that educator development workshops enriched their content knowledge. Additionally, 59.1% of respondents disagreed with the statement ‘the facilitator informed me of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning’. In all three aspects, less than 35% of respondents indicated ‘agree’ and less than 6% of respondents indicated ‘strongly agree’, while less than 5% of respondents indicated ‘strongly disagree’. Educator training workshops are a form of professional development. Respondents clearly do not feel professionally developed in the aspects listed above after attending the educator development workshops.

7.3.4 Need for Life Sciences Educator Professional Development

From the data analysis, it is observed that an average of 56.6% of respondents indicated that they ‘moderately needed’ professional development in the areas of enhancing content knowledge, updating knowledge of effective teaching strategies, linking of subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning, understanding how to integrate different cognitive levels into teaching, using various strategies of assessment and selecting appropriate resources to improve teaching and learning. An average of 37.5% of respondents indicated that they ‘greatly needed’ professional development in the aspects listed above, while only 5.7% of respondents indicated that professional development in the aspects listed above were ‘not needed’. Professional development, which is specific to an aspect, would better develop an educator, which would impact on the teaching and learning process in the classroom.

7.3.5 Advantages of the Life Sciences Educator Profile Questionnaire (Annexure A)

This questionnaire addressed aspects of Pedagogical Content Knowledge in relation to teacher professional development. This tool could serve as an intervention to guide the planning, facilitation and monitoring of professional development activities to ensure successful Pedagogical Content Knowledge development for Life Sciences educators. This study focused on the Durban Central circuit of the Umlazi district of the Kwa-Zulu Natal Department of Education, therefore limiting the generalisation of the results. This questionnaire may prove useful to other education districts in determining teacher pedagogical content knowledge needs and finding ways to effectively develop these needs. As the facilitation and aspects of education constantly change, so should the manner of professional development in order to assist educators to evolve their pedagogical content knowledge and the implementation thereof.

7.4 RECOMMENDATIONS

The recommendations of this study are derived from the analysis of data collected and are presented based on the sections and questions of the questionnaire (Annexure A). Recommendations are also based on the Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output (Figure 4.1) in Chapter four.

7.4.1 Section B: Recommendations based on the Results of Biographical Details of the Sample Respondents

7.4.1.1 Gender and Age Profiles

It is recommended that the Human Resources Sector of the KZN Department of Education (due to the limitation of this study) monitors the ratio of males to females in the teaching occupation. The findings of this study reveal that there are approximately twice the number of female Life Sciences educators as compared to male Life Sciences educators.

It is recommended that there should be monitoring of the current age range of Life Science educators as well. Findings of this study reveal that a greater number of educators lie in the >40-year-old age range. This can have implications for the use of teaching strategies which are more traditional in nature. This may also impact on the use of integrated computer technology in classrooms, limiting the teaching and learning process. By monitoring the current age statistics, the Department of Education should be able to identify educators who would be in need of curricular knowledge development through professional development opportunities. Curricular knowledge would entail educating the teacher on the expectations of the CAPS document and the support documents associated with it, such as the assessments document. CAPS promotes a move away from traditional teaching methodologies and promotes constructive learning methodologies.

It is also recommended, given the low number of educators in the 20-25-year-old age range and the 26 – 30-year-old age range, that the Department of Education work in partnership with tertiary institutions to promote the youth entering into the teaching qualification to specialise in Life Sciences as a teaching subject.

7.4.1.2 Highest Academic Qualification which Includes a Study in Biological Sciences

The findings of this study reveal that 55.9% of respondents completed a study in Biological Sciences at a Grade 12 level. This implies that these respondents themselves have no level of specialisation in Life Sciences or Biology content. They have the same basic knowledge that will be imparted to learners. It is therefore recommended that the school management teams, together with the various levels of management in the Department of Education, screen all newly appointed educators to determine their level of content specialisation in Life Sciences. Should the newly appointed educator only possess a professional teaching qualification and Biological Studies / Life Sciences at Grade 12 level, then the educator should attend a form of professional development to focus on the specialisation of content knowledge. An educator who does not possess sufficient content knowledge would not be equipped to teach learner beyond the parameters of a textbook.

7.4.1.3 Professional Teaching Qualifications

It is recommended that the Department of Education regularly monitor the professional teaching qualifications of educators. Over time, policy documents change with regards to curriculum, assessment strategies as well as inclusivity. The tertiary studies course work for teaching qualifications are adapted to these changes, yet an educator with an older professional teaching qualification is not up-to-date with these changes. By regularly monitoring educators' professional qualifications, the Department of Education can identify educators who need to be professionally developed in the area of curricular knowledge and the related subject knowledge. This in turn would result in professional development for assessment strategies development, as well as pedagogical knowledge that are in line with the curriculum.

Findings reveal that 16% of respondents possess a professional teaching qualification in the category of 'Other'. The category 'Other' would include older teaching qualifications outside of the current professional teaching qualifications listed in the questionnaire (Annexure A).

Only 17% of respondents have a Post-Graduate Certificate in Education qualification, indicating that they have an academic qualification with a specialisation in the content knowledge of the subject area. It is possible that of the 69% of respondents that have a Bachelor of Education qualification, some respondents may have completed an academic qualification in Biological Studies. However, this professional qualification does not focus on content knowledge. Therefore, by regularly monitoring educator professional qualifications, the Department of Education can provide professional development in aspects of content knowledge to promote lifelong learning; to allow the educator to become a specialist in the field; and for the educator to become a knowledge worker.

7.4.2 Section C: Recommendations based on the Results of Professional Development of the Sample Respondents

7.4.2.1 The Relationship between Professional Teaching Qualifications and Aspects of Knowledge

From the findings of this study, it is recommended that tertiary institutions adjust their teaching qualifications course layout to include a course in the content knowledge specialisation of Life Sciences topics. This would develop the would-be educator in content knowledge, making the individual a specialist in the field of Life Sciences, therefore being able to teach beyond the parameters of the prescribed work schedules with confidence. It is also recommended that a relationship be developed with the different faculties that offer the content to allow individuals (learners) to be part of the scientific inquiry-based process. The experience of this process develops the individual for what he or she would be demonstrating and facilitating in a Life Sciences classroom.

7.4.2.2 Educator Professional Development Workshops

It is recommended that educator training workshops not be general workshops. Educators' needs must be identified prior to planning teacher training workshops. As educator development workshops are facilitated by subject advisors per education circuit, a needs analysis tool should be completed by Life Sciences educators within that circuit at the end of the academic year and returned to subject advisors so that planning for the new academic year with appropriate educator development workshops can commence.

It is further recommended that facilitators of the educator development workshops should be aspect specific, for example:

- a training and development activity which develops and improves a Life Sciences teacher's content knowledge; should be facilitated by tertiary institute professors or lecturers who are already specialists in the field;
- a training and development workshop which trains and develops educators or improves educators' knowledge on how to effectively use integrated computer technology in the Life Sciences classroom should be facilitated by an information technologist specialising in the computer programmes to be used;
- a training and development workshop which discusses the CAPS document or any education policy with regards to the subject area should be facilitated by both a curriculum specialist and the subject advisor; and
- a training and development workshop that trains and develops educators on how to make use of simple household items to facilitate scientific–inquiry in the case where laboratory equipment are not available should be facilitated by tertiary institute professors or lecturers or laboratory technicians.

7.4.3 Recommendations Relating to the Formulation of the Conceptual framework Linking Professional Development to Improved Life Sciences Education Output

From the analysis of data collected from sample respondents, the following provisional recommendations for the Department of Education are suggested:

7.4.3.1 Factors affecting South African Education

It is recommended that senior management of the Department of Education monitor changing trends in international education curricula on a regular basis, not only when there is a change in government leadership or a global pandemic. It is also recommended that the Department of Education takes into consideration the resources that are available to educators in the most impoverished areas, resources for carrying out investigations and resources for teaching, before drawing up a Life Sciences curriculum.

A further recommendation is the monitoring of educator competency level as not all educators have specialisation academic qualifications in the teaching subject area. Some educators learn from textbooks prior to imparting the knowledge to learners. It is recommended that professional development and training of content knowledge activities be established for educators in order to create knowledge workers in the education sector.

It is also recommended that there be a regular cycle of monitoring the implementation of the curriculum, as the aim of curriculum reform is to improve on short-comings.

7.4.3.2 Education Policies, Curricula and Strategies

Many policy documents and strategies have been created to support the curriculum document and its implementation in order to ensure that learners achieve the maximum support in the classroom and achieve at their best. There are also revised policy documents and strategies. As these documents are available for reading at both school level and on internet website platforms, many educators are not aware of these documents and what they entail. The contents of these documents impact on the teaching and learning process, hence it is important that educators have access to them and understand the contents of the documents so that adequate implementation in the classroom takes place. It is therefore recommended that School Management Teams be workshopped or professionally developed with regard to the updates in curriculum knowledge. A monitoring tool should be created to ensure that the school management team cascades this curriculum knowledge as a form of professional development to educators.

7.4.3.3 Teacher Professional Development and Training

It is highly recommended that the aims and outcomes to be achieved for educator development and training workshops be reviewed. Professional Development and Training activities should be created on the basis of a needs analysis by Life Sciences educators. Aims and outcomes should focus on the aspects of knowledge that educators indicate they need development in. It is also recommended that an evaluation of the professional development and training activities be conducted with the aim of identifying short-comings and finding ways to remedy them so that subsequent professional development and training activities will be more effective.

7.4.3.4 Pedagogy

Pedagogy refers to the use of teaching and learning strategies during lessons. It is recommended that educators be professionally developed on the various pedagogies available for use in Life Sciences lessons and how these pedagogies facilitate the construction of knowledge by learners. The pedagogy of choice should be inclusive, appealing to the strengths of learners in the teaching and learning process. It is recommended that educators should be professionally developed on the use of integrated computer technology. This aspect of development should be compulsory as the world escalates into the technological era of the Fourth Industrial Revolution. During the global COVID-19 global pandemic of 2020, where South Africans were forced into a nationwide lockdown for their own safety, educators who knew how to use integrated computer technology continued to teach and educate learners using online platforms, while educators who did know how to use integrated computer technology did nothing, leaving their learners to find their own means of knowledge. Educators being developed on how to use technology which is in the palm of their hands allows them to teach effectively and efficiently while being a knowledge worker on a global scale in the fourth industrial revolution.

7.4.3.5 Benefits of the Conceptual Framework Linking Professional Training and Development to Improved Life Sciences Education Output

The Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output (Figure 4.1.) has been developed with the foresight that each section of the framework plays a critical role in the South African Education System, which ultimately impacts on the learners' learning and development. Each section has been explained in detail in Chapter Four, as well as the relationship that one section may share with another section. Recommendations based on sections of the framework have been discussed in this chapter. The Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output (Figure 4.1.) proves scientifically that the factors mentioned will always be present and that these factors affect aspects of educator pedagogical content knowledge.

The framework outlines the process that should be followed when developing a professional development and training activity, which is influenced by the needs of educators according to aspects of educators' pedagogical content knowledge. This process has been devised after researching training and development models. The framework highlights the educator as a knowledge worker; indicates the characteristics of a knowledge worker; and that these characteristics impact on the development of the learner in the learning process. This conceptual framework, although developed for the Life Sciences subject area, actually serves a universal purpose as it can be used to guide other subject areas.

7.5 DIRECTIONS FOR FUTURE RESEARCH

This study focused on the formulation of a Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output (Figure 4.1.), for the Department of Education. The conceptual framework was developed on the basis of the History of South African Education, International trends in education, Professional Development and Training Models, Models of Learning styles, as well as aspects of educator knowledge. Data was collected from sample respondents by means of a questionnaire (Annexure A) and was then analysed. The findings of the data analysis provided crucial information on the perspectives of respondents with regards to educator development and training workshops; aspects of knowledge that respondents would want to be professionally developed in; and what aspects of knowledge their professional qualifications have adequately developed them in. The findings also revealed that the most prevalent teaching strategies in the present-day classrooms are traditional teaching methodologies. These results have re-inforced the sections and aspects included in the Conceptual Framework Linking Professional Development to Improved Life Sciences Education Output (Figure 4.1) as pivotal factors that impact on learner learning and development.

However, the results are limited to one circuit of one district of the Kwa-Zulu Natal Department of Education. Future research should be conducted in other districts and circuits throughout the country and the overall results could provide crucial information that shapes educator professional development with regard to aspects of Pedagogical Content Knowledge. The findings of this study identified the need to evaluate educator development and training workshops. Future research on the development of an evaluation tool for educator development and training workshops should be explored. There should also be future research conducted on the development of a detailed needs analysis tool to determine the aspects of knowledge that educators want to be professionally developed in. This would assist in the planning of future training and development activities. The design, development and success of these tools may be tested using a mixed methods approach, which is a combination of quantitative research and qualitative research designs. Qualitatively, the researcher may obtain information on the perspectives of respondents on the design and development of the tools, as well as whether the tools would serve to be useful and why. Quantitatively, the data collected may be analysed scientifically, where results can be used to test hypotheses.

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ANNEXURE A

LIFE SCIENCES EDUCATOR PROFILE QUESTIONNAIRE

* Required

1. CONSENT : I hereby confirm that I have read and been informed by the researcher, Nathasia Naidoo about the nature, conduct, benefits and risks of this study. Research Ethics Clearance Number: 25/18FREC.I have also received, read and understood the above written information regarding the study.I am aware that the results of the study, including personal details, regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.In view of the requirements of research, I agree that the data collected during this can be processed in a computerised system by the researcher.I may at any stage, without prejudice, withdraw my consent and participation in the study.I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me. *

   Check all that apply.

   - [ ] Yes, I do consent in participating in this questionnaire for research purposes
   - [ ] No, I do not consent in participating in this questionnaire for research purposes

BIOGRAPHICAL DETAILS

2. Are you currently teaching Life Sciences? *

   Check all that apply.

   - [ ] Yes
   - [ ] No

3. What is your gender? *

Check all that apply.

- [ ] Male
- [ ] Female

4. What is your age range? *

Mark only one oval.

- ( ) 20-25 years
- ( ) 26-30 years
- ( ) 31-35 years
- ( ) 36-40 years
- ( ) 40 years and older

5. How many years have you been employed as a teacher? *

Check all that apply.

- [ ] 0-1 year
- [ ] 2-3 years
- [ ] 4-5 years
- [ ] 6-7 years
- [ ] 8-10 years
- [ ] more than 10 years

6. Indicate the number of years you have taught Life Sciences to Grade 12 learners? *

Check all that apply.

- [ ] Never taught
- [ ] 0-1 year
- [ ] 2-3 years
- [ ] 4-5 years
- [ ] 6-7 years
- [ ] 8-10 years
- [ ] more than 10 years

EDUCATIONAL HISTORY

7. What is your highest academic qualification which includes a study in Biological Studies? *

Check all that apply.

- [ ] Grade 12
- [ ] Certificate
- [ ] Diploma
- [ ] Degree
- [ ] Honours
- [ ] Masters
- [ ] PhD

8. List your completed academic qualification which includes a study in Biological Studies. *

9. What is / are your professional teaching qualification/s? *

Check all that apply.

- [ ] B.Ed.
- [ ] ACE
- [ ] PGCE
- [ ] NDE
- [ ] Hons. B.Ed
- [ ] M.Ed.
- [ ] Other

10. Are you currently registered for Life Sciences / Biological Sciences studies? *

Check all that apply.

- [ ] Yes
- [ ] No

PROFESSIONAL DEVELOPMENT

11. To what extent has your professional qualification helped you develop as a teacher with respect to teaching the relationship between the Human Nervous System and the Endocrine System? *

Check all that apply.

	Strongly Agree	Agree	Disagree	Strongly Disagree
Subject matter knowledge has improved (content according to the prescribed work schedules)	☐	☐	☐	☐
Content knowledge has improved (content beyond the parameters of the prescribed work schedules)	☐	☐	☐	☐
Knowledge of various teaching and learning strategies have increased	☐	☐	☐	☐
Knowledge of the curriculum has improved	☐	☐	☐	☐
Knowledge of assessment techniques to accommodate the learner has improved	☐	☐	☐	☐
Has developed your confidence to teach and facilitate learning	☐	☐	☐	☐
Ability to link subject matter knowledge/content knowledge to the appropriate teaching and learning strategies have improved	☐	☐	☐	☐

12. Referring to the statements below, why would you not register for any study programme with respect to teaching the Human Nervous System and Endocrine System? *

Check all that apply.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I believe I am qualified and confident to handle the expectations outlined in the Life Sciences CAPS document	☐	☐	☐	☐
I am competent in content knowledge therefore I do not need to study further	☐	☐	☐	☐
I do not have the financial mean to study further	☐	☐	☐	☐
My lessons are learner centered, meeting the outcomes of constructive learning	☐	☐	☐	☐

13. Have you attended any teacher training workshops? *

Check all that apply.

☐ Yes
☐ No

14. Were any of these teacher training workshops hosted by the KZN Department of Education? *

Check all that apply.

☐ Yes
☐ No

15. What is your opinion of teacher training workshops? *

Check all that apply.

	Strongly Agree	Agree	Disagree	Strongly Disagree
The workshop enriched my knowledge of the subject matter	☐	☐	☐	☐
The workshop enriched my content knowledge	☐	☐	☐	☐
The facilitator informed me of how to link various teaching strategies with subject matter / content knowledge to improve teaching and learning	☐	☐	☐	☐

16. Indicate whether you make use of the following teaching strategies during your Life Sciences lessons? *

Check all that apply.

	Always	Sometimes	Never
Teacher speaks, learners listen	☐	☐	☐
Learners copy notes from the blackboard into their notebooks	☐	☐	☐
Teacher ,makes use of inquiry based learning (learners hypothesis, select apparatus, identify variables and draw conclusions	☐	☐	☐
Teacher tells learners the answers to questions from past exam papers	☐	☐	☐
Teacher makes use of Integrated Computer Technology	☐	☐	☐
Learners copy notes from a textbook into their notebooks	☐	☐	☐
Learners practice questions during collaborative learning	☐	☐	☐
Teacher encourages whole class discussions to construct meaning of topics	☐	☐	☐
Teacher encourages scaffolding (assisting learners to move towards new skills, concepts and levels of understanding)	☐	☐	☐

17. To what extent do you think you need professional development in the following areas of your profession? *

Check all that apply.

	Greatly needed	Moderately needed	Not needed
Enhance content knowledge	☐	☐	☐
Update knowledge of effective teaching strategies	☐	☐	☐
Ability to link subject matter knowledge / content knowledge with the appropriate teaching strategies to improve teaching and learning	☐	☐	☐
Understanding how to integrate different cognitive levels into teaching	☐	☐	☐
Make use of various strategies of assessments	☐	☐	☐
Select appropriate resources to improve teaching and learning	☐	☐	☐

ANNEXURE B

Faculty of Management Sciences

Department of Human Resource Management

Registration number: 21751994
Cell: 0724335437
Email: priyasia@yahoo.com

Dear Participant

REQUEST TO COMPLETE QUESTIONNAIRE

I am a registered student at the Durban University of Technology in the Department of Human Resources Management. I am currently pursuing the Doctorate Degree in Human Resources Management in the Faculty of Management Sciences. My topic is titled**: A Professional Development Framework supporting Life Sciences Educators' Pedagogical Content Knowledge in the relationship between the Human Nervous System and the Endocrine System.** The focus of the study is on life science educators practicing at secondary schools in the Umlazi District of the KZN DoE. In order to successfully complete the latter part of my research, the secondary component deals with the empirical investigation. This involves the completion of a structured questionnaires in the format of Linkert scale questions. You have been randomly identified as one of the respondents that formed the sample for this study.

I shall be most grateful if you could please complete the attached questionnaire and return it to me by the 2018-04-25. The researcher will make arrangements to personally pick up the questionnaire. The questionnaire will take about 20 minutes to complete and only requires you to tick the relevant pre-coded response in an objective manner. Your participation is voluntary and you are at liberty to withdraw from answering this questionnaire at any time. Please rest assured that your responses will be treated with utmost confidentiality and no names will be divulged to any third party. The collated responses will be only used for statistical analysis.

Your co-operation in assisting me with this important component of my study is highly appreciated and I look forward to a speedy return of the completed questionnaire. Please answer all the questions and do not leave any question or Likert scale statement blank. If there are any queries, please do not hesitate to contact me at the above email address or via my cell phone. I take this opportunity to once again thank you for your kind assistance in completing this questionnaire in an informed and objective manner.

Sincerely

____

Ms Nathasia Naidoo
Cell: 0724335437

____

Supervisor: Dr. Melanie E. Lourens
Contact Details: 031-373 6787 Melaniel@dut.ac.za

ANNEXURE C

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

15 March 2018

Student Name: Ms. N Naidoo
Student No: 21751994
FREC REF: 25/18FREC

Dear Ms. Naidoo

PhD IN MANAGEMENT SCIENCES: HUMAN RESOURCES

TITLE: A PROFESSIONAL DEVELOPMENT FRAMEWORK SUPPORTING LIFE SCIENCES EDUCATORS' PEDAGOGICAL CONTENT KNOWLEDGE IN THE HUMAN NERVOUS SYSTEM AND THE ENDOCRINE SYSTEM

Please be advised that the FREC Committee has reviewed your proposal and the following decision was made: **Approved – Ethics Level 2**

Date of FRC Approval: 24 April 2018

Approval has been granted for a period of two years from the above FRC date, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.
Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours sincerely

____

Prof JP Govender
Chairperson: Faculty Research Ethics Committee

ANNEXURE D

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma | Tel: 033 392 1041 | Ref.:2/4/8/1334

Ms N Naidoo
85 Rainbow Crescent
Westcliff
Chatsworth
4092

Dear Ms Naidoo

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"PROFESSIONAL TRAINING AND DEVELOPMENT FRAMEWORK FOR LIFE SCIENCES EDUCATORS' PEDAGOGICAL CONTENT KNOWLEDGE IN TEACHING THE RELATIONSHIP BETWEEN THE HUMAN NERVOUS SYSTEM AND THE ENDOCRINE SYSTEM IN SELECTED KZN SCHOOLS"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 04 September 2017 to 09 July 2020.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMlazi District

Dr. EV Nzama
Head of Department: Education
Date: 04 September 2017

...Championing Quality Education - Creating and Securing a Brighter Future

KWAZULU-NATAL DEPARTMENT OF EDUCATION
Postal Address: Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
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Tel.: +27 33 392 1004/41 • Fax.: +27 033 392 1203• Email: Phindile.Duma@kzndoe.gov.za •Web:www.kzneducation.gov.za
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ANNEXURE E

SEKARIN & BOUGIE'S LIST FOR SELECTING SAMPLE FROM A GIVEN TARGET POPULATION

N	S	N	S	N	S
10	10	220	140	1 200	291
15	14	230	144	1 300	297
20	19	240	148	1 400	302
25	24	250	152	1 500	306
30	28	260	155	1 600	310
35	32	270	159	1 700	313
40	36	280	162	1 800	317
45	40	290	165	1 900	320
50	44	300	169	2 000	322
55	48	320	175	2 200	327
60	52	340	181	2 400	331
65	56	360	186	2 600	335
70	59	380	191	2 800	338
75	63	400	196	3 000	341
80	66	420	201	3 500	346
85	70	440	205	4 000	351
90	73	460	210	4 500	354
95	76	480	214	5 000	357
100	80	500	217	6 000	361
110	86	550	226	7 000	364
120	92	600	234	8 000	367
130	97	630	242	9 000	368
140	103	700	248	10 000	370
150	108	750	254	15 000	375
160	113	800	260	20 000	377
170	118	850	265	30 000	379
180	123	900	269	40 000	380
190	127	950	274	50 000	381
200	132	1 000	278	75 000	382
210	136	1 100	285	1 000 000	384

SOURCE: Sekarin, U & Bougie, R (2003: 294)

ANNEXURE F

N.Naidoo 21751994

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ANNEXURE G

EDITING LETTER

696 Clare Road

Clare Estate

Durban

4091

27 November 2021

To: Whom it may concern

Editing of PhD: Nathasia Naidoo: 21751994

A PROFESSIONAL DEVELOPMENT FRAMEWORK SUPPORTING LIFE SCIENCES EDUCATORS' PEDAGOGICAL CONTENT KNOWLEDGE IN THE RELATIONSHIP BETWEEN THE HUMAN NERVOUS SYSTEM AND THE ENDOCRINE SYSTEM

This letter serves as confirmation that the aforementioned thesis has been language edited.

Any queries may be directed to the author of this letter.

Regards

MP MATHEWS

Lecturer and Language Editor

Mercillenem@dut.ac.za

083 676 4778