



THESIS

Submitted in fulfilment of the requirements for the degree of

DOCTOR OF EDUCATION

In the field of

CURRICULUM STUDIES

With the title:

Life Sciences Teacher Educators' Perspectives of the Principle of Knowledge

Integration in the Life Sciences teacher education curriculum

FACULTY OF EDUCATION

Candidate: Kwanele Boo

Student Number: 215298233

Supervisor: Dr M. E. Khuzwayo

I. Abstract

This study aimed at examining the Life Sciences teacher educator's perceptions and perspectives of knowledge integration in the espoused curriculum prescribed by the South African Department of Higher Education and Training through the policy of Minimum Requirements for Teacher Qualifications (MRTEQ). The qualitative research design was adopted for data collection procedures. The selection of the sampling was purposive, in the sense that the Higher Education Institutions (HEIs) who participated were classified into two categories. The first category consisted of three historical or traditional universities and the second category was formed by three higher education institutions that emerged after the merger of Teacher training Colleges, Technikons and universities. The study targeted lecturers, senior lecturers and professors in the field of Life Sciences Education who participated in the development of curriculum for Life Science teacher education and training. The interviews were conducted to elicit data on the experiences and perceptions that influenced the process of designing and developing the curriculum blue print which came out as a product to be adopted by the institution.

The results of the empirical study were analysed by using qualitative procedures, which are; coding of data, classification of data into categories and the identification of themes and issues. The contesting views and perceptions were summarised in the results highlighted follows:

The school Life Science curriculum requires teachers who are capable of integrating knowledge from various domains of scientific knowledge but the study demonstrates that the Life Science teacher educators who participated in the study had views and perceptions that are not congruent with those of the curriculum as it presently stands. This could imply that the Life Science teachers educated and trained for the school Life Science curriculum could experience problem with its implementation in classrooms. The twenty first century teacher could be expected to demonstrate competences such as; critical thinking, creative thinking, logic and independent thinkers.

The study further concluded that there are academics in Science Education departments who still adhere doggedly to the traditional ways teaching their own disciplines. This study confirms the importance of breaking the artificial disciplinary boundaries to facilitate interdisciplinary

knowledge construction. This study endorses the emerging trend of knowledge integration in Science Educations. Finally the study suggests that collaborative and collegial deliberations among Science teacher educators and experts in various knowledge domains could be a way of finding common ground on issues highlighted in the study.

II. Declaration

I Kwanele Booi declare that the work presented in this thesis document with a title “**The Life Sciences Teacher Educators’ Perspectives of the Principle of Knowledge Integration in the Life Science teacher education curriculum**” is my own work and where other sources were used for reference, they were acknowledged and referenced according to the Harvard system of referencing.

Name: Mr Kwanele Booi at Cape Peninsula University of Technology (South Africa)

Signature: _____ . Date: 30 March 2017

III. Acknowledgements

I would like to express my heartfelt gratitude to my supervisor Dr M. E. Kuzwayo for her scholarly and emotional support she provided me throughout the period when this study was conducted. Her patience and sacrifices she made has not only developed me in one dimension (as a doctoral student) but she went beyond her call of duty in many ways. She imparted values of professionalism and taught me how to be a good supervisor from modelling it in her practice.

Secondly, if it was for the financial support of the Cape Peninsula University of Technology, where I am employed through the Teacher Development Grant and University Research Fund it would have been impossible to conduct this study to the end. I would also acknowledge the financial support towards finishing this doctoral support from the National Research Fund who provided me with a sabbatical grant for the whole 2017 academic year.

University authorities who gave me clearance to involve their employees in the study is acknowledged and appreciated.

If it was not of the availability and openness of Science Teacher Educators from the six universities sampled for this research, I would not have gained an insight of their perspectives of knowledge integration in the espoused curriculum. They made it easy for me to access data through interviews and made their curriculum documents accessible for the study to continue. I am immensely indebted to them.

I would also like to thank a mentor in research that I have found during the time this study was conducted. His advises, encouragement and support went beyond a person who just helped a stranger whom he just met. Professor Bongani Bantwini has indeed been such a blessing.

I would like to appreciate Dr Matthew Curr for editing and his scholarly input in the development of this thesis to be what it is today. Ms Marlana MacMinn is specially appreciated for her helpfulness and sacrificial support during the time this study was conducted.

The support I received from my wife Nono and the children was amazing. I bless the Lord for giving me such a wonderful family.

Lastly but not least, everyone who was used and moved by God to assist me in any way is acknowledged.

IV. Glossary of Terms

ANC	African National Congress
B. Ed.	Bachelor of Education
CAPS	Curriculum Assessment Policy Statement
CEA	Council of Economic Advisors
CEPD	Centre for Education Policy Development
CHE	Council of Higher Education
CMSA	Curriculum Models for South Africa
COTEP	Committee on Teacher Education Policy
DHET	Department of Higher Education and Training
DoE	Department of Education
EEA	Educators Employment Act
FET	Further Education and Training
GET	General Education and Training
HE	Higher Education
HEIs	Higher Education Institutions
HEQF	Higher Education Qualification Framework

HEQC	Higher Education Qualifications Committee
HSRC	Human Sciences Research Council
IPET	Initial Professional Education Training
MRTEQ	Minimum Requirements for Teacher Education Qualification
NCS	National Curriculum Statement
NECC	National Education Crisis Committee
NEPI	National Education Policy Institution
NS	Norms and Standards
OBE	Outcomes Based Education
RDDA	Research Design Dissemination Adaptation
SAIDE	South African Institute for Distance Education
SAQA	South African Qualifications Authority
SGB	Standards Generating Body
SP	Senior Phase

V. LIST OF FIGURES

Figure: 1 adopted from Carl 2005: 74 illustrating Tyler's conceptualisation of a curriculum design.

Figure: 2 illustrating the steps in curriculum development in a Tyler Model adopted from Ornstein and Hunkins, 1998.

Figure: 3 Illustration how behaviourists have influenced the teaching and learning process of Learning

Figure: 4 Illustration of integration of knowledge and pedagogical approaches to teaching and learning for integrated knowledge acquisition.

Figure: 5 Illustration of knowledge integration; focusing on real-life experience for meaningful learning and acquisition of enabling knowledge.

Figure: 6 Adopted from Langenhoven and Ogunniyi (2009).

VI. LIST OF APPENDICES

1. Appendix A: Ethical clearance
2. Appendix B: Consent form
3. Appendix C: Research instruments
4. Appendix D: Permission to conduct research from Universities
5. Appendix E: Proof of Editing

Contents

I. Abstract.....	1
II. Declaration	3
III. Acknowledgements.....	4
IV. Glossary of Terms.....	6
VI. LIST OF APPENDICES	9
Chapter 1: Research Overview	15
1.1 Background to the study	15
1.2 Problem Statement.....	17
1.3 Theoretical Framework.....	18
1.4 Literature Review.....	21
1.5 Aim of the Study.....	24
1.6 Research Questions.....	24
1.7 Objectives of the study.....	25
1.8 Research design and methodology.....	25
1.8.1 Research paradigm.....	25
1.8.2 Research methodology.....	26
1.8.3 Qualitative Research Methods.....	28
1.9 Reliability and validity.....	30
1.10 Pilot Study.....	31
1.11 Data analysis	32
1.12 Ethical considerations	33
1.13 Orientation of the study	34
1.14 Plan for the study and time-lines	35
Chapter 2: Conceptual Framework.....	36
2.1 Introduction.....	36
2.2 Indicators of paradigm shifts in Curriculum Research in South Africa in the 1990's: towards emerging new international trends.....	38
2.3 Brief Overview of Trends in curriculum research for Senior Phase (SP) and Further Education and Training Phase (FET) under the democratic educational dispensation South Africa.....	40

2.4 Perspectives on the Implications of Alignment of School curriculum with Teacher Education and Training at Higher Education Institutions.....	43
2.4.1 Norms and standards as guidelines for developing the curriculum for teacher qualification programmes for curriculum changes: Curriculum 2005 and National Curriculum Statement NCS.	45
2.4.2 Perspectives on implementing the curriculum policy in the design and development of teacher qualifications in South Africa from 1999-2010.	49
2.5 Re-aligning Curricula for teacher education with the core Curriculum and Assessment Policy Statement, CAPS.	54
2.6 Critical analysis of various concepts of integration in different educational contexts.	57
2.6.1 Knowledge Integration.....	57
2.6.2 Images of integrating knowledge into curricula.	58
2.7. Key Areas benchmarked for integration into the curriculum for teacher education and training (MRTEQ).	62
2.8 Concept of curriculum development.....	66
2.8.1 Conceptualizing knowledge integration in the process of knowledge production and the implications for epistemological disciplinarity.....	68
2.8.2 ‘Multi-disciplinary’ knowledge as a mode of knowledge integration.....	71
2.9 Approaches to integration of knowledge.	73
2.9.1 Inter-disciplinary Curriculum Model.....	75
2.10 Contesting Perspectives of Philosophical Foundations, Paradigms and Images of Curriculum Research Design and Development.....	77
2.10.1A Conventional Perspective, or Traditional Intellectual Approach: an Empirical-analytic Paradigm for curriculum research and theory.....	78
2.10.2 A Progressive Perspective: Social Behaviorists Approaches: a Hermeneutic Paradigms for curriculum research and theory.....	81
2.10.3 Revolutionary Perspective; a Critical Paradigm for Curriculum Design and Development, and Critical Curriculum Theory.....	84
2.11 Overview of Models that influence Curriculum Design and Development.	86
2.11.1 Tyler Model of curriculum design and curriculum development.....	87
2.11.2 The Taba Model of curriculum design and development.....	89
2.11.3 Bruner’s Spiral Curriculum Model.....	92
2.12 Contesting Approaches to curriculum programming.....	93

2.12.1 Critical Analysis of Outcomes Based Curriculum and its Philosophical Foundations.	94
2.13 Summary	99
Chapter 3: Theoretical Framework	101
3.1 Introduction	101
3.2 Theories influencing the teaching and Learning of Life Sciences curriculum	101
3.4 Summary	110
Chapter 4: Research methodology and data collection procedures.	111
4.1 Introduction	111
4.2 Research paradigm and Methodology.	112
4.2.1 Interpretive paradigm	112
4.2.2 Qualitative Research Method	113
4.3 Ethical Considerations	121
4.4 Reliability and validity	122
4.5 Pilot Study	123
4.5.1 Synopsis of findings from the pilot Study.	123
4.5.2 Analysis of data from the sub-sample (pilot study).	123
4.6.1 Analysis of data collected by means of in-depth interviews and presentation.	125
4.6.2 Qualitative data analysis of data collected from document analysis and presentation.	126
4.6.3 Data interpretation and discussions of findings from in-depth interviews and document analysis.	127
4.7 Summary.	127
Chapter 5: Data analysis, Presentation and Discussion.	128
5.1 Introduction	128
5.2 Presentation of qualitative data organised into units and categories.	130
5.2.1 Perceptions of knowledge organisation.	Error! Bookmark not defined.
5.3 Themes highlighting contesting views about models of curriculum design and development.	Error! Bookmark not defined.
5.3.1 Theme #3: vertical articulation of knowledge	Error! Bookmark not defined.
5.3.2 Theme #4: Perceptions highlighting challenges facing academics in preparing teachers to teach Life Sciences.	Error! Bookmark not defined.

5.3.3 Theme# 5: How divergently integration of knowledge in the curriculum for Life Sciences education and training is perceived.....	Error! Bookmark not defined.
5.3.4 Theme# 6: knowledge integration as an emerging discourse in pedagogy in higher education.....	Error! Bookmark not defined.
5.4 Analysis of data collected by means of documentation.....	Error! Bookmark not defined.
5.4.1 Theme: learning outcomes of the course.....	144
5.4.2 Theme: Organisation of content knowledge.....	147
5.5 Summary.....	163
Chapter 6: Synthesis of Findings and Discussions.....	164
6.1 Introduction.....	164
6.2 Issues that indicated progressive and critical paradigms in education and training of Life Sciences teachers.....	164
6.2.1 Issue#1: Consideration of prior research on educational transformation: Situational analysis.....	164
6.2.2 Issue#2: Engaging students in the sharing of information: critical and hermeneutic paradigms.....	165
6.2.3 Issue #3: Deductive, Inductive and Inquiry Learning: critical paradigms.....	165
6.3 Issues identified regarding resistance to implementation of transformation in the academic and professional training of Life Sciences teachers.....	167
6.3.1 Issue #1: Reproduction of incompetent teachers for Life Sciences.....	168
6.3.2 Issue#2: Challenges facing organization of academic disciplinary knowledge for Life Sciences teaching.....	169
6.3.3 Issue #3: Academics not complying with the Higher Education Qualification Framework Policy.....	170
6.3.4 Issue #4: models that influenced certain patterns of thought identified from findings.....	174
6.3.5 Issue# 5. Non-compliance with the principle of integration in curriculum development for teacher qualification.....	177
6.4 Discussion of the summary of findings in line with critical questions, objectives and the topic of this thesis.....	178
6.5 Conclusions.....	182
6.6 Summary.....	187
Chapter 7: Recommendations and proposals for future research.....	188
7.1 Introduction.....	188

7.2 Recommendation #1: Sustainable development goals to provide the contexts for multi-disciplinary and interdisciplinary knowledge organisation in the academic curriculum for Life Sciences teacher education and training.	188
7.3 Recommendation # 2:Consideration of the needs of the 21st century Life Sciences teacher.	189
7.4 Recommendation #3: Paradigm shift for conceptualizing a competent Life Sciences teacher for effective implementation of Life Sciences curriculum innovations.	190
7.5 Recommendation #4: Discourse in pedagogical approaches in the education and training of Life Sciences teachers.....	191
7.5.1 This proposal is presented in the following models.....	192
7.5.2 Diagram illustrating knowledge integration for Life Sciences indicating interrelations and connections for enabling knowledge (knowledge application).....	193
7.5.3 Concept mapping in facilitating integration of knowledge.....	193
7.6 Limitations related to arrangements of interviews and collection of documentation.	194
7.7 Summary.....	195
References	197

Chapter 1: Research Overview

1.1 Background to the study

The principle of knowledge integration in curriculum research in teacher education and training was introduced as an integral component of outcomes based education. This introduction of integration had implications for organization and structuring of subject content knowledge from homogenous to multi-disciplinary knowledge design (Gravette and Geysler, 2004, Jansen and Christie, 1998). The Norms and Standards curriculum policy ushered in a new paradigm for teacher educators which Jansen and Christie (1998) considered to be a radical change; resulting in various misconceptions. Fullan (1995 and 2006) concludes that change is a process which is overloaded with new concepts, beliefs, attitudes, interpretations and misconceptions for those who are engaged in it. Literature highlights that there are protagonists for, and antagonists to, change. Resistance to change is viewed by researchers in social sciences as a phenomenon that imposes challenges upon new innovations and reforms in education (Goodson, 1994; Fullan, 2006 and Apple, 2004). This study considers the beliefs, attitudes, interpretations and conceptions of Life Sciences teacher educators to be critical in curriculum innovations in the Higher Education Institutions (HEIs). The principle of integrated knowledge and integrated learning underpins the curriculum policy for teacher education and training as stated in the Minimum Requirements for Teacher Qualification (MRTEQ), (DHET, 2015). It follows that those educators in the field of Life Sciences at universities designing curricula for teachers, have to base their new curricula upon principles of integrated knowledge and learning. The theory that informs this principle declares that there should be a shift in the conceptualisation of knowledge

from a heterogeneous model of Science taught in separate ‘silos’ of knowledge [Botany, Chemistry etc.] to a multi-disciplinary knowledge structure and integrated learning (pedagogy).

Research indicates that since 1998 and up until 2010, teacher education and training struggled to re-conceptualise the Life Sciences curriculum model for implementing multi-disciplinary or integrated approaches to knowledge acquisition (Bantwini, 2014; Bansilal and Mkhwanazi, 2014 and Jansen and Christie, 1998). The Review of the Curriculum Policy for teacher education and training was another indication that teacher educators in Higher Education and Training faced challenges in developing an adequate curriculum to implement multi-disciplinary and integrated learning. It is in this context that this study explores the disturbingly different perceptions of Life Sciences teacher educators concerning the principle of knowledge integration for integrated learning.

Because of the excessive diversity of these perspectives, this study formulated a thesis that there exists the possibility of both antagonism and optimism in the perspectives of Life Sciences teacher educators regarding the proposed principle of integrated knowledge and learning in the Minimum Requirements for Teacher Qualifications (MRTEQ). Researchers into higher education in South Africa point out that certain qualifications, such as the Bachelor of Science degree offered at many Faculties of Science, still retain a discipline-specific curriculum completely unaligned to parameters of integration set out in government education documents. As a result, Life Sciences teacher educators qualified in specialised knowledge in the field of Science and cannot teach the new school syllabus. The array of separate disciplines offered by many Faculties of Science still offer compartmentalized and distinct areas of knowledge for teachers in training: such as Botany, Mathematics, Statistics, Chemistry, Biochemistry, Microbiology, Human Physiology and Zoology. As a result of the requirements for the Science

degree (as it was pre-1994 at many South African universities), many Life Sciences teacher educators have specialised in one or two of these disciplines and studied one of these specialist subjects at postgraduate level.

This worrying disjunction, between government policy for integration, on the one hand, and university curriculum designers on the other hand, who chose to ignore integration, is the core issue of this investigation. Academics in Faculties of Science Education need to shift from educating teachers in separated disciplines (areas of specialisation), to embrace an integrated knowledge model for learning across disciplines. If academics do not make this shift, the schism between school syllabus and teacher training in Science will grow wider; very much to the detriment of learners and the country as a whole. If academics continue to ignore the guide-lines for Science instruction at school and their duty to design university syllabi to suit school integration models, teachers in training will be drawn further into specialist areas as they inevitably follow the passions of their university mentors and so perpetuate an old pattern of thought (pre-1994).

1.2 Problem Statement.

MRTEQ's principle of integration in curriculum research in teacher education and training was introduced as an integral component of outcomes based education and bore certain implications for organization and structuring of subject content knowledge from heterogeneous or multi-disciplinary knowledge design to integrated knowledge design (Gravette and Geysler, 2004 and Jansen and Christie, 1998). According to Bernstein's theory of *Codes and Modalities*, the

process of knowledge production is guided by principles; so, changing from heterogeneous subject content knowledge to homogenous (integrated) subject content knowledge is perceived in this study to be an issue of main concern. Fullan (2006) concludes that curriculum change introduces new concepts, values, attitudes and interpretations which this study regards as an integral part of the process of curriculum development for teacher education qualifications at universities. Compounded with these critical issues is the notion of compliance with the espoused curriculum policy which could be viewed as a threat to some academic privileges such as the sort of institutional autonomy which universities have traditionally enjoyed. Contestations and debates were seen in this study as inevitable in matters concerning decision-making, or philosophical and theoretical attributes in the process of curriculum development (Carl, 2012). These topics provided a background to the problem under investigation in this study which has been stated as follows: How Life Sciences teacher educators conceptualized the knowledge integration principle as specified in the espoused curriculum as part of their practice and the approaches they thought were suitable for implementing the principle of integrated knowledge into the Life Sciences curriculum.

1.3 Theoretical Framework

Synthesis of the following literature provided the theoretical framework to be used as a lens to locate and analyse the empirical findings of this study (Davies, 2001, Morais and Neves, 2001, Gibson *et al.*, 1994, Wilmsen, 2008; Barreteau, 2010; Bocking, 2007; Brunet *et al.*, 2014; Nowotny *et al.*, 2003). Analysis of Bernstein's Theory in Davies (2001) and Morais and Neves (2001) suggests that subject content knowledge is unique because of the codes that serve as principles which regulate knowledge organization, syntax and concepts. In this view, every

subject has its own unique syntax that generates meaning of the real world. Maton (2000:7) affirms this opinion by stating that all subject knowledge production is influenced either by positivist absolutism or constructivist relativism. According to Maton (2000), positivist absolutism refers to knowledge produced as if it were objective and free of values; whereas constructivist relativism refers to knowledge production as innately social in construction. Analysis of Bernstein's Theory in Davies (*ibid.*) and Morais (*ibid.*) supports the view that subject knowledge per discipline is distinct and unique. The Knowledge Reproduction Model according to this theory provides a description of modes of knowledge production that generates the language or syntax and semantics for knowledge produced. Knowledge Reproduction Theory was used to analyse the findings of this study and to identify the new syntax and semantics that are used to describe integrated knowledge in Life Sciences and how university academics deal with the issue of code modalities; something which Bernstein (2000) describes as determinants or principles regulating knowledge production.

The model of 'knowledge reproduction and cultural transformation' and 'pedagogic discourse' described in Bernstein's theory asserts the importance of codes as regulatory principles for knowledge production in respective fields or subjects. This theory claims that the legitimacy of knowledge production in each discipline is classified according to specific code modalities which provide recognition rules and syntax of knowledge generation. Bernstein's theory declares that knowledge production is driven by three forces: labour market in the society, socio-economic development and political environment. In keeping with this theory, Levy and Murnane (2005); Stewart, (2010) and Walmart, (2010) state that increasing pressures of competitiveness in a rapidly changing world are re-defining skills and expertise for the 21st century. Davis (2001)

points out that, although Bernstein's theory focuses on research in sociology, it has had an influence upon educational research in the 21st century.

Moore and Young (2010) challenge the schools of thought that promote the view of subject knowledge as distinct realities. These researchers point out that certain models of curriculum design and development [those dominated by a set of assumptions about knowledge production as neo-conservative traditionalism and technical-instrumentalism] serve the cognitive and technical agenda. Students or teachers 'produced' by such curricula are seldom competent, creative and critical thinkers which are key abilities required in the 21st century. In endorsing knowledge integration from Mode 1 [which is a heterogeneous discipline or taxonomy of discipline] to mode 2, the shift to the amalgamation of disciplines is made plain. In respect of Sciences teaching (Gibbons *et al*, 1994) and Fullan (2006) assert that teachers should be grounded in a plethora of themes: Biological sciences (animal and plant anatomy and human physiology) Paleontological studies and biomedical studies, Ecology and Biochemistry, chemistry, Physics, and Geography. Conceptualisation of sciences in the school curriculum indicates that knowledge of science entails a broad field of knowledge: the animal kingdom, chemistry, biochemistry, microbiology and human physiology, physics, geology and geography.

The neglect of knowledge integration in the university curriculum deprives teachers of Sciences of an opportunity to learn about the inter-relatedness and inter-connections between the subject content areas in Sciences. Killen (2015:91) points out that "school learners cannot be expected to integrate knowledge within and across the subject boundaries without considerable guidance of the teacher who is competently trained". Jansen and Christie (1999) note that hybridisation of knowledge in teacher education introduced a paradigm for teaching and learning in universities which is a way of aligning teacher training with transformation in the school curriculum. The

argument stresses that hybridisation of knowledge requires competences and expertise of teaching across traditionally heterogeneous subject content.

1.4 Literature Review

Literature points out that integration or amalgamation of knowledge introduces a remarkable discourse in curriculum research that profoundly influences emerging trends in knowledge production globally and internationally (Gibson *et al.*, 1994, Department of Education and training, 1997). Gibson *et al.* (1994) assert that there are various approaches to knowledge integration and integrated learning: trans-disciplinary knowledge production (which means teaching across disciplines for the purpose of enabling learners to acquire skills); knowledge and competences (which means the ability to transfer such skills and knowledge in their learning); multi-disciplinary knowledge production (which means the clustering of themes from various disciplines that allows students to explore knowledge and develop multiple skills); and inter-disciplinary knowledge production (which deals with the issue of learning of concepts that relate to other disciplines that are clustered into one theme).

Proponents of knowledge integration theory advocate a shift from fragmentation of subject or disciplinary knowledge to a broad field of knowledge (Slattery, 2010, Apple, 2004, Gravette and Geysler, 2004 and Fullan, 2006). This theory defends the generation of knowledge independent of proper context and still practised by academics and researchers at various universities. Theorists who propose this theory argue that world problems and real-life challenges cannot be solved by compartmentalised knowledge (Nowotny *et al.*, 2003, Berkes, 2008 and Gibson *et al.*, 1994).

Minkler and Wellerstein (2008) and Wemsen (2008) point to a shift from mode 1 (which comprises heterogeneous disciplines or taxonomy of disciplines) to mode 2 (which is the amalgamation of disciplines). This shift requires HEIs to adopt participatory research approaches for knowledge production. Ahmed (2014) point out amalgamation of the following disciplines: biological sciences (animal and plant Anatomy and Physiology), paleontological studies and biomedical studies, Ecology, Biochemistry. This amalgamation results in a broad field of study called Life Sciences which is mode 2 type knowledge production (inter-disciplinary and intra-disciplinary approaches to curriculum design and development). According to Gibson *et al.* (1994) the shift from fragmented knowledge to one broad field of study, enables students to transfer knowledge and skills in the process of learning. There is a wider scope for exploration without the limitations of boundaries caused previously by separating disciplines.

Pioneers of the multi-disciplinary approach in South Africa describe the clustering of related subject disciplines into Learning Areas and the principles of knowledge integration underpinning the Outcomes Based Education (OBE) curriculum model as curriculum reform or curriculum for a 21st century democratic society in South Africa (Nkomo, 1998 and NQF, 1997, Department of Education and Training, 1997 and Gravette and Geysler, 2004).

Researchers into this multi-disciplinary approach to Fields of Life Sciences recommend that, in order for academics at universities to implement multi-disciplinary and integrated approaches, they need to take into account two factors. First, researchers should accept the reality that knowledge is an outcome of mobilising a range of theoretical perspectives and practical methodologies to solve problems. Second, they should be mindful of the fact that knowledge production through research can no longer be characterised as an 'objective' investigation of the natural world while ignoring the context of application (Berkes, 2008; Wemsen, 2008 and Brunet

et al., 2014). Jansen and Christie (1998) refer to multi-disciplinary paradigms in teacher education and training as hybridisation of knowledge which requires competences and expertise of teaching across traditional disciplines or areas of subject content knowledge.

Researchers indicate that at universities in South Africa before the transformation of teacher education in 1994, curricula were based on heterogeneous disciplines as areas of specialization (Jansen and Christie, 1998; Gravette and Geysler, 2004; Wolhuter, 2014). This separation and isolation implies that academics who are specialists in one or two disciplines could be biased towards particular disciplines in selecting themes. Students may acquire theoretical and applied knowledge dominated by the speciality areas of teacher educators. This tendency may run contrary to the principles of multi-disciplinary or integrated approaches, and to knowledge acquisition itself.

This study purports to trace and explore the codes, modalities and principles that regulate approaches to integrated knowledge production as well as the syntax or terminology used in conceptual frameworks for integrated knowledge used for teaching and learning of Life Sciences at many Faculties of Education at South African universities. According to Davis (2001), pedagogic discourse is an integral part of knowledge production. In his synthesis of pedagogic discourse in Bernstein's theory, Davis (*ibid.*) concludes that this model has three fundamental levels: generation of knowledge, re-contextualising knowledge and transmission of knowledge. In the context of this study, academics who are involved in teacher education and training hold certain ideas pertaining to pedagogical discourse for integrated knowledge of Life Sciences. The purpose of applying Bernstein's theory and Maton's legitimation Codes theory as lenses to search and analyse perceptions of Life Science teacher educators, was justified by the question of the legitimacy of approaches to knowledge integration as perceived and adopted in the espoused

Life Sciences curriculum. This study contributes to formation of the association of Life Sciences teacher educators at universities: a project which is aimed at focussing research on models that are suitable to equip novice students with competencies to teach Life Sciences at schools.

1.5 Aim of the Study

The aim of this study was:

To examine how Life Sciences teacher educators perceive of integration of knowledge in the teaching and training of Life Sciences for integrated knowledge.

1.6 Research Questions

How do Life Sciences teacher educators conceive of the principle of knowledge integration in the espoused curriculum?

Why do Life Sciences teacher educators hold such conceptions and perspectives of knowledge integration?

How do Life Sciences teacher educators view the integration of disciplinary knowledge in the Life Sciences curriculum for teacher education and training as stated in the policy (MRTEQ)?

1.7 Objectives of the study

The objectives of this study were:

To identify patterns of thought regarding integration of knowledge for Life Sciences Education.

To identify dominant perspectives from the point of view of Life Sciences educators regarding the principle of integrated knowledge in the Life Sciences curriculum changes for initial teacher education and training.

To identify models of knowledge integration preferred by academics to promote integrated disciplinary learning in the education and training of competent Life Sciences teachers.

1.8 Research design and methodology

1.8.1 Research paradigm

The empirical study undertaken was guided by the principles of interpretivist theory of knowledge production. Henning *et al.* (2004) describe interpretivist research paradigms as suitable for seeking views, experiences and perceptions of participants. An interpretivist paradigm employs qualitative inquiry methods for collecting data: qualitative strategies for selecting sample data use of qualitative research instruments, data presentation and analysis in keeping with qualitative research strategies. The rationale in adopting the above paradigm was to probe deeper the teacher educators' perspectives of knowledge integration vis-à-vis

compartmentalising knowledge to maintain disciplinary codes and syntaxes used to regulate how knowledge is taught in its “pure form” without hybridising it with other disciplines. Contesting views were seen as being inevitable in the process of curriculum design and development for Life Science teacher education.

1.8.2 Research methodology

1.8.2.1 Multiple case studies

Initially, the stance taken by the researcher was to deal with the sampled institutions as having different characteristics and attributes. This is supported by Kumar (2005:112) stating: “a multiple case study method has been defined as an approach to studying social phenomenon through the analysis of an individual case”. Kumar (*ibid.*) asserts that all data relevant to the case are gathered and organised in terms of relevance to the case being studied. The advantage of using a case study is that it provides an opportunity for the researcher to engage more deeply within-depth interviews; ensuring rigorous analysis of data and providing an opportunity for intensive interrogation of specific details often overlooked by other methods.

1.8.2.2 Target population

According to Welman *et al.* (2005), the population encompasses the total collection of all units of analysis about which the researcher wishes to draw specific conclusions. The population of universities offering teacher training and education are 23. All 23 universities were possible to be selected to participate in the study on condition that offer in-service teacher education and training in rural and urban areas of South Africa.

1.8.2.3 Sampling strategy

Six universities were purposively sampled according to the following criteria: 1. 3 Traditional universities which are universities that were not affected by the merger process which was done by the then Department of Education post 1994, during the post-apartheid era. 2. 3 University who were formed as a result of merging colleges of Education, Technikons and universities, hence they assumed a new identity.

According to Kumar (2005), in a multiple case study design, individual cases are treated as units. For data collection and analysis, two participants were selected from each of the three (3) universities Traditional Universities [X]; [Y] and [Z]; and two participants were selected from Merged Universities [P]; [Q] and [R]. Participants ranged from professors, senior lecturers and lecturers who train teachers to teach Life Science. Participating universities were treated as individual cases during data collection: the purpose was to acquire in-depth information concerning each of the three research questions based on the uniqueness of each institution. This study was based on the belief that each university has its own contextual attributes that have influenced the conceptualization of integrated knowledge in the teaching and learning of Life Sciences at individual Higher Education Institutions (HEIs).

1.8.3 Qualitative Research Methods

1.8.3.1 In-depth interviews

According to Kumar, 2005 in-depth interviews comprise face-to-face engagement between a researcher and participants directed at understanding informants' perspectives on experiences or situations as expressed in their own words.

The questions asked during interviews were prepared or structured before the arrangement of the interviews. Participants were asked the same set of questions; seeking data to answer the questions on their views and perceptions of knowledge integration as well as their views on compartmentalising of different subjects which have subsequently been integrated to form a single multi-disciplinary subject (Life Sciences). Permission was sought from different university gate-keepers and consent forms given to participants for the integrity of the study and for ethical reasons. Data was collected through in-depth interviews and Life Sciences curriculum documents were request that were used for the re-curriculation of Life Sciences teacher education. The next step was to contact interviewees telephonically and via e-mail to secure dates of appointments. The dates were diarized and reminders were sent to the participants. The participants were asked for permission to use an audio-recorder during interviews. The transcripts were then developed after the interviews for analysis purposes.

1.8.3.2 Document analysis

The instrument for curriculum documents was designed to solicit data such as: (i) Templates outlining proposed scope of content for Life Sciences curriculum, (ii) proposed Life Sciences course outlines for all year levels in the Bachelor of Education qualification and (iii) where possible, copies of minutes taken from meetings during the process of designing and developing Life Sciences curricula informed by MRTEQ policy were requested. Data collected by means of document analysis were used to triangulate information collected by in-depth interviews.

According to Schumacher and McMillan (2006), triangulation in the process of data collection is meant to strengthen the data collected by means of qualitative tools. The purpose of document analysis in this study was to provide the researcher with critical information that covered certain aspects that were not covered through in-depth interviews during the data collection process of the study. These documents afforded the researcher the opportunity to conduct follow-up sessions with participants when clarity in certain issues obtained during the data collection was required; in an effort to answer the three research questions that this study investigated.

The process of document analysis bench-marked the following aspects:

Alignment of themes with HEQF level descriptor approaches to teaching and learning to address student professional needs in Life Sciences.

Organization of content for vertical and horizontal progression in the design of the Life Sciences curriculum.

Compliance of the curriculum design and development with the Curriculum Policy guidelines (MRTEQ): integration of learning of knowledge and enrichment of disciplinary/subject content knowledge.

1.9 Reliability and validity

According to Kumar (2005), in testing the validity of research instruments, validity is the capacity of an instrument to measure what it was intended to measure. Smith (1991:106) (in Kumar 2000) defines validity “as the degree to which the researcher has measured what he has set out to measure”. It is crucial for this study to ensure that both interview questions and curriculum documents solicited for triangulation purposes were tested for validity [in answering the three research questions that this study aimed to address] and that the questions in the research instruments clearly articulated what this study aimed to achieve.

Reliability on the other hand is referred to as a strategy for ensuring consistency and stability of research instruments used to pursue the research question throughout the study. Kumar (2005) states clearly that the instruments need to be consistent in applying the same instrument for a specific purpose under similar or same conditions to yield the same results. In this study, the same interview questions and documents used in the process of developing and designing curricula were used to measure the conceptions and perspectives of Life Sciences teacher educators on the principle of knowledge integration informed by principles required for the principle of integration of knowledge in the espoused curriculum (MRTEQ).

The reliability and validity of research instruments were tested through the pilot study before the study was conducted on a full scale. Mini interviews were conducted with colleagues and used by the researcher to improve instruments where necessary before interview questions could be used in soliciting final data.

1.10 Pilot Study

According to Schumacher and MacMillan (2006: 202), a pilot study is recommended for testing instruments before they are used in a full-scale study. Welman *et al.* (2005:148) concur with this view of testing reliability and validity of instruments. The following were detected during the pilot study: flaws in the research tools and procedures as well as the need to eliminate unclear and ambiguously-formulated items from the instruments.

The sample for piloting the instruments was devised among colleagues who were approached and requested to participate in in-depth interviews; conducted with three lecturers who were involved in Life Sciences curriculum development at the researcher's institution and one nearby institution. The purpose of pilot testing the data collection was to ensure that they adequately captured the necessary data to answer the three critical research questions for the study. Questions that were ambiguous and irrelevant were then restructured through the advice of colleagues who participated in the pilot study and the supervisor.

1.11 Data analysis

Analysis of the data collected from the pilot study formed a miniature of the full-scale study and served as a spring-board to launch the full-scale study. The findings of this pilot study were discussed in the synthesis of the full-scale research in the latter chapters of this study. After the pilot study, having checked the research instruments for validity and reliability, the study proceeded according to a sampling strategy.

The process of data analysis in the pilot study commenced soon after the pilot study had been completed and instruments for data collection had been tested for their reliability and capacity to address all three research questions for this thesis. When the full-scale data for the study had been collected through interviews, the data were analysed through coding and development of themes from processed qualitative data obtained from interview transcripts. The data collected by means of interviews were analysed within the framework of qualitative methods which were followed by themes obtained from the analysis and synthesis of data. Discussion and interpretation of themes obtained from both interviews and analysis of documents were informed by synthesis of literature which was provided; in the context of answering the research questions benchmarked and objectives identified in the study.

1.12 Ethical considerations

In research, the ethos, values, needs and expectations of all stakeholders targeted in the study, need to be considered. In conducting research, certain issues inform ethical considerations of all stakeholders and need to be built into the study: issues which could cause harm to individuals, breach confidentiality or improperly deploy information obtained from the study or introduce bias into the study (Kumar, 2005:210).

Ethical clearance to conduct the study was obtained from the university where the researcher is registered for the study. Written consent was sought from every participant in the study undertaken. In the consent form, the purpose of the study was explained and the role played by each Participant was made clear. A copy of the consent form was e-mailed to stakeholders involved in this particular study. In the consent form, the universities who participated in the research were given a written consent form to be signed by Heads of Research at each institution, Heads of Department at institutions where the study was conducted and individual curriculum designers and developers of Life Sciences Education who participated in the study. Once permission was obtained, arrangements for conducting interviews were conducted. Anonymity of institutions and curriculum developers was taken into consideration. As such, code-names for institutions and pseudonyms for individual curriculum designers and developers were used throughout the study. Kumar (2005) states that as long as participants are made aware beforehand about information to be solicited, Participants need to be given sufficient time to participate in the study, without any major inducement.

1.13 Orientation of the study

This study consists of the following chapters.

Chapter One

This chapter presents an overview of the study.

Chapter Two

A detailed synthesis of the relevant literature for the conceptual framework of this study is provided in this chapter.

Chapter Three

A detailed theoretical framework that highlights issues to be considered in this study is presented in this chapter.

Chapter Four

The research design and methodology adopted for this study are discussed in depth in this chapter.

Chapter Five

This chapter draws up summaries of data generated in the process of data analysis. In this chapter data are interpreted within the context of the purpose of the research tools.

Chapter Six

A summary of findings is discussed in the context of each of the research questions and problem statements.

Chapter Seven

A synthesis of the findings of the study is presented in the context of the research aims and objectives of the study. Conclusions and recommendation are made.

1.14 Plan for the study and time-lines

Submission of proposal to the FRC	16 June 2015
Defence of proposal to the FRC	21 July 2015
Final proposal submission to HDC	16 September 2015
Ethical clearance granted	22 November 2015
Submission of the draft of chapter 1	7 March 2016
Submission of draft chapter 2 and 3	30 March 2016
Pilot Study	March to August 2016
Data Collection	April 2016 to January 2017
Data handling, interpretation, presentation and synthesis	January to February 2017
Analysis and synthesis of data and submission of a first draft submitted to supervisor	February 2017
Second composite draft submitted to supervisor	March 2017
Final draft submitted to supervisor	April 2017
Submission of the HDC	May 2017

Chapter 2: Conceptual Framework

2.1 Introduction

This chapter presents an in-depth synthesis of current research and literature relevant to the topic in order to define, contextualize and introduce accurately key concepts of this study highlighted in chapter one: ‘knowledge integration’, ‘curriculum development; Life Sciences and ‘pre-service’ teacher education curriculum. Literature indicates that these concepts are associated with various perspectives in educational research and are defined as operational terms in this study. In chapter one, reference is made to the operational use and meaning of these concepts without detailed elaboration. Synthesis of literature provided this study with both local and international readings of these concepts in educational research. Conceptualization of this study was chiefly informed by the views, recommendations and suggestions provided by those scholars and researchers in educational research who pursue philosophical and theoretical means of knowledge construction for meaningful learning (Young and Moore, 2010, Pinar *et al.*, 1995; Carl, 2012; Pinar, 2010 and Slattery, 2009)

This review of literature covers a wide range of issues or aspects of curriculum research in South Africa: (i) historical perspectives of curriculum development for teacher qualifications in Higher Education Institutions from 1994 to 2011; (ii) contesting views of alignment between Teacher Education curriculum and school curriculum [from the advocacy of curriculum changes in school curriculum called Curriculum 2005 to National Curriculum Statement as well as Curriculum and Assessment Policy Statement] and, last (iii) the transformation of Higher Education Institutions. Discussion of these issues provides the background to the argument for radical re-

conceptualizing the Life Sciences curriculum for teachers' education and training in higher education institutions which forms the focus for this study. Researchers both locally and international highlight in their findings that the quality of teachers implementing curriculum changes in schools is poor: learner performance is not improving. Researchers into higher education, specifically regarding teacher education and training, point to the curriculum for teachers as a 'qualification [that is]... problematic' (DHET, 2008). The revised policy for teacher education and training regards disciplinary knowledge and specialised content knowledge and specialised subject pedagogical content knowledge as the main issues of consideration in the Minimum Requirement for Teachers Qualification.

Various perspectives of what the concept of 'integration' entails in knowledge organization and structuring during the processes of curriculum research, design, development and adaptation. Chapter two highlights that the conceptualisation of 'integration' in South Africa has implications for curriculum design and development for basic education as well as curriculum design for teacher education and training. Literature shows that integration of heterogeneous knowledge into broader fields of study takes different forms and meanings: trans-disciplinary, inter-disciplinary and multi-disciplinary. Analysis of information gathered from sources reveals that these approaches to knowledge integration developed emerging trends in conceptualisation of curriculum: a paradigm shift took place from what used to be traditional specialised subject knowledge, to fields of aggregated knowledge (Schubert, 1986 and Pinar, 2012). Similarly, Fogarty, (1991: 62-65) illustrates knowledge integration in various models to enhance understanding of approaches to integration of knowledge within a single discipline (trans-disciplinary); integration across more than one discipline (inter-disciplinary) and integration of knowledge across disciplines (multi-disciplinary). Synthesis of information identified certain

converging ideas which were organised and presented under sub-headings; models of integrated curriculum development, broad field curriculum models, philosophical foundations underpinning curriculum development and cycles in curriculum development.

2.2 Indicators of paradigm shifts in Curriculum Research in South Africa in the 1990's: towards emerging new international trends.

Literature provides a broad survey of historical developments in South Africa in the five years before the country's general elections of democratically-elected government (National Education Crisis Committee, (NECC), 1990, and Nkomo, 1997). The search for a curriculum model for a democratic society by the various committees of the NECC, which is the National Education Policy Investigation (NEPI 1991), recommended a major shift: away from the so-called conventional curriculum policy of textbook learning, and towards new trends of thought in line with international standards (Nkomo, 1997 and NEPI, 1991). The committee's recommendations suggest that an alternative curriculum model for a democratic society should be underpinned by the 'principle of integration'. Implementation of these principles according to the project of (NECC, NEPI, 1992: 40-41) was to be introduced through the following:

Curriculum content was to be organized for four phases in the schooling system (junior, senior primary, junior and senior secondary). The seven school subjects were to be organised into 'Learning Fields'. Social Sciences integrated knowledge of what were Geographical and Historical knowledge, while Life Sciences integrated into one learning field what were General Science, environmental studies, Chemistry, Geography, Physics and Biology.

Researchers in the NEPI project argue that an alternative curriculum model for a democratic and non-discriminatory society in South Africa could adopt any form of integration. The NEPI, 1992: 73) argues that:

Integrated studies in Curriculum Models for South Africa (CMSA), proposes the extension of an integrated approach to senior primary and junior secondary phases. Integration can take a number of forms, from a loose inquiry-based approach , which is not separated into disciplines, theme teaching across disciplines, a multidisciplinary approach where disciplines maintains their identities.

Supporters of integration in curriculum research in South Africa highlight the significance and the benefit of integration of any form when stating (NEPI, 1992: 73) that:

Integration overcomes the fragmentation of subject knowledge. It allows emphasis on the transfer of skills across fields of knowledge than focus on content knowledge only. Integration promotes task-oriented and participatory learning. And it is the basis for a more open-ended and a flexible curriculum.

Integrated studies in the curriculum replace what may have been worthwhile and tested approaches to knowledge construction in the 1970's, with integration of knowledge: by which teachers are better prepared in content and assessment methods compared to existing dis-integrated disciplines. Experts were of the view that participatory and task-oriented learning characterised a flexible curriculum which was not possible in the disintegrated model of the past.

Literature indicates that both opponents and supporters of the principle of integration in the alternative curriculum for post-apartheid education expressed their concerns about implementing integration:

Preparation of teachers: The crucial point is that teachers require a theoretical basis for integration as well as aims and methods of the programme. If skills-based teaching and alternative teaching methods and learning styles and participation in the curriculum development are to be achieved, pre-service and in-service education and training is necessary to improve teachers' existing knowledge and skills. Competences required from teachers to implement integration include ability: to analyse information from various resources, to formulate learning objectives that enhance integration, and to select learning experiences that enable learners to transfer skills across disciplines and assess them adequately.

Resources to support implementation in classrooms: Integration studies are introduced as school-based curriculum development. Implementation requires support within the school, resources and texts to support curriculum innovations.

2.3 Brief Overview of Trends in curriculum research for Senior Phase (SP) and Further Education and Training Phase (FET) under the democratic educational dispensation South Africa.

Literature shows that the recommendations of those supporting integrated studies received favourable consideration from curriculum designers and developers in the education ministry led by the African National Congress (ANC) (DoE, 1997). The advocacy documents on curriculum changes in South Africa stipulated (DoE, 1997: 1) that:

Essentially, the new curriculum will effect a shift from one which has been content-based to one which is based on outcomes. This shift aims at equipping all learners with the knowledge, competencies and orientation needed for success after they leave school and have completed

their education and training. The curriculum will begin to *integrate* education and training – incorporating a view of learning which rejects a rigid division between academic and applied knowledge, theory and practice, and knowledge and skills.

Advocacy documents (DoE, 1998: 4-10) integrated what were known to be subjects in the former content-based curriculum into broad-fields called Learning Areas. Definition of curriculum provided a frame-work for integration:

A curriculum is everything planned by the educator which will help develop the learner. All knowledge is integrated; and teaching and learning are not sharply divided.

According to DoE (1997: 11-12), principles of integration were to underpin the processes of curriculum research, design, development and adaptation (RDDA). This implies that the process of knowledge production by researchers should: enforce the notion of integrated knowledge system; shift from compartmentalised knowledge into broad clusters of subjects; integrate knowledge and skills, knowledge across Learning Areas or fields of knowledge and lastly integrate learning and assessment as a trend that is pursued by researchers in knowledge production.

The implementation of the principle of integration in knowledge organisation contained in the curriculum guidelines introduced a cluster of so-called Learning Areas. The definition of this term in DoE, 1997: 14) is:

Learning Area is a group of related knowledge, skills, values and attitudes. In the learning process, the learning area should enable the learner to demonstrate the skills, knowledge, values and attitudes associated with the specific learning area. Learning Areas provide a context for the learning of transferable competences, skills, attitudes and knowledge.

Literature highlighted that adjustments and continuities in the curriculum for a democratic society had not introduced a fundamental shift from the philosophical foundations of Outcomes Based Education (OBE); particularly for Senior and FET Phase and Intermediate Phase in the General Education and Training (GET) Band (DoE, 2000, 2005 and 2011). The clustering of subjects into broader fields of study are still manifesting in Life Sciences, Life Sciences and Technology, Economic and Management Sciences. Subjects such as Life Sciences amalgamated themes from different disciplines to structure knowledge into related and relevant themes such as the “earth and beyond theme” which incorporates knowledge from the following disciplines: Geography, environmental sciences, Zoology, Botany, Chemistry and Physics.

The Minister in the National Department of Basic Education stated that the on-going changes effected in national school curriculum are not fundamental but that the changes are the streamlining of the curriculum to address concerns at the implementation level (DoE, 2011).

Researchers into curriculum studies (Jansen, 1999, Chisholm, 2000 and Jansen and Christie, 1998) who are aligned with researchers of the NEPI, caution that the issue of an integrated approach in the RDDA in any curriculum change should first prepare teachers by equipping them with suitable theoretical knowledge. The implications for curriculum change for teachers were encapsulated in the Norms and Standards as set out. This meant that the curriculum of pre-service teacher education and training in DoE (1998: 23-38) should prepare the envisaged teacher to demonstrate the following qualities:

Focus on achieving outcomes of education rather than merely conveying information

Translate learning programmes into an achievable entity

Find ways of providing conditions of success in the classroom – a positive learning environment

Be creative and innovative

The stipulations of Norms and Standards for educators in the new curriculum change had serious implications for academic tuition of teachers at Higher Education Institutions (Gravette and Geysler, 2004).

2.4 Perspectives on the Implications of Alignment of School curriculum with Teacher Education and Training at Higher Education Institutions.

Literature shows that the paradigm shift, from desegregated curricula to an integrated curriculum for all schools, had implications for the training of teachers at institutions of higher learning (Allias, 2003; Marrow, 2007 and Parker, 2001). It became apparent that teachers who were trained at higher education institutions required education and training that enabled them to teach innovations introduced in the national school curriculum. Researchers (HSRC, CEPD & SAIDE, 2005) into teacher education and training expressed their concerns:

Ways of designing and delivering teacher education were inadequate to address the needs of those parts of the country most in need of quality teachers.

Research conducted by a consortium of researchers from the Centre for Education Policy Development (CEPD), Human Science Research Council (HSRC), Centre for Evaluation and Assessment and South African Institute for Distance Education (SAIDE) proposed guidelines for development of curricula for teacher education and training. The guiding principle behind the model of curriculum for teacher education and training was 'integration' (Parker, 2001). Integration in teacher education and training implied: linking theory and practice, which was possible through acquisition of competences: for example, foundational competence (mastery of

knowledge in the discipline), practical competence (skills and abilities) and reflexive competence. Harley and Wedekind (2004, 195) argue:

Curriculum will begin to integrate education and training-incorporating a view of learning which rejects rigid division between academic and applied knowledge, theory and practice, and knowledge and skills.

Literature indicates that policy on curricular changes for teacher education was not received without criticism from academics. There were concerns from universities about the greater interference of the Department of Education in curriculum development for teacher education and training. During apartheid, universities were expected to align their qualifications with the policies of the department. The issue of compliance was not emphasised; as is the case with the current dispensation in higher education (Themane, 2013, Christie, 1999, Cinaph, 2000 and Tylor, 1999). The policy on curricular development for teacher education and training defined the roles of the competent teacher; while curriculum designers and developers in universities evaluated their curriculum and its output (DoE, 1998). Researchers (Wedekind and Harley, 2004, Jansen and Christie, 1998, DoE, 2004 and Taylor and Vinjevol, 1999) held that the policy on teacher education and training caused chaos: as each institution gave diverse interpretations of what was required; more specifically in terms of what constitutes an 'integrated approach' and 'outcome based education'. It was reported that, at some universities, the competences were used as mere guidelines to develop the curriculum; while others used roles to design modules for the programme. In some instances, outcomes were used as no more than points of departure for organising content (Morrow, 2007 and Shalem, 2010).

Literature indicates that there are uncertainties encountered by academics regarding curriculum design and development; as shown in the Higher Education Quality committee reports. The incapacity [inability or refusal] of academics at some universities in the country to design and develop adequate curricula was of serious concern to the Department of Education because the incapacity delayed implementation of teacher qualification programmes; thus teacher demand increased. Marrow (2007) and Themane (2013) condemn the Department of Education for its radical changes which coerced academics into a complete overhaul of what they knew about curriculum for teacher education and training. Morrow (2007) considers the Department to have been over-ambitious about change in higher education and training. The critical view expressed by these researchers indicates that curriculum change is a collaborative endeavour which requires shared views and common understanding about the nature and quality of the eventual output. This view implies that individuals involved in the process should have knowledge of curriculum design and development as well as an understanding of philosophical and theoretical knowledge of policy. Du Toit (2013) argues that deliberations and decision-making about curriculum design or models and content are processes: any quick-fix approach results in chaos and instability.

2.4.1 Norms and standards as guidelines for developing the curriculum for teacher qualification programmes for curriculum changes: Curriculum 2005 and National Curriculum Statement NCS.

Gravette and Geysers (2004) point out that, in the policies formulated by the National Qualification Framework (NQF) and South African Qualification Authority (SAQA) with regards to curriculum for teacher education and training and developments, the focus fell firmly upon alignment of teacher competences with developments and continuities in the national

school curriculum. According to Chisholm (2000), higher education institutions were expected to introduce teacher trainees to Learning Areas; instead of separate subjects and disciplines. This implied that universities were to search for a suitable approach that could enable teachers to teach across disciplines or subjects. Innovations in the Curriculum 2005 were aligned with the competences introduced in the Norms and Standards for Educators (NSE) in 1998. This policy promulgated the roles of the envisaged teacher and the learner for Curriculum 2005 of the Outcomes Based Education in South Africa; recorded in NQF and SAQA (1999: 23), as follows:

Learning Mediator, Interpreter and designer of Learning programme, Leader, administrator and manager, Scholar, researcher and Lifelong learner, Community, citizenship and pastoral role, Assessor and Learning Area,/subject/ discipline/ phase specialist.

The Educators Employment's Act (EEA) (DoE, 1998) and Norms and Standards for Educators policy stipulated fundamental competences which should be demonstrated by qualified teachers to teach outcomes based curricula at schools: foundational competences (knowledge of the discipline/subject/learning area and specialisation in the phase); practical competence (specialised pedagogical content knowledge to teach knowledge across the curriculum, designing and interpreting learning programmes and materials);and reflexive competences (the abilities to reflective and discern or to make judgement on the content and context).

Literature indicates that implementation of these policies encountered challenges in the design and development of an ideal curriculum model to prepare teachers for the espoused national curriculum statement for schools (Parker, 2001, DoE, 2004 and Marrow, 2007). The interventions of the Department of Education through various documentations tried to streamline

Norms and Standards after the evaluations of teacher qualifications by HEQC of the Council of Higher Education (CHE). The consortium formed by the CEPD, CEA, HSRC and SAIDE was mandated to search for an adequate model for teacher education and training which could be adopted by all institutions of higher education.

According to the qualification policy framework (DoE, 2000:15–22), the following should be adhered to:

Qualification must be designed around the specialist role, as it encapsulates the purpose of the qualification and shapes the way the other six roles and their applied competences are *integrated* into the qualification.

A specialisation for teaching will always include both a Subject Learning Area specialisation and phase specialisation.

The role of Learning Area/ subject/discipline and phase specialist is to determine the required learning mediation.

The list of roles is integrated into three competences which provide a description of what it means to be a competent educator.

Qualification should reflect an applied and *integrated* competence which demonstrates the ability to integrate theory and practice in teaching.

Researchers reported that teachers produced through the modular system and curriculum based on guidelines of Norms and Standards are unable to teach content and skills. The performance of learners in literacy skills and in subject content knowledge is hazardous at best (Chisholm, 2007, Jansen and Hoadley, 2004 and Harley and Wedekind, 2004).

Literature shows that the key roles and competences that pertain to subject content knowledge and specialised subject pedagogical content knowledge in the Curriculum Framework for teacher qualification, (2007) and Norms and Standards for Educators (2000) are: interpreter and designer of learning programmes and Learning Area/ subject/discipline and phase specialist.

Interpreting and designing a learning programme is associated with the ability or competence of a teacher to select and prepare adequate textual and visual resources; select, sequence and pace learning in a manner that is sensitive to the differing needs of the Learning Area and learners. Learning Area/ subject/discipline and phase specialist role implies a teacher well-grounded in the relevant knowledge, skills, values, principles, methods and procedures in the discipline or subject and Learning Area phase of the study or professional or occupational practice. Literature on the advocacy of the policy framework for initial teacher qualification shows that the notion of applied competences is integrated into six roles of the competent and the qualified teacher for curriculum change in South Africa. Applied competences are associated with assessment Criteria. Applied competence is the overarching term for three interconnected kinds of competence which are: foundational competence, practical competence and reflexive competence. Foundational competences were linked to the Learning Area/subject/discipline: phase specialisation, interpreter and designer of the programme role imply that competence must be demonstrated within the subject or phase specialist role that defines the purpose of the qualification. Practical competence is a demonstrated ability, in an authentic context, to consider a range of possibilities for action, make considered decisions about which possibility to follow and to perform the chosen actions

Reflexive competence is demonstrated when learners demonstrate the ability to integrate or connect performance and decision-making with understanding and the ability to adapt to change

and unforeseen circumstances, and explain the reasons behind these actions. Literature reports that the review of teacher qualification by both providers of teacher qualifications and external reviewers of the Council of High Education (CHE) arrived at similar findings about the challenges facing this initiative.

2.4.2 Perspectives on implementing the curriculum policy in the design and development of teacher qualifications in South Africa from 1999-2010.

Literature states that implementation of the NSE guidelines in development of teacher qualifications was interpreted in various ways by academics at various Higher Education Institutions in South Africa. It is indicated by researchers in the CHE Report (HE, 2010) that: ‘The onus for programme design rests almost entirely on the professional judgement of the provider. This judgement needs to accommodate both appropriateness of the programme to the purpose of the qualification and its responsiveness to local needs. The other issue noted by researchers is the threat that faced successful implementation of the NSE: the fact that the paradigm shift was too complicated for academics who had never engaged in the process of curriculum development. Parker (2001:12) argues that:

The NSE envisaged ‘a completely new way of designing and delivering teacher education in South Africa’ The ‘new way’ is informed by the ‘seven roles of the educator’ and no fewer than 133 discrete ‘competences’ were identified. This presented a major challenge to curriculum designers, because there is a degree of ambivalence in the NSE about whether the roles and competences are ultimately generative or, by contrast, prescriptive. The NSE is, on the other hand, much less specific than COTEP about actual curriculum structure. One of the NSE’s more significant effects has been to increase the regulation of

programme outcomes, in the form of roles and competences, while at the same time being less specific about how a programme should be designed to achieve these outcomes.

Other researchers (Jansen and Christie, 2004 and Tylor, 1999) contend that the new arrangement of school phases complicated this neat distinction because it affected phase-related areas of specialisation offered in B.Ed. programmes. Morrow (2007) contends that the National Curriculum Statement introduced three significant issues for phase specialisation. First, the Senior Phase (Grades 4–7) uncomfortably straddles the current systemic divide between ‘primary’ and secondary’ education. A major question is how B.Ed. areas of phase-specialisation should address the senior Phase (with Grade 7 located in the primary school and Grades 8–9 located in the secondary school). This affects programmes that prepare teachers for the primary and for the secondary school sector. Secondly, secondary school programmes need to prepare secondary students to teach across the differing arrangements of disciplines in both the GET learning area and the FET subjects bands.

Literature demonstrates that an additional complication in the design of B.Ed. programmes was caused by the re-categorisation of the school sector. All former regulations for Initial Professional Education Training (IPET) qualifications were described (in DHET, 2010) to have “Posited on an existing relationship between the school sector and the phase-related specialisation of qualifications; the old relationship, which allowed for a clear distinction between the training of teachers for the primary and for the secondary school sectors”. Researchers note that universities were unable to design curricula for an envisaged teacher despite streamlining new policy guidelines for teacher qualifications called the Minimum Requirements for Teacher Qualification. The fact that these qualifications were registered by SAQA implied that not all Initial Professional Education Teaching programmes met criteria

required to comply with the provisions determined by the SGB (Standards Generating Body) as well as those set out in the NSE. The Standard Governing Bodies (SGB) specified a qualification matrix setting minimum credit allocations for fundamental, core and elective components [different from the practical, foundational and reflexive competences of the NSE] as well as a set of exit-level outcomes not directly related to the seven roles of the educator: for the B.Ed., nine exit-level outcomes subdivided into total credits (DoE, 2008).

B.Ed. curriculum designers met the needs expressed in the NSE for pedagogical knowledge to be applied to an area of specialisation. In most cases, the specialist role informing B.Ed. programmes is a school phase (Foundation Phase, Intermediate Phase, Senior and Further Education and Training band). Literature dealing with the threats and challenges facing development of an integrated curriculum in universities argues that while the importance of application to a specific phase of school learning cannot be underestimated, there is a danger that the academic subject base (for example, education theory, teaching subjects) can be reduced to the point where narrow application of knowledge predominates over a broad intellectual framework on which critical, sound and reliable methodological application ought to depend.

Further concerns in the literature related to transforming attitudes of academics from a subject and discipline curriculum to an integrated one. Researchers of the DHET (2008) indicate that the chief difficulties for curriculum designers with regards to academic and professional aspects of Initial Profession Education and Training programmes included: a lack of adequate resources, expertise and experience from the cohort of academics. Certain problems appeared which constrained officials from implementing the curriculum policy which was introduced to develop initial teacher education and training qualifications. These constraints included: diverse interpretations of the meaning of the terms ‘integration of applied competences’ and ‘roles of the

educator’; the issue of credit allocation; integrating exit level outcomes with role and competences; and last, the need to comply with regulatory documents DHET (2010). According to the Jansen and Hoadley (2004), the ‘new way’ of setting and exacting standards for outcomes organisation, remains an intellectual challenge in designing and delivering teacher education at South African universities.

Arguments manifested in relevant literature indicate that critics of transformation of teacher education blame rigid regulations and measures of the Council of Higher Education (CHE) as the cause of poor quality teachers. Researchers who share this view, (Morrow, 2007, Jansen and Christie, 1998) condemn sudden changes in teacher education and particularly issues of regulated roles, competences, exit outcomes, overloaded curricula and replacement of a sound theoretical framework for the programme with what they regard as an artificial and mechanistic mapping of regulated imperatives onto courses, units and modules.

Literature, however, affirms the determination of the CHE to make sure that universities, as providers of teacher qualifications, comply with regulatory documents as useful guidelines for HEIs to use in designing programmes and ensuring that roles, competences and outcomes are integrated and coherent in the vertical and horizontal articulation of senior phase curricula for teacher qualifications. By contrast, formulators of the Higher Education Qualifications Framework (HEQF) summarise research findings concerning the state of curriculum design for teacher qualification CHE (2010: 164-166) as follows:

There have been considerable differences in the ways institutions have applied the NSE regulations to the design and delivery of their B.Ed. programmes. In some cases these regulations have provided a reasonably flexible framework that needs to be adapted to

sound educational theory and socio-educational context. These cases on the other hand emphasise the freedom and responsibility that are assigned to the provider, and the fact that schedules of roles and competences are not meant to be a checklist against which one assesses whether a person is competent or not. The NSE has been construed as a tightly-regulated set of prescriptions; a conceptual matrix in which each and every role and competence needs to be explicit, to the extent that some programmes have taken the roles and competences as their design template and as a map of their exit-level outcomes.

Literature indicates that academics offering teacher education programmes need to correct misconceptions resulting from diverse interpretations of national curriculum policy for teacher qualification, including the following DHET (2010) Report: ‘The way this diversity of interpretation has affected the design of programmes became clear from statements made during site visits. Evidence suggests, however, that many teachers are in fact requested, or choose, to cross these phase-divisions. While persuasive arguments can be presented for phase-specific specialisation on the grounds that they represent distinct parallel phases of child development....’

Certain statements in the Department’s report specify the constraints and challenges that occur in implementing curriculum innovations in teacher education and training at universities. Indicators suggest that some academics were reluctant to comply with provisions regulating the design and development of curricula for the programmes. The DHET report highlighted that the main issues of concern were:

The range of institutional statements suggests that the purpose of the programmes reviewed is to produce teachers who are primarily phase or subject specialists, rather than to equip graduates to adapt knowledge and skills to any other areas of the school or the

curriculum. It also suggests that where a conceptual framework based on educational theory is included, it tends in many cases to be embedded (or assumed to be embedded) in the specialised focus. It needs to be noted that B.Ed. graduates are not formally prepared to cross the NCS phase (or learning area and subject) boundaries. It is also evident that the aim of producing agents of educational change and prospective educational leaders features in very few statements of programme purpose.

This brief background is based on research reports about efforts to align curricula for teacher qualification with changes and continuities in school curricula.

2.5 Re-aligning Curricula for teacher education with the core Curriculum and Assessment Policy Statement, CAPS.

The Higher Education and Quality Committee (HEQC) of the Council of Higher Education (2010: 73) emphasises that reviews of teacher qualifications take into account the needs of basic education for all:

In choosing the area of education, and in particular, professional qualifications in education as the focus of this review, the HEQC took into account the fundamental role that basic education and the national schooling system have in the development of a democratic society. It also took into account the responsibility that higher education institutions have in this regard given their role in the training of teachers both in pre-

service and in-service situations. The selection of the specific type of qualifications to be accredited took into account the size of the enrolments as well as the strategic importance attached to mathematics and science in the broader developmental goals of the country.

Literature indicated that review committees were mainly concerned to design and develop curricula in the field of Science, Mathematics and Technology and to integrate applied competences (CHE, 2010: 86): ‘A preferred area selected for review was the field of Science, Mathematics and Technology Education. In choosing specialisations in relation to the B.Ed. and the PGCE, it was decided to review Senior Phase and the Further Education and Training band respectively. In this way the Review could provide insights into the quality of training received by teachers responsible for the entry and exit phases of the schooling process. Literature emphasises that streamlining the National Curriculum Statement, in terms of changes proposed by the ministerial committee in 2011, forced the Department of Higher Education to formulate policy guidelines that were in keeping with the proposal of the Ministerial Committee of the Department of Basic Education. The Department of Higher Education (DHET, 2011) gazetted the modified curriculum policy to guide the design and development of curricula for teacher qualification. The process of evaluating teacher qualification programmes resulted in departments undertaking the action presented (CHE, 2010: 87):

The currency of the report’s findings and their relevance, despite its delayed publication, is a sign of the persistency of the difficulties faced by the country in the area of basic education. It also highlights the complex relationship between higher education institutions’ conceptualisation of teacher education and the understanding and

experiences of the teaching profession operating among policymakers, government, unions, the broad public and the teachers themselves. In finalising the decision-making process the HEQC Board took due cognisance of the strategic importance of the provision of teacher education nationally and took, in consultation with the Department of Education, a developmental view in those cases in which the closing down of programmes.

Research pointed out that the same cohort of academics who reported to have difficulty [or reluctance/resistance] in interpreting NSE regulators, were expected to align programmes with the guidelines provided in the Minimum requirements for Teacher Qualification (MRTEQ). The programme could have accommodated the provisions of the NSE, and at the same time been in a position to re-align existing programme design and curriculum structures with the principles of the new regulations. The panel reports indicate, however, that, on the whole, the staff of B.Ed. programmes were balanced in terms of the range of disciplinary fields, the phase or learning programme specialisations offered and the practical and theoretical components of the B.Ed. Reports point out that institutions of Higher learning are faced with the challenge and the problem of finding replacement staff with the appropriate professional and academic qualifications and experience, particularly in terms of equity. The report noted that institutions that provide teacher education qualifications often have staff members who are not engaged in scholarly activities such as research and other forms of structured inquiry. The DHET (2010) reported:

This suggests that the level of staff qualification across the sector as a whole is generally low (the reason for this being again related to the history of teacher education and the

process of its incorporation into universities) and in need of urgent attention at a number of institutions.

HEQC (2010) in the National Review of B.Ed. degrees offered in South African Higher Education Institution reported that: ‘the B.Ed. is deemed to be the training of efficient classroom practitioners’.

Analysis of the guidelines provided by the CHE for aligning curricula and programmes for teacher qualification identified similarities between regulations in the NSE (2000) and those in the MRTEQ (2015). The chief difference was the explicit differentiation indicated in the knowledge matrix and the exit outcomes enshrined in the roles. The main emphasis remains on integration of learning which needs to be manifested in the knowledge mix in the programme.

2.6 Critical analysis of various concepts of integration in different educational contexts.

2.6.1 Knowledge Integration

Integration of knowledge, as perceived by certain scholars and researchers (Young, 2010; Kutti, 2007, Golding, 2009, Spelt *et al.*, 2009, Nikitina, 2002 and Repko, 2007) in the field of education is twofold; referring to approaches to pedagogy, and to subject knowledge structure. According to Golding (2009: 18), there are three domains in epistemic structure: dualism, relativism and critical pluralism. Dualists regard knowledge as objective, certain and absolute. Scholars of this school of thought view knowledge and the world in terms of facts. Relativists think of knowledge as subjective: including individual beliefs and theories. To a relativist thinker, values and therefore knowledge are contextual and contingent (Hoadley, 2014). The

critical pluralist contends that knowledge is absolute in nature. Critical pluralists in educational research emphasise critical, reflective and inter-subjective approaches to knowledge structuring. Golding (2009) reflects on this trend as a shift from the dual approach to epistemic research, to an inter-disciplinary approach.

2.6.2 Images of integrating knowledge into curricula.

Literature shows that integration of knowledge into a curriculum manifests some of the following images. The first group of models depicts integration of knowledge within a single discipline. Integration could take any of the following forms: fragmented models, connected models and nested models.

2.6.2.1 Integration within single-discipline models.

Fragmented model: regarding integration of knowledge within the same discipline. This view of knowledge integration advances the uniqueness of knowledge (taking into consideration that the discipline is the same). According to Killen (2005), outcomes-based curricula introduced in South Africa propose integration of learning outcomes within the Learning Area which is called *within Learning Area integration*. Gibson (1994), Kutti (2007) and Repko (2007) argue that this integration involves transferring skills and enhances the effective development of conceptual knowledge in the learning of disciplinary knowledge.

The Connected model: This is another model that advocates integrating knowledge within a single discipline. The key to this model is the deliberate effort to relate ideas within the discipline; rather than assuming the student will automatically understand the connections.

Hartzler (2000) posits that this model of knowledge integration relies upon units as organisers for students to notice interconnections of ideas and skills within a discipline.

Drake (1998) purports that ‘integration is inherently interdisciplinary; involving design with horizontal organizations that break down walls of traditional academic disciplines by providing learning experiences that explicitly link content, skills, and/or values of different areas with the same subject area, but more commonly, between two or more of the traditional academic disciplines’. The integrated curriculum provides the context for learning; however, ‘instructional practices must make these connections explicit’ (Hartzler, 2000: 155).

2.6.2.2 Integration within and across traditional subject boundaries.

The immersed model for integrating knowledge filters all content through the lens of interest and expertise. In this model, integration takes place among learners; with little or no outside intervention.

A network model views the curriculum as a prism which creates dimensions and directions of focus. In this model, learners themselves direct the process of integrating knowledge. It is assumed in this model that only learners themselves, being ‘knowers’ of intricacies and dimensions of the field, can target the necessary resources; as they reach out within and across their area of specialisation. The network model is seen to a limited extent in elementary schools and, in this case, learners become aware of their areas of interest.

2.6.2.3 Integration across several disciplines.

Sequenced model:

The sequenced model, adopted from Fogarty (1991: 62), views the curriculum through lenses that are separate and yet connected by a common frame although topics or units are taught separately; they are re-arranged and sequenced to provide frameworks for related concepts.

Shared model:

A shared model, as adopted from Fogarty (1991:62), views the curriculum through binoculars, bringing two distinct disciplines together into one focussed image. By using overlapping concepts as organising elements, shared models involve shared planning or teaching in two disciplines.

Threaded model:

In this model of knowledge integration, the curriculum is viewed through a magnifying glass. 'Big ideas' are enlarged throughout all content with a meta-curricular approach. This model threads thinking skills, social skills, study skills, graphic organisers, technology and multiple intelligences approaches to learning through all disciplines. In this model, various thinking skills and forms of intelligence supersede all subject matter content: so that production is a skill used in Mathematics, for example; forecasting is used in current events; anticipation is employed in writing a novel, and hypotheses are paramount in the science laboratory. Consensus-seeking strategies are used to resolve conflicts in any problem-solving situation.

Using the idea of meta-curriculum, grade level or inter-departmental teams can target a set of thinking skills to be infused into existing content priorities: thinking skills or social skills are threaded into content.

Integrated model:

An integrated model views a curriculum through interdisciplinary topics that are re-arranged around overlapping concepts, emergent patterns and designs. Using a cross-disciplinary approach, this model blends four major disciplines by identifying overlapping skills, concepts and attitudes. Integration is a result of sifting related ideas out of subject matter content. Integration emerges from within various disciplines and teachers make matches among them as commonalities emerge. An interdisciplinary team discovers they can apply the concept of argument.

Webb model:

This model uses fertile themes to integrate subject matter such as inventions. A cross-departmental team chooses a theme which members use as an overlay for different subjects. Inventions signify the study of technology, science, reading, and writing, designing and building devices and making flow charts in Mathematics and Computer Technology classes. In departmentalised situations, the Webb curricular approach to integration is often achieved through the use of generic, fertile themes such as patterns. A conceptual theme provides rich possibilities for various disciplines. Patterns or conceptual themes provide fertile ground for cross-disciplinary units of study.

2.7. Key Areas benchmarked for integration into the curriculum for teacher education and training (MRTEQ).

Integration of applied competence and roles of the educator

Integration of teaching and assessment

Integration of discrete competences (foundational/ practical/ reflexive)

Integrated learning and forms of knowledge, fundamental learning/situational learning/
integrated knowledge (disciplinary knowledge/ subject pedagogical content knowledge/ general
pedagogical content knowledge / practical knowledge

In line with the above frame of thought, ushering in a democratic political dispensation in South Africa after the 1994 General Election stimulated radical changes in higher education and training. The National Qualification Framework (NQF) and South African Qualification Authority (SAQA) sparked the reorganization and restructuring of higher education. The Outcomes-based education system was the recommendation of the NQF and SAQA. This education system had implications for alignment of higher education with curriculum designs for schooling systems in South Africa (Jansen and Christie, 1998; Chisholm, 2000; Gravette & Geysers, 2004 and DoE, 1997 and 1998).

The above structures, together with the Higher Education and Qualification Framework (HEQF) revealed shortcomings in the Norms and Standards (NS) of teacher education and training policy. Policy on Norms and Standards for teacher education and training was not aligned with the

HEQF. Attributes for teacher qualification were more skills-driven; which resulted in the system producing what would be later viewed as technician-type teachers who lack adequate disciplinary knowledge (Jansen and Christie, 1999). Critics of curriculum changes for teacher education, such as Jansen and Christie (1999) contend that curriculum policy guidelines for teacher education and training in South Africa would not produce teachers able to implement 21st century curriculum transformation and continuities. This claim was based on the fact that there has been a recognised gap between universities' curriculum and school curriculum changes. This assertion presumes that school curriculum since 1997 has been a political issue rather than an academic endeavour. This belief echoes what many academics in South African universities perceive concerning school curricula and teacher education and training.

The above assertion is coupled with findings from research conducted by government and agencies commissioned by the government to diagnose issues leading to such a gap between tertiary and secondary programmes of education. Such a disjuncture (e.g. Joint Education Trust) led to further research conducted to review the causes of such gaps and how they could be dealt with; as a result of recommendations made in the policy on Minimum Requirements for Teacher Education Qualification (MRTEQ) (DHET, 2015). MRTEQ has recently been proposed as a tool for further alignment between curriculum for teacher education and expectations of the school curriculum and society's educational goals.

This overview of curriculum changes in teacher education sets the stage for tracing the concepts and perspectives that have influenced curriculum development and resolving some of the shortcomings listed in DHET, 2015; particularly the perceptions and perspectives of Life Sciences teacher educators regarding the principle of knowledge for producing competent teachers capable of handling any aspect of content knowledge required by those exiting teacher

training programmes at Higher Education Institutions (HEIs) or universities in South Africa. Themane (2014) argues that university academics should not be dictated to by the Department of Higher Education on matters pertaining to academic and professional development of teachers. This researcher argues that compliance with departmental policy guidelines confines academics to the philosophies of those who hold political powers (Apple, 2010). Researchers show that the South African universities' curriculum before transformation of teacher education was based on disconnected disciplines and separate areas of specialization (Jansen and Christie, 1998; Gravette and Geysler, 2004; Wolhuter, 2014). This kind of fragmentation meant that specialists in one or two disciplines could be biased towards their disciplines in selecting themes and areas of study; students studying under such specialists tended to gain theoretical and applied knowledge in small areas which undermined the principles of a multi-disciplinary or integrated approach to knowledge acquisition.

This study aims in particular to reveal how and why teacher educators initially conceived of the principle of integration in the development of curriculum content in Life Sciences. In a Foucauldian way, this thesis undertakes archaeology of knowledge formation: discovering or unearthing how teacher educators in specialist areas perceived content selection in the designing and developing of curricula for knowledge integration. Models of integration of disciplinary knowledge require balance in content coverage of all sub-disciplines that constitute Life Sciences.

This study researches models that are suitable for equipping pre-service teachers with competencies to teach Life Sciences to senior phase learners in schools and for enabling them to manage Life Sciences content in the FET phase in schools when they qualify as Life Sciences educators. The argument that this study proposes, is that, despite the policy guidelines provided

by the DHET, academics are the custodians of knowledge production through local and international research. Above all, they are experienced in theories of teaching and learning. This study examines perspectives of teacher educators in designing and developing Natural Science curricula for Senior Phase teacher training and development, and specialisation in Life Sciences teacher education curricula for FET phase; based on principles of knowledge integration as informed by the policy on Minimum Requirements of Teacher Education policy (MRTEQ).

Curriculum formation has been, and still is, routinely viewed as a product of planned activities. The intent of this image is to be explicit about what is offered to students. What is offered in this image resonates with the belief that students are passive participants in the process of teaching and learning. Within the above view of curriculum design and development, the concept of a curriculum as product [according to Schubert (1986) and Cornbleth (1990)] dominates curriculum research: a curriculum is conceived centrally and disseminated to institutions through policy guidelines; in the form of one size fits all. This study is directly opposed to this notion of knowledge as 'banking', in Freire's terms. The role of such traditional curriculum developers is to interpret the policy and develop curriculum according to guidelines stipulated in Departmental policy. John Dewey asserts that the image of a curriculum as pedagogical content knowledge, known as Shulmans' domains, views curriculum as a set of activities or predetermined ends. Dewey advocates curriculum as a learning experience (curriculum as praxis) based on curriculum as a means to ends continuum. According to Schubert (1986), educational means and ends are inseparable parts of a single process or experience. Evolving the curriculum is at the centre of this image: the teacher in this image focuses on personal growth of each student: the curriculum is a process of experiencing the sense of meaning and direction that ensues from teacher and scholar dialogue.

The last curriculum image to be introduced in this thesis takes into account the uniqueness of students; based on their environmental differences and their prior knowledge, what they contribute in the acquisition of meaning-making in a class. Knowledge is constructed and based on students sharing autobiographical accounts with others who strive for understanding. This perspective is demonstrated by Schubert (1986) as a social process whereby individuals reach a point of understanding who they are, who the other partakers of knowledge are, and the nature of the environment in which this knowledge is acquired. These pursuers of knowledge share a mutual space with others who are not in immediate proximity. According to Schubert (1986), this curriculum imagery regards curriculum as the interpretation of lived experiences. This study locates dominant images adopted by participants in the study in order to gain more insight into concepts held by different institutions that have influenced the structuring of the espoused curriculum and to trace the source of such concepts and influences based on the curriculum documents developed for MRTEQ.

2.8 Concept of curriculum development.

The concept of curriculum is described differently according to various philosophical and theoretical frameworks. For example, the humanist view of curriculum is that it comprises the sum total of a learner's experiences: curriculum encompasses a learner's self-actualization, satisfying experiences, an individual's cognitive, affective, and physical needs. Proponents of this concept relate curriculum to the peak experience on which learning should be based. Curriculum development, to the humanist, entails consideration of the learner in context; cognitive, social, economic and physical.

Some researchers prefer the term ‘curriculum’ when referring to institutional curriculum because it includes contextual factors such as: selection of content, availability of human and physical resources and day-to-day teaching and learning activities, implementation as well as designing assessment (Carl, 2010; Higgs, 2003, Biggs, 2000; and, 2012). Research indicates that concepts of curriculum development result from contesting concepts of what curriculum ‘is’. To some researchers, curriculum is a process, whereas to others a curriculum is a product; while for many, curriculum is viewed as praxis (Schubert, 1986; Kelly, 2010 and, 2010).

Schubert (1986) dismisses notions of planned activities in curriculum altogether: ‘To characterise curriculum as planned activities is to place major emphasis on outward appearance rather than inner development of knowledge impartation (Schubert, 1986:27).’ In this scenario, curriculum is a valuing of outcomes which negates the process of knowledge acquisition. Curriculum invests in the ends rather than focusing on the means to an end.

Some curriculum researchers and reviewers contend that curriculum should not comprise activities highlighted above. They argue that curriculum should focus directly on intended outcomes. According to Schubert (1986), the shift advocated in this particular image is that its focus should be on the pedagogical content knowledge. The intent of this curriculum imagery is to be explicit and defensible with regards to content offered to students, and the means of packaging and delivering content to students. Schubert (1986) avers that focusing on intended learning outcomes as the prime factor in curriculum draws attention away from unintended outcomes: which could be an exceedingly powerful force in what learners learn at schools. Knowledge that assists one student in making meaning of what is being taught when it combines with the rest of his or her cognitive and affective repertoire may be enlightening to him but the same intended outcome may be of no use to other students. The intended outcome may, however,

be quite different when taught through an enquiry, simulation or lecture method. The crux of the matter is that the intended results may differ from the actual ones; even within a group of students who seem to have acquired the intended outcomes. This study proposes that learning cannot be viewed as one-dimensional but multi-dimensional (Hoadley, 2010).

2.8.1 Conceptualizing knowledge integration in the process of knowledge production and the implications for epistemological disciplinarity.

Gibbons (1994) pioneered the so-called Model of knowledge production which promotes a complex of ideas, methods, values and norms which apply to a broader field of study compared to disciplinary subject matter. This mode in Kutti (2007) focuses on extension of the field of inquiry into knowledge acquisition that encompasses cognitive competences and social norms. Golding (2009) argues that ‘interdisciplinary’ as mode 1 knowledge production entails legitimating and diffusing knowledge into homogenous disciplines in a particular field of study. Barnett (1994) defines an interdisciplinary curriculum as one that combines several school subjects into one active project; since that is how children encounter subjects in the real world, “combined in one activity”. Curriculum is therefore perceived as an educational approach that prepares children for life-long learning.

Glatthorn (1994:164-165) goes beyond the definition of curriculum as a linking of subject areas. To Glatthorn, curriculum entails the creation of new models for understanding the world. In an integrated curriculum, learning is not an acquisition of facts but an experience which provides learners with a unified view of commonly-held knowledge (by learning the models, systems and structures of the culture). A curriculum motivates and develops learners’ powers to perceive of

new relations: thus creating models, systems and structures. Interdisciplinary knowledge structures are viewed by Repko (2007) as modes of knowledge integration which suggest that knowledge production should not be compartmentalised into distinct subjects but be recognised as an interdependent whole. In this view, relativism is emphasised. Gibson (1994) and Gravette and Geysler (2004) refer to the concept of interdisciplinary knowledge as mode 1 knowledge integration. The trend to heterogeneity in generating epistemic structures was contested in Gibbons,(1994), Kutti, (2007) and Repko, (2007)and challenged for promoting narrow judgments between warranted and unwarranted knowledge.

Minkler and Wellerstein, (2008) and Wemsen, (2008) show the shift from mode 1 (heterogeneous disciplines or taxonomies of disciplines) to mode 2, (amalgamation of disciplines).

An interdisciplinary curriculum is defined as an organization which cuts across subject matter lines/parameters to focus upon comprehensive life problems or broad-based areas of study that bring together various segments of a curriculum into meaningful association. Integration of knowledge has certain characteristics, described by Palmer (1991:59) as follows:

Developing cross-curriculum sub-objectives within a given curriculum guide

Developing models and lessons that include cross-curricular activities and assessment

Curriculum integration views education as a process for developing abilities required by life in the twenty-first century rather than as discrete, departmentalized subject matter. All of the definitions of integrated curriculum or interdisciplinary curriculum entail the following approaches (Lipson *et al.*, 1993:252).

A combination of subjects; an emphasis on projects, sources that go beyond prescribed textbooks; thematic teaching and learning; experiential education, connection between concepts; connected patterns aimed at presenting meaningful knowledge. Integration avoids the fragmented and irrelevant acquisition of isolated facts and therefore encourages transformation of knowledge into personally useful tools for learning new information; developing enrichment or enhancement activities with a cross-curricular focus including suggestions for cross-curricular “contacts” following each objective; developing assessment activities that are cross-curricular in nature and including sample planning wheels in all curriculum guides.

Kutti (2007) refers to ‘intra-disciplinary’ activities of this kind as mode 2 knowledge production which emphasises production of knowledge and distributes knowledge in the form of application, or in a context of application: knowledge production cannot be detached from its arena of application because knowledge is socially accountable in application. Knowledge production in mode 2 comprises, according to Kutti (2007: 4): ‘Application of knowledge brings in a number of varied intellectual and other interests, such as social, political or economic ones, and it depends on situations in which these interests will be considered legitimate’.

Gibbons (1994) agrees; stressing that research should be focused on the social, economic and political needs of a society. Gibson challenges universities to adopt socially accountable discourse in research for knowledge production. Literature reveals that mode 3 of knowledge production called Multi-disciplinary knowledge has dominated educational research. Mode 3 contests the relevance of mode 1 and mode 2 knowledge production.

2.8.2 ‘Multi-disciplinary’ knowledge as a mode of knowledge integration

Researchers (Gravette and Geysler, 2004; Nkomo, 1997 and Brunet *et al.* 2014) hold that there is an emerging trend in knowledge integration which contests intra-disciplinary and inter-disciplinary approaches to knowledge integration in favour of mode 3 knowledge production: a broader mode called multi-disciplinary knowledge production. Scholars such as Jansen and Christie (1998) recommend multi-disciplinary knowledge integration in the curriculum for teacher education and training because it allows for hybridisation of knowledge. The rationale for this recommendation is that teaching is a multifaceted career; therefore a broader knowledge base is required for acquiring competencies and expertise of teaching across disciplines or subject-specific forms of knowledge. These researchers allude to the need for competences that enable teachers to manipulate knowledge from related subject matter content knowledge that enhances pedagogical content knowledge. The proposed multi-disciplinary approach to knowledge integration is recommended to fulfil this need.

Researchers into the multi-disciplinary approach in the field of Life Sciences recommend that, in order for academics in universities to implement a multi-disciplinary, integrated approach, they need to: first accept the reality that knowledge is an outcome of a range of theoretical perspectives and practical methodologies mobilized to solve problems; and second that academics should be mindful of the fact that knowledge production through research can no longer be characterised as an ‘objective’ investigation of the natural world and in the process ignore the context of application (Berkes, 2008; Higgs, 2003 and Golding, 2009 and Brunet *et al.*, 2014).

Academics have their own perspectives and models of curriculum required for producing a specific curriculum that supports integration of knowledge in Life Sciences including adequate content knowledge for transformation in the teaching and learning of Life Sciences as guided by principles of knowledge integration without prescriptions. This argument upholds the view that *carte blanche* academics in the field of teacher education and training are key role players in the process of improving the quality of teachers: that they should be given the upper hand in curriculum theory and research about teacher education and training curriculum (as informed by policy guidelines) without being dictated to by politicians or any other body that wishes to impose its ideals (which may or may not be supported by good scholarly engagement). This study does not endorse this for academics.

The concept of knowledge integration underlies the conceptualization of knowledge integration in this study and is in agreement with modes 2 and 3 of knowledge production. In the context of curriculum change and continuities in South Africa, researchers highlight that Gibbons' conceptions of knowledge integration influence curriculum research for teacher education as well as basic education. Such modes of knowledge integration, according to Nkomo (1997), influence trends of thought about curriculum content for Outcomes Based (OBE) Education in South Africa. Gravette and Geysler (2004) conclude that curricula for teacher education and training have to adapt to the trend introduced by OBE: by integrating heterogeneous disciplines into broad fields. The shift from subject-oriented school curricula to a curriculum guided by Learning Areas in the General Education and Training band of the National Qualification Framework has implications for universities which offer teacher education and training (Jansen and Christie, 1999 and Jansen, 2002). The assumed stance on teacher training and development has to be viewed differently as teachers produced under the new dispensation have to be capable

of handling a changed school curriculum. Change in the teacher training programmes has to take into consideration changes that have been introduced in the school curriculum; especially the principle of multi-disciplinary integration of knowledge in the curriculum of specific learning areas.

2.9 Approaches to integration of knowledge.

Proponents of knowledge integration theory advocate a shift: away from disconnected and fragmented subject or disciplinary knowledge, and towards broad fields of knowledge (Slattery, 2010, Apple, 2004; Gravette and Geysler, 2004 and Fullan, 2006). This theoretical trend contests the generation of knowledge independent of its social, historical, economic and political contexts: the sort of abstraction which is still pursued by academics and researchers at some universities. Theorists who propound the broad field pedagogical model argue that world problems and real-life challenges cannot be addressed by disconnected knowledge (Nowotny *et al.*, 2003, Berkes, 2008 and Gibbons *et al.*, 1994; Golding, 2009; Kutti, 2007).

According to Gibbons *et al.*, (1994), the shift from disconnected disciplines to one broad field of study, Life Sciences, enables students to transfer knowledge and skills in the process of learning because of the wider scope of exploration without limitations of disciplinary boundaries. Pioneers of a multi-disciplinary approach in South Africa describe clustering of subjects into Learning Areas and the principles of knowledge integration underpinning what was known as the Outcomes Based Education (OBE) curriculum model, now adapted to form CAPS, as curriculum

reform (or curriculum for 21st century) for a democratic society in South Africa (Nkomo, 1998 and NQF, 1997, Department of Education and Training, 1997, and Gravette and Geysler, 2004).

Golding (2009) claims that individuals adopting inter-disciplinary approaches to knowledge acquisition are able to present complex challenges to students which emanate from the complexity and rich interconnectedness that comes from working across what were distinct multiple disciplinary ways of knowing. Problems that seemed insurmountable to students when knowledge was dispensed according to the previous norms (of teaching disciplines in separate 'silos') became manageable in interdisciplinary modes. In as much as this approach is seen to be challenging to teach, it is necessary if policy stipulations are to be put in place. Individuals gain both ontological and epistemological access to critical knowledge from different disciplines without reducing content. The benefit of this approach is its ability to promote linkages of knowledge across disciplines in thematic thinking, teaching and learning.

Researchers into educational curriculum studies (Bybee, 2010, Drake, 2012, Dede, 2008, Windschit, 2009 and Stewart, 2010) recommend a radical shift; away from teaching separated subjects in 'silos' in the school curriculum. The trend for integrating disciplines into broad fields of study emanates from proponents of integrated approaches to teaching and learning of knowledge which is underpinned by an appreciation of the rapidity of social, political and economic change in the modern world; changes which demand *inter alia* scientific innovations and advancement in knowledge based on inquiry and research. Windschit (2009) argues that Science Education should equip learners with skills such as critical thinking, problem-solving and knowledge-construction informed by scientific research. Pioneers of 21st century curricular design such as Terwel and Walker (2003) emphasize that, for science learners to cope with the pressures of rapid technological changes and pressures of economic competitiveness, science

education must focus on fostering deep content knowledge through active intellectual engagement and emulation of interdisciplinary practices. Drake (2012) contends that the 21st century is the age of relevance, social immediacy, and media interconnectedness and communal accountability: pedagogies and standards of knowledge have to ensure that Life Sciences learners are exposed to global perspectives through inter-disciplinary, intra-disciplinary and multi-disciplinary teaching and learning. In this view the conceptual realm of Life Sciences should be constructed from integrated disciplines in the field of Life Sciences that pertain to the biosphere, hydrosphere and stratosphere.

2.9.1 Inter-disciplinary Curriculum Model.

Inter-disciplinary studies are organised into comprehensive inter-disciplinary or multi-disciplinary unit plans that focus on a specific topic, theme or problem. Studies are explored by using the skills and techniques (ways of knowing) associated with any academic disciplines that inform the topic, theme or problem under investigation; equal emphasis is placed upon mastery of content (concepts, facts, generalisations, and principles); and finally, accommodates student diversity by providing different ways of investigating and reporting.

Golding (2009) encourages curriculum developers and designers to engage in inter-disciplinary translation and synthesis of knowledge to develop more complete and comprehensive images that are more useful than those focused on a single discipline. A central challenge for Life Sciences teacher educators is to engage in educating pre-service teachers through both disciplinary and inter-disciplinary expertise. This combination creates depth in content

knowledge across related disciplines but forms a single discipline or field of study; Life Sciences in this case. Golding (2009) claims that inter-disciplinary education should educate individuals to excel in all disciplines; contributing to multi-disciplinary approaches. Inter-disciplinary education must go deep in disciplinary knowledge acquisition through relevant teaching and learning strategies, (Killen, 2015), so that students can learn to respond to challenges that transcend disciplines within a confluence of multiple disciplines. The advantage of this larger pedagogical perspective is that it allows for development of research trajectories that do not conform to standard (constrictive) disciplinary paths (Golding, 2009:2).

An inter-disciplinary approach to curriculum design and development draws upon content from particular disciplines that are ordinarily taught separately. An inter-disciplinary curriculum maintains work on a specific topic or theme but within a discipline-specific field of study which accommodates extra-discipline-specific strategies for solving a set problem. Multi-disciplinary instruction makes use of two or more disciplines when exploring a specific topic or theme; while it maintains a somewhat greater focus on the individual disciplines involved in a study. This approach in a way maintains the uniqueness of the particular discipline while drawing on conceptual knowledge gained across specific themes or subjects. Multi-disciplinary instruction remains subject-oriented while allowing choice of content relevant to the problem set in a particular discipline. Information from different disciplines involved in solving a problem is combined and reported at the conclusion of such a multi-disciplinary study (Grossman, 2005: 73).

Inter-disciplinary instruction accommodates the strength of student diversity and learning preferences; offering many more opportunities for differentiation of instruction. Such differentiation of instruction entails: the content that is taught and how students are given

opportunities to develop it; how to process the information given the means to enable students to complete their cumulative products; how the learning environment is adapted to facilitate different ways of giving students access to information (as students differ in their learning styles); and the different variables that enable students to reach understanding in different ways (Hoadley, 2004 and Grossman, 2005).

A review of relevant literature shows that integration or amalgamation of knowledge profoundly influences emerging trends in knowledge production globally (Gibbons *et al.*, 1994; Department of Education and Training, 1997). Inter-disciplinary approaches concern learning concepts that relate to other disciplines clustered into a single theme.

Golding (2009) claims that, while depth is needed in the integration of disciplines, students must be able to form connections between related themes within related disciplines. Linn *et al.* (2006) comments that amalgamation of certain disciplines (biological sciences, human, animal and plant anatomy, physiology, paleontological studies, biomedical studies and ecological studies) resulted in the broadfield of study called Life Sciences: a mode 2 knowledge category of knowledge production.

2.10 Contesting Perspectives of Philosophical Foundations, Paradigms and Images of Curriculum Research Design and Development.

Literature indicates that curriculum research and adaptation of curriculum design are undertaken by the National Department of Education. This process is directed by the needs of the society and that of the learner for whom the curriculum is designed. The goals and purpose of the

curriculum are formulated by curriculum policy-makers and disseminated to educational institutions. Philosophical foundations of the curriculum form part of decisions taken at national level and are encapsulated in the curriculum policy which serves as guideline. In the case of Higher Learning in South Africa, it is the prerogative of the Department of Higher Education and Training to formulate curriculum policy for teacher education and training. The attributes of the envisaged teacher are articulated at this national level. Educational institutions are expected to work within the parameters of the Department's policy in order for the qualifications to receive full accreditation. Literature shows that at institutional level those involved in the process of developing the curriculum do generally [but not in all cases] adopt models of curriculum development which are suitable for attaining the purpose and the goals stipulated in the national curriculum policy or guidelines (Carl, 2015, Schubert, 1986, , 2014 and Kelly, 2014).

Literature reveals that there are various models that curriculum developers could adopt and that these models are underpinned by certain philosophical beliefs. This implies that curriculum is not a neutral product: articulations and decisions about what curriculum should entail are, by necessity, inherent in the political/social/economic views and beliefs of curriculum developers who uphold certain cultural and social prejudices. According to Grundy (1994), curriculum developers first work out the image of the envisaged educational framework that determines the purpose and the objectives of the entire curriculum.

2.10.1A Conventional Perspective, or Traditional Intellectual Approach: an Empirical-analytic Paradigm for curriculum research and theory.

Literature demonstrates that curriculum research for educational and broadly national transformation and social upliftment (Pinar, 2009 Carl, 2014 and Schubert, 1986), is hampered somewhat by resistant, old-guard views. Philosophical foundations of curriculum, according to

researchers, are classified into categories: the conventional, progressive and liberating philosophies (Ornstein and Hunkins, 2014, Grundy 1994, Themane, 2011, Cornbleth, 1990). Literature shows that curriculum research that is influenced by conventional philosophical tenets such as perennial philosophy emphasises a top-down approach. Proponents of this philosophy in curriculum research hold the view that only academics and experts should be involved in decision-making about what a society's social, economic and political needs are: such experts play a dominant role in curriculum design and development (Schubert, 1986, Ornstein and Hunkins, 2014, Kelly, 2009 and Carl, 2010). In the same vein, McNeil (1990) refers to the conceptual understanding of curriculum underpinned by this philosophical belief as an 'academic approach'. This academic approach in McNeil's interpretation of curriculum is the prerogative of representatives of an elite culture; those involved in scientific processes of producing knowledge required by a society. Schubert (1986) argues that the tendency to organise knowledge into distinct and specific structures is identical with 'intellectual traditionalist views and they depict the perennial philosophical beliefs in curriculum research'. Researchers who concur with these perennial philosophical views support the intellectual traditionalist and academic ideas about the aim of education: to develop the mind and to acquaint individual with great ideas through subject content knowledge (Ornstein and Hunkins, 2014, Carl, 2014, Pinar, 2012, Slattery *et al.*, 2014 and Kelly, 2009).

Literature indicates that the views of the perennialist philosophy had a dominant influence upon curriculum theories and research before the new trend of thought called progressivism emerged to challenge the *status quo* (Ornstein and Hunkins, 2014, Kelly, 2009). Literature indicates that an image frequently associated with a typical perennialist curriculum is that of the curriculum seen as, or referred to as, a product. According to Grundy (1994) such a product-curriculum is

designed by experts at national level: the purpose, goals and objectives are formulated by bureaucrats of a National Department of Education. The design and development model is decided upon by the highest structures that develop policy guidelines for curriculum content in each subject. Schubert (1986) argues that the conceptual framework or paradigm underpinning perennial and intellectually traditionalist curriculum inquiry pursues rationality in subject content knowledge through empirical-analytic methods. This is a paradigm within which articulation of purpose, selection of content and curriculum evaluation are located. Schubert (1986: 181) elaborates on an empirical analytic paradigm as:

... positing principles of control and certainty. It operates in the interests of law-like propositions that are empirically testable and assumes knowledge to be value free. Knowledge is assumed to be objectified and accepts knowledge or social reality as is unquestioningly.

Researchers affirm that conceptual-analytic paradigms emphasise a linear approach to policy formulation, curriculum design and development and evaluation (Grundy, 1994, Pinar 2009 and Kelly, 2011). The implication of the linear approach is the control of curriculum design and development by those who hold positions in bureaucratic structures. Schubert (1986) points out that researchers who operate within this paradigm, advocate a curriculum that serves a technical interest; meaning that all that tends to be knowledge should be hypothetically tested and studied empirically. Kelly (2011) affirms that a curriculum that pursues technical interests, promotes acquisition of algorithms that underpin knowledge production in a particular subject or discipline. McNeil (1990) contends that, since this view dominates the academic mode of curriculum design and development, the researchers' intention is to promote distinctiveness in discipline or subject content knowledge. This implies that each subject has its own distinct

technical approach to knowledge production and is controlled by experts in the field (DHET, 2011, Pinar, 2014 and Kelly, 2009).

Curriculum design and development depicts a particular pattern because of the theoretical knowledge that underlies it. Schubert (1986: 132) cites Beauchamp (1968: 13) to describe the theory as:

A set of interrelated constructs or concepts, definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting the phenomena.

According to researchers in curriculum theory, a curriculum could be developed and designed according to specifications of three broad curriculum theories: descriptive, prescriptive and critical theory (Kelly, 2009, 2011 and Ornstein and Hunkins, 2014). In respect of the perennial curriculum and a curriculum that pursues technical interest, design and development, models are more inclined to specifications of descriptive theory (Pinar, 2014 and Grundy, 1994). Key features in descriptive theory that are aligned with perennial curriculum and a technical interest curriculum are: principles are value-laden; they use models that control and direct behaviour and users are unable to see beyond the fetters of narrowly positivistic epistemological, axiological, metaphysical and political bias. Last, empirical-analytic methods are critical in curriculum models (Schubert, 1986: 132).

2.10.2 A Progressive Perspective: Social Behaviorists Approaches: a Hermeneutic Paradigms for curriculum research and theory.

Research studies conducted internationally show that perennial philosophical priorities still wield a dominant influence over much curriculum inquiry and research, models of curriculum design and development. This dominance, however, is challenged by progressivist philosophy (Grundy, 1994, Pinar *et al.*, 1995 and , 2011). Critics of Perennialism in curriculum research challenge the notion of absolutism and universality of knowledge as truth. The other critical issue criticized by the progressive researcher is the idea of imposing factual knowledge upon learners under the assumption that only experts can produce and organize subject content knowledge. According to Schubert (1986), the hermeneutic approach to curriculum inquiry or research was advocated by researchers who considered curriculum to be a process of making meaning: interpretation was the means to attain objectives. Curriculum paradigms adopted by progressive researchers pioneered the view of a curriculum that pursues acquisition of cognitive skills through social interaction: all are learners and all participate in crafting unique and commonly-held versions of subject content knowledge (Slattery, 2005, Pinar et al., 1995, Pinar 2012 and Grundy, 1994). Grundy (1994: 69) reports that hermeneutic paradigms [used in the conceptualisation of the models of curriculum design and development] focus on attaining ‘practical cognitive interest’ through acquisition of skills. The tenets of a hermeneutic curriculum are: how practitioners make meaning and interpret curriculum blueprints. These frameworks in curriculum development affect implementation; curriculum text is translated into action: practitioners and students engage their own judgement, learners are active participants and learning, not teaching, becomes the central concern. Schubert (1986) and Carl (2005 and 2014) note that a hermeneutic paradigm advocates and emphasises social interaction as the chief mode of rationality for knowledge production; rather than an empirical analytic mode. Schubert (1986) and Kelly (2009) posit that the process known as ‘inter-subjectivity’ takes place between and among persons; enabling

individuals to interpret historical events, cultural, political, social and economic issues. According to Schubert (1986: 181), the following are the key issues proposed by such a curriculum, which:

Emphasises understanding and communicative interactions

Sees human beings as active creators of knowledge

Looks for assumptions and meanings beneath the texture of everyday life

Views reality as inter-subjective: constituted and shared within a historical, political and social context

Focuses sensitively to meaning through use of language

A theoretical background informs a progressive curriculum: a practical interest curriculum is identical with prescriptive theory. According to Grundy (1994) and Ornstein and Hunkins (2014), prescriptive curriculum theory seeks to clarify and defend principles upon which advocacy rests. Similarly, (2014) and Kelly (2009) confirm that a curriculum founded on principles of prescriptive theory should organise and set its activities in accordance with norms and guidelines prescribed; in order to attain its purpose. Schubert (1986: 132) affirms that: it is the theory in which principles, stating what ought to be done in a range of practical activities, are formulated and justified. However, some critics condemn this theory for its tendency to restrict freedom in its approaches to teaching and learning. According to this theory, policy-makers advocate, and researchers and theorists have the task of discovering, true knowledge.

2.10.3 Revolutionary Perspective; a Critical Paradigm for Curriculum Design and Development, and Critical Curriculum Theory.

Literature reveals that analysis of curriculum policy by scholars brings with it analytic, interpretive, normative and critical perspectives (Ornstein and Hunkins, 2014 and Pinar *et al.*, 2014). Analysis of curriculum policy enables researchers to guide academic and professional instruction in the foundation of educational studies, education and educational policy studies (Pinar, 2009 and Apple, 2004). Discussions of normative and interpretive paradigms above account for development of critical paradigms in curriculum research and critical curriculum theory. According to Grundy (1994), Pinar and Slattery (2004), critical paradigms emanate chiefly from the emancipation and liberation ideas pioneered by Paulo Freire in his *Pedagogy of the Oppressed*. Apple (2004) points out that emancipation theory contests the views pursued in normative and interpretive curricula, which promote oppression and bureaucracy in societies. According to Pinar (2014), critical theory creates a revolutionary perspective in learners by inspiring liberating ideas such as critical thinking, problem-solving and debate. Similarly, Grundy (1994) argues that critical theory and its praxis curriculum promote a shift from an empirical-analytic approach to epistemological, axiological and political realities, critical inquiry and a more interactive approach. Researchers working within this curriculum paradigm dispute the perception of elite culture and knowledge production as a monopoly belonging to academics and experts (Pinar, 2014 and Apple, 2004). The researcher in this mode promotes the view that curriculum design and development have to be created to assist learners to produce knowledge systems that relate to their everyday lives and experiences through interactions, debates, discussion: to find solutions to social, political and economic challenges. The recommended

approaches to learning are inquiry learning, co-operative learning, problem-based learning and research (Grundy, 1994, Schubert, 1986, Slattery, 2006, McNeil, 1990 and Apple, 2004). According to Pinar (2004), critical theory upholds interdependence between humans and nature which becomes the point of departure in knowledge production. This school of thought holds that nature is interrelated and interdependent, holistic, dynamic, ecologically driven and that humans are an integral part of nature. Humans, in this view, should not be treated as outsiders or passive spectators of their environment: man and nature are inseparable (Shubert, 1986, Pinar *et al.*, 2014).

Literature indicates that a critical paradigm in curriculum research, design and development emphasises emancipation above technical and practical concerns. Emancipation and liberty in educational practice refer to cognitive growth and freedom to explore; using a variety of lenses to understand realities of life and the nature of things in the environment. To scholars in this paradigm, emancipation and liberty to explore and pursue issues of interest lead to the production of enabling knowledge which enriches and awakens the process of learning (Kelly, 2009 and Pinar *et al.*, 2014).

2.11 Overview of Models that influence Curriculum Design and Development.

Curriculum research proposes various models for curriculum design as well as its development. Theories and perspectives in curriculum research discussed in the above paragraphs highlight contestations in the field of curriculum studies which have led to development of models that are perceived to be adequate for the adaptation of such principles and views. Carl (2015:69) describes what a curriculum design process entails: curriculum design as a phase within curriculum development relates both to the creation of the new curriculum and to the re-planning of the existing one after a more complete evaluation has been made. This is a stage of decision-making on issues pertaining to criteria for curriculum development, procedures for curriculum development, educational and teaching objectives, child knowledge, subject-content knowledge, teaching strategies and assessment procedures. Carl (*ibid.* 67) avers that curriculum design requires representation of various stakeholders: curriculum experts, subject specialists, subject didacticians, educational psychologists as well as those practising teaching. Du Toit (2013) demonstrates that the process of curriculum design and development for minimum teacher education qualification (MRTEQ) should involve all parties or stakeholders: because their interests and inputs are critical in the training of teachers for curriculum change in South Africa.

According to Schubert (1986) and Carl (2005 and 2014), the model of curriculum design and curriculum development which influenced research in this field was a linear trend introduced by Ralph Tyler. The model is called the Tyler Model. Researchers posit that Tyler Models work out from a perennial paradigm or conceptual framework and depict principles suggested by an empirical-analytic approach and prescriptive theory in curriculum design and development (Pinar, 2014 and Pinar *et al.*, 2014). Schubert (1986) and Grundy (1994) assert that Tyler

introduced four central issues in the process of designing curriculum: purposes, learning experiences, organisation and evaluation. Researchers state that in this model, academics are recognised as experts in decision-making processes on matters related to the purpose, organisation and selection of subject-content knowledge, teaching strategies, learning styles and assessment procedures. Practitioners within this model do not have the luxury of participating in deliberations.

2.11.1 Tyler Model of curriculum design and curriculum development.



Figure: 1 adopted from Carl 2005: 74 illustrating Tyler’s conceptualisation of a curriculum design.

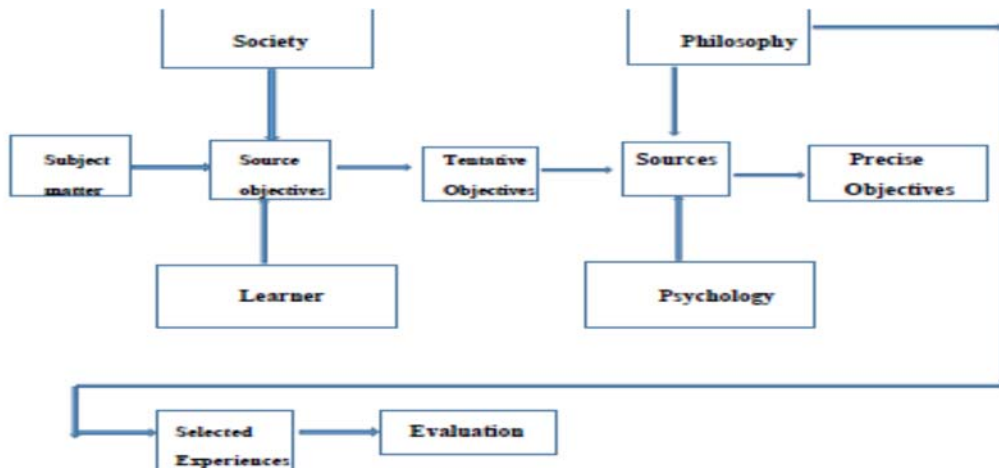


Figure: 2 illustrating the steps in curriculum development in a Tyler Model adopted from Ornstein and Hunkins, 1998.

According to Ornstein and Hunkins (2014), the above diagrams illustrate or summarize Ralph Tyler's configuration of steps in the processes of curriculum design and curriculum development. These researchers refer to this model as a technical–scientific model which dominated trends of thought about curriculum design and development for some time. Researchers into curriculum design and development, such as Carl (2014), Schubert (1986) and Kelly (2014), view the Tyler Model as the most-used model for conceptualizing curriculum design and development. The linear development of a curriculum advocated in Tyler Models begins with identification of learning aims and objectives. In this model, aims and objectives are formulated after the data has been gathered from subject matter, the learners and the society. Analysis of objectives should reveal the philosophy of the institution concerned and the psychology of learning used there. Instructional objectives are created from these broad educational aims and learning objectives (Ornstein and Hunkins, 2014, Kelly 2009 and, 2011). The next step involves selection of learning experiences or subject content knowledge: this stage in Kelly (2009) entails consideration of learners' perceptions and previous experiences; most importantly alignment between content knowledge and human development. According to Schubert (1986), this model is driven by behaviourist psychology: it emphasizes sequencing and organisation of learning experiences. Formulation of learning objectives in this model enshrines ideas, values and skills that are woven through the curriculum subject content. Last, is the issue of evaluation of plans and actions which entails monitoring implementation of curriculum models and its efficacy in attaining pre-determined aims and learning objectives (Ornstein and Hunkins, 2014, Pinar *et al.*, 2012 and Pinar, 2014).

Literature notes that researchers who subscribe to the Tyler Model uphold a top-down approach in curriculum designing and development. Grundy (1994) and Cornbleth (1990), aver that top-down approaches emphasise decision-making processes regarding curriculum policy, models of curriculum design and development, paradigms of knowledge organization and selection which rest solely with experts and academics. This approach tends to promote a culture of elitism and reproduction of the *status quo* in an authoritarian society. Learners depend on critical lenses of curriculum developers to understand social, economic and political landscapes (Pinar, 2012, Apple, 2004, Pinar *et al.*, 2014 and Slattery, 2006). Carl (2014) contends that a top-down approach creates a culture of subordination because practitioners are alienated from the process and as a result become recipients of documents to be implemented in classrooms and lecture halls. Disregard of stakeholder interest in the process of design and development is perceived by researchers such as Fullan (2006) to be flawed and the root cause for challenges facing implementation of a liberal curriculum in classrooms and lecture halls.

2.11.2 The Taba Model of curriculum design and development.

Researchers indicate that the Taba Model, unlike Tyler's model, is informed by contemporary philosophies and theories of curriculum research (Ornstein and Hunkins, 2014, McNeil, 1990, Pinar *et al.*, 2014 and Apple 2004). According to Carl (2014), the Taba Model is sometimes called a 'grassroots rationale' because it introduces a new paradigm for design and development of curriculum; allowing practitioners to participate in these processes. Ornstein and Hunkins, 2014: 186) describe the intentions of Taba Model and its tenets in practice. Taba believes that curriculum should be designed by its users. Teachers should begin by creating specific teaching-

learning units for their students and then build them up to a general design. Taba advocates an inductive approach rather than the more traditional deductive approach of starting with a general design and working down towards specifics. According to Schubert (1986) and Kelly (2009), Taba Model identifies seven major steps to be considered in the process of curriculum design and development which are summarized as follows in Ornstein and Hunkins (2014:186):

Diagnosis of needs: The teacher (curriculum designer) identifies the needs of the students for whom the curriculum is being planned. *Formulation of objectives:* The teacher specifies objectives. *Selection of content:* The objectives suggest the curriculum content. The objectives and content should match. The validity and significance of content are determined. *Organisation of the content:* A teacher organises the content into a sequence; taking into account learner maturity, academic achievement and interests. *Selection of learning experience:* The teacher selects instructional methods that engage students with the content. *Organization of learning activities:* The teacher organises learning activities into a sequence: often determined by the content. The teacher must bear in mind what kind of students are to be taught. Last, *evaluation and means of evaluation:* The curriculum planner determines which objectives have been achieved. Students and teachers must consider evaluation procedures.

McNeil (1991) affirms that the Taba Model is in keeping with the views of researchers who support a down-top approach. Preedy (1989) describes a down-top approach as a de-centralized approach to curriculum design and curriculum development. It emphasises wide consultations between stakeholders and teachers, school managers and parents for the purpose of gathering information. A broad base of views, opinions and perceptions helps to articulate the purpose, goals, aims and learning objectives of such a socially accountable curriculum: transformation of

society. According to Preedy (*ibid.*), this approach is particularly suitable for the kind of curriculum change and social re-construction needed in South Africa.

Proponents of the 'down-top' approach strive to broaden the process of curriculum design and development to include other sectors of communities (Carl, 2010, Preedy, 1994, Apple, 2004, Kelly 2010, Conbleth, 1990 and Slattery *et al.*, 2013). This approach propagates the consultation process to include as many opinions and views of those members of the community who are involved in the process of curriculum development. Research into curriculum design and development shows that there are contesting perspectives: concerning conceptualization of curriculum design, development, dissemination and adaptation (RDDA). Researchers into curriculum design advocate that this process entails consultation and open discussion with all stakeholders: members of the public, government departmental officials or other relevant members of the public sector, business sector, students, or interest groups (Du Toit, 2013; Klein, 1992; Carl, 2010; Smith and Ewing, 2002 and Grossman *et al.*, 2005).

Curriculum policy guidelines stipulate that students as stakeholders should engage in knowledge construction in order to devise new theories and develop the ability to engage critically in replacing or changing what has often been accepted and perpetuated without question (education in an overtly totalitarian SA 1948-1994). Novice teachers are expected to perform activities that motivate them to think like scientists (operating in the realm of descriptive theorist). The attributes of a competent teacher intended to be produced by the espoused new curriculum include the ability to engage learners in the formulation of a problem for investigation and to select appropriate scientific methods of inquiry into a given phenomenon.

2.11.3 Bruner's Spiral Curriculum Model

Literature shows that Bruner's ideas concur with the behaviourist notion of alignment of knowledge with human development; however, the focus of his model falls on disciplinary structure (Pinar *et al.*, 2014). Researchers who analyse Bruner's convictions about curriculum design agree that Bruner's model advocates vertical articulation of disciplinary knowledge. Ornstein and Hunkins (2014) posit that designing curriculum in Bruner's model should first reflect the base structure of the field of knowledge to provide students with fundamental understanding of the field. According to Pinar (2012), this model should be adopted and implemented only under the guidance of the ablest scholars and experts in a discipline: with teachers and students merely participating in the process of curriculum design and development. Researchers assert that this model acknowledges that curriculum reflects the nature of knowledge and the nature of the knower (student) and the process of knowledge acquisition in the learning process. Pinar *et al.* (2014) and Ornstein and Hunkins (2014) explain that Bruner's model is underpinned by the conviction that understanding a discipline's structure enables a student to understand how a discipline works: how it solves its problems, what conceptual and methodological tools it employs to solve those problems and what constitutes knowledge in the discipline. This model derives its name from the perception pioneered by Bruner that meaningful learning begins with assimilation of ideas (the structural characteristics of the discipline) which facilitates understanding (or apperceptive mass) which enables students to acquire sophisticated knowledge later in engagement in the discipline. Researchers claim that Bruner's 'spiral curriculum model' dominated the field of curriculum research in many countries and its influence has been significant. More importantly, its impact has been large in designing and

developing curricula at institutions of higher learning (Pinar *et al.*, 2014, Pinar 2012, , 2011, McNeil, 1990 and Kelly, 2009).

2.12 Contesting Approaches to curriculum programming.

Literature reveals that curriculum research in the 21st century explores paradigms suitable for re-conceptualisation of curriculum design and development. Researchers such as Spady (1990) and Killen (2005, 2010 and 2015) influence curriculum research in their advocacy of Outcomes Based Education. This is considered by Spady (1990), Sato (2003) and Higgs (2003) to be part of meliorism in curriculum research. Outcomes based education, according to Carl (2015), is classified into three categories: transmission, transactional and transformational outcomes based education. Killen (2005) avers that the model of Outcomes based education adopted to introduce curriculum changes is chiefly transformational. Institutions of higher learning were to introduce outcomes driven curriculum into their qualification programmes (Gravette and Geysler, 2004). Nkomo (1997) and Soudien (2010) point out those institutions of higher learning ought to shift from narrow and outdated conceptualisations of knowledge and move into broader fields of study in order to align epistemological research with integrated knowledge and learning. Outcomes-based curriculum programming in South Africa encapsulates a new paradigm for knowledge organisation and integrated learning.

2.12.1 Critical Analysis of Outcomes Based Curriculum and its Philosophical Foundations.

Researchers into Outcome Based Education, Sampa (2015), Copleston (2003), Kemerling (2011), Spady (1994), Killen (2000) and Spady and Marshall (1991) posit that a philosophy of OBE refers to an embodied and expressed set of beliefs and assumptions about learning, teaching and the systemic structures within which these activities take place. These researchers explain that early Greek philosophers (the Peripatetics) saw themselves as itinerant teachers whose basic concern was the love of wisdom (philo-sophia); a praxis which gave rise to the philosophical lexicon cherished today in philosophical discourse. Copleston (2003:287) posits the argument about the philosophical foundation of OBE around Aristotle's view concerning knowledge and man which emphasises that it is the nature of man to desire knowledge. Aristotle places the man who seeks knowledge for its own sake above him who seeks for knowledge of some particular kind with a view to the attainment of some practical effect (*op.cit.*287).

According to Copleston, (*ibid.*) and Higgs (2003), the philosophy of Outcomes education revolves around the concept of knowledge. This argument explicates philosophical foundations of Outcomes-Based Education through a careful revisiting of philosophical concepts associated with knowledge: as reality (ontology), its theory (epistemology), its dissemination (pedagogy) and its context (consciousness) which, when taken together, provide the basic principles for practical application. Copleston (2003: 287) concludes that such principles can provide coherence to a wide array of outcomes-based education models and practices and lay a foundation for successful implementation. Sampa (2014) challenges the assertion that OBE has no philosophical and theoretical foundations. The argument advocated by the findings of this

research is that the term 'philosophy' is sometimes used too loosely and inappropriately by some researchers who associate it with dogmatic expressions: whereas philosophy means that man can think and reason in pursuit of wisdom.

Literature reveals that researchers into OBE and its curriculum design and development such as Spady and Marshall (1991), Spady (1994) and Killen (2000) highlight that conceptualisation of curriculum is often informed by ideas of Constructivist theorists. The curriculum in this approach proposes that learners invent their own ideas through interaction with others and the environment. The learner selects and transforms information, constructs hypotheses, and makes decisions; the focus is on knowledge construction. Knowledge is constructed through personal experience, previous knowledge and beliefs. Learners have to be encouraged to discover principles by themselves; through varied opportunities for dialogue among their peers and with teachers. Teachers need to present information to be learned that matches or closely matches a student's current level of learning. The curriculum is to be organized in a spiral manner, so that students continually build upon what they have already learned. Teaching strategies have to be diversified to suit student responses and encourage them to analyse, interpret, and predict information in the course of their learning.

Outcomes based curriculum encapsulates constructivist approaches to knowledge, teaching and learning: Biggs (2007), Coil (2005), Noll (2013) and Rowland (2006) affirm that constructivists such as James Bruner, considered to be one of the founding fathers of constructivist theory, present a broad conceptual framework with numerous perspectives; they claim that knowledge is made, not found; and that multiple realities exist. Bruner's theoretical framework is based on the theme that learners construct new ideas or concepts based upon existing knowledge. Learning them is an active and interactive process.

A similar sentiment was expressed by Semester (2007), Kemerling (2011) and Sampa (2014) when re-iterating that Outcomes based curriculum provides a dynamic approach to understanding learning outcomes; to include both emergent outcomes and unintended outcomes that are equally beneficial to the purpose of social enlightenment and transformation. In light of the constructivist knowledge paradigm, Spady (1994) (cited in Tavner, 2005:257), makes good sense in his conceptualization of OBE as follows: the basic tenets of OBE are shifting the focus of educational activity from teaching to learning; skills to thinking; content to process; and teacher instruction to student demonstration.

Research into Outcomes-based curriculum highlights various perspectives; indicating beliefs and assumptions of researchers about epistemological, ontological and axiological principles underlying a curriculum (Sampa, 2014; Dancy, 1991; Biggs, 2007; and Bodrova and Leong, 2007). These researchers conclude that there are traces of relativism in the manner in which knowledge, reality, experiences and thoughts are explicated in the OBE curriculum. In relativist terms, all experience, thought or reality are relative to something else. This implies that all understanding is a form of interpretation using a lens of choice of some kind; such as culture, prior experience, status, gender and the like. Sampa (2014) affirms that relativistic ontology implies an existence of multiple realities, multiple answers, and multiple perspectives. OBE is defined as a process that focuses on what is to be learned: outcomes are arguably an implication of relativistic ontology (Kudlas, 1994). Spady (1994), claims that in Outcomes Based Education and its curriculum, it is more appropriate to speak of convergence or hybridization of knowledge than homogeneity or purity of reality: so that all knowledge provides no more than a limited aspect of reality or a version of it. In the context of Outcomes-based curriculum, all experience is

mediated by the knower's personal experience, psychology, political outlook, economic grouping etc.

Literature shows that Outcomes Based Education and its curriculum advocate an alternative perspective or approach to epistemology. Dancy (1991: 141) claims that OBE embraces a subjective epistemology; something which concerns itself with the creation and dissemination of knowledge. In a narrower way, epistemology deals with the study of knowledge and justified belief. Epistemology is conceived as a philosophical discipline for determining necessary and sufficient conditions, and for justifying knowledge claims and refuting scepticism. Subjective Epistemology implies that the teacher and the student co-create understanding. It is not a one-way process of transfer. Wherever the call goes up for learner-centered approaches to teaching and learning, this underlying philosophical tenet of OBE applies. The teacher has something to offer; yet knowledge in this philosophical mode is a product of encounter between teacher and students. This meeting or convergence of thought and experience justifies knowledge creation and refutation of scepticism.

In supporting the view of Subjective epistemology, Spady (1994) claims that an outcome is a culminating demonstration of learning: a demonstration of learning that occurs at the end of a learning experience. It is a result of learning which is a visible and observable; a demonstration of three elements: knowledge, combined with competence, combined with orientations (Killen, 2003: 23). This epistemic foundation for knowing things is essentially propositional knowledge which can be more or less complete, justified inferentially and, on the basis of experience, can be communicated (Dancy and Sosa, 1993:240).

Literature points out that the paradigm adopted for educational and curriculum transformation in South Africa is Outcomes based (Killen, 2005, 2010 and 2015, Carl 2014 and Chisholm, 2000). The curriculum design and model for curriculum development focuses on re-alignment between content-based [fragmented epistemological and ontological approaches] and integrated, broad field curriculum models for teacher education and training. According to Killen (2005), there are five principles for designing and developing an OBE curriculum: *clarity of focus*, outcomes are clear, observable demonstrations of student learning that occur after a significant set of learning experiences. They are not values, attitudes, feelings, beliefs, activities, assignments, goals, scores, grades, or averages, as many people believe. A well-defined outcome will have clearly defined content or concepts and be demonstrated through a well-defined process beginning with a directive or request such as 'explain', 'organize', or 'produce'. The second principle is, *high expectations*: this principle emphasizes the vertical articulation of the content to enable learners to move from simple to complex outcomes. According to Killen (2005) this entails the organisation and selection of content, context and competence in accordance with Bruner's Spiral curriculum model. The advancement in the attainment of outcomes by learners from simple to complex levels requires continuous assessment to provide evidence of advancement (Killen 2010). The third principle is *designing backwards* and *delivering forward*: this principle entails consideration of the pre-determined learning outcomes in the planning and implementation of the curriculum. This implies that outcomes should be the point of departure or starting-point for selecting teaching strategies, designing opportunities for learning, deciding on learning styles, selecting content, concepts and integration. Last, is *Learner-centred principle and expanded opportunities* which emphasise consideration of learner needs, prior knowledge, structuring of learning that is specifically to help learners achieve outcomes, a variety of methods

of instructions, use of multiple examples and explanations of key points and a positive learning environment.

Literature points out that pioneers of OBE and OBE curriculum design and development converge in explicating the concept of ‘outcomes’: they articulate that an outcome encapsulates demonstrations, or performances, and reflects three things: (1) what the student knows; (2) what the student can actually do with what he or she knows; (3) the student's confidence and motivation in carrying out the demonstration. Learning is facilitated carefully toward achievement of designated outcomes; characterized by an appropriateness to each learner's development level, and is active and experienced-based (Spady, 1991, 1993 and 1994, Killen, 2000, 2003, 2005 and 2015, Boschee&Baron1993, Biggs 2007, Rowland, 2007, Noll, 2013 and Coil (2005).

2.13 Summary

This review of relevant literature highlights important concepts that form the basis for supporting data obtained from interviews and curriculum design documents reviewed and collected from Life Sciences teacher education programmes sampled at Higher Education Institutions; to explore how Life Sciences teacher educators conceive of integration of knowledge during curriculum design and development; as charged by the MRTEQ policy document.

The concept of what comprises curriculum includes: how integration of knowledge in a multi-disciplinary subject has been explained and broadly explored; unpacking each concept involved in integration of knowledge from different disciplines that form Life Sciences disciplinary knowledge; and how each one can be packaged and presented. Information obtained from this synthesis of literature, especially Bernstein’s theory of codes and modalities in knowledge

production research was taken into consideration. Bernstein's codes in particular provide the lens necessary to detect themes from the results of the study and provide perspectives of how participants regarded integration of knowledge.

Curriculum models set the stage for presentation of data and interpretation in chapters five and six. The following theories were identified and synthesised: (i) descriptive curriculum theory, (ii) prescriptive curriculum theory and (iii) critical curriculum theory. Perspectives and philosophical foundations for curriculum design and development were: (a) conventional (b) progressive and (c) revolutionary. These perspectives have informed this study of bitterly contesting trends of thought in the realm of curriculum theory, and curriculum design and development in South Africa. This chapter discusses paradigms which inform three key perspectives of curriculum theory: (1) the empirical-analytic paradigm (2) the hermeneutic paradigm and (3) the critical paradigm. These paradigms enable the researcher to locate and identify participants' perceptions and perspectives during data analysis and interpretation. The three models of curriculum design and development which dominate research in curriculum studies are: the Tyler Model, the Taba Model and Bruner's Spiral Model. Last, are approaches to curriculum programming and epistemological theories: Outcomes based curriculum programming, Content-based curriculum programme and Competence-based curriculum programming.

Chapter 3: Theoretical Framework

3.1 Introduction

This chapter presents a synthesis of theoretical information generated from a wide range of sources during the review of literature. A theoretical framework was used to design interview questions and criteria for document analysis used in the empirical study. This chapter presents critical theoretical information generated from analysis of various perspectives and paradigms concerning curriculum theories which serve as guidelines for conceptualising designs or models of knowledge production in curriculum design and development. This theoretical framework served as a platform for presenting data, synthesis of findings of the study and formulation of recommendations.

3.2 Theories influencing the teaching and Learning of Life Sciences curriculum

The synthesis of literature indicated that the theoretical principles underpinning the conceptual pedagogical knowledge for Life Science teacher education drew from philosophical beliefs of both positivism and constructivist realists (Muller, 2000 and Luckett, 2009). Literature indicates that research on approaches of epistemic development is influenced by the notions of truthfulness, objectivity and universality in knowledge (Muller and Young, 2007). The perspective that upholds this belief about the theory of knowledge advocated approaches to pedagogy in the field of Life Sciences which promotes: self-discovery, experimentation, investigation and other deductive and inductive methods of teaching and learning, such as inquiry-based-learning and problem-based learning (Killen, 2005; 2015 and Young, 2006). The analysis of these pedagogical approaches is critical in this study for it provide the lens through which the data collected by means of interviews from Life Science educators will be analysed. Furthermore, the perspectives on the application of these pedagogical approaches in the preparation of pre-service teachers in the field of Life Science education were used as a mirror

against which the responses of the academics' in the departments of Life Science Education were analysed and conceptualised in the context of knowledge integration.

Inquiry-based /problem-based learning theories and their implications in the preparation of Life Science teachers

The proponents of this approach to pedagogy view inquiry-based learning not as the teaching method but as a design of a curriculum that is structured around phenomena for inquiry (Lockett, 2009; Killen, 2015; Kuhlthau, Maiotes and Caspari, 2007). This perspective on inquiry –based learning asserts that the following are critical: carefully structures programme of teaching and learning, well organised and managed activities with clear targeted competences and skills to be acquired, flexibility of the opportunities allowing students to explore the phenomenon and to reflect on their findings and lastly, is the authenticity and fairness of evaluation or assessment (Kuhlthau, Maiotes and Caspari, 2007: 136).

Killen (2015:298) points at inquiry based teaching and learning as of value in;

- Ensuring that students get opportunity to manipulate sources and engage in asking questions. They develop skills to identify variables and work out the connections and interrelatedness of functions of variables in the system. Students are also able to draw their own conclusions based on their individual or group observations present in specific subject content
- Encouraging students to create their own hypothesis on given content, instead of accepting conclusions from other scientists. In this instance student acquire means of knowledge production and skills of testing the truthfulness of knowledge.
- Encouraging students to strive for more than superficial understanding of conceptual knowledge. If knowledge is presented as problematic, students become sceptical about its truthfulness and they are motivated to inquire on such speculations to arrive at the truth under the guidance of the educator.
- Allowing students to synchronise in their synthesis the isolated pieces of information as they inquire for absolute and comprehensive understanding of the phenomena comprising the Life Science curriculum.

This study adapted the views of the proponents of Inquiry-based and problem based learning theories to pursue the argument of integration of knowledge. The rationale being the flexibility that inquiry and problem based curriculum provide for Life Science teachers to explore phenomena that are related or that impact organisms and their lives, for instance; issues of environmental change and climate change. Lockett (2009) in the same rhetoric indicated that through inquiry and problem-based curriculum student in the field of science education could learn across the curriculum, collaboratively and share different methods of inquiry which are used in other fields as they explore and manipulate sources and information. The use of experimentation, investigation and self-discovery learning methods are considered by Killen (2005 and 2015) as fundamental to both inquiry and to problem-based learning theories.

In the same rhetoric, Desai *et al* (2008) recommend that inquiry based learning and problem-based learning have to be the point of departure in both conceptualising and development of pre-service Life Science teachers. This view point into Life Science Education emphasises the development of the novice-researchers under the guidance of professional researchers. The programming of the curriculum, in this perspective should allow the developmental continuum of scientist-in-training from novice to proficient technicians and to knowledge producers (Desai *et al.*, 2008: 108). Researchers assert that, the skills, knowledge and expertise the Life Science undergraduates acquired through inquiry-based and problem-solving learning from the education and training in universities enables them to teach the subject effectively in classrooms (Yarden, 2009, Gengarely and Abrams, 2009).

Rhetorically, Sharma, (2017) in the same vein argues that inquiry based and problem based methods are suitable for the integrated approaches to teaching of a variety of disciplinary science subjects. This view point commends these methods for embracing the day-to-day life and knowledge which addresses a socio-economic context; rather than being fragmented chunks of information. Sharma (*ibid*: 2), posits that:

“One does not need the specialised and deep knowledge as advocated and contained in the specialised branches of science”.

The emphasis of the above is based on the premise that Life Sciences, stated as general science, can serve the purpose of knowledge links across related disciplines which can serve the purpose of learning well as science of everyday use; elementary and simple in comprehension.

Perspectives of Psychologists that influence conceptual knowledge of pedagogy in Life Science

Literature points to the traditional and progressive theories that dominated conceptions of the knowledge about subject content knowledge, the learner and instructional approaches. The conceptual knowledge of pedagogical content knowledge against which, pre-service teacher are trained draws from, three dominant theories; behaviourism, cognitive theory and constructivism.

(i) Behaviourism theories and Life Science subject pedagogical content knowledge

Literature points out that idea of behaviourism influences subject content knowledge (SCK) and their Subject Pedagogical Content knowledge (SPCK). The proponents of behaviourist theories used animals to test hypothesis about learning as the change of behaviour (Ornstein and Hunkins, 2014: 94). The principles such as classical conditioning, stimuli-response, assimilation or internalisation, law and effect underpinned theories of teaching and learning of Life Sciences. Thorndike, for instance, in Ornstein and Hunkins (2014: 95) asserted:

- (i) Behaviour was influenced by conditions of learning
- (ii) Learners attitudes and abilities could improve over time through proper stimuli
- (iii) Instructional experiences could be designed and controlled and

- (iv) It is important to select stimuli and learning experiences that are consistent and mutually reinforcing.

Researchers in educational practice associate these principles with Tyler and Taba models of linear learning which supports theory of Benjamin Bloom commonly known as Bloom's taxonomy (Carl, 2010 and Killen, 2015, Sharma, 2017). The view point of Tyler and Taba advocates that teaching is a process whereby the teachers select learning objectives which predetermines what should be learned and the strategies or methods of teaching. This perspective outline the stages of how teaching ought to be planned Carl (2010: 53)

- (i) Identifying of learning objectives

- (ii) Selecting content knowledge

- (iii) Deciding on instructional strategies

- (iv) Evaluation of the lesson against learning objectives

Blooms taxonomy in this perspective provides the parameters of learning in a form of continuum starting with knowledge, comprehension and application as the basic cognitive skills, and analysing, synthesis, evaluating and creating as high order cognitive skills (Killen, 2005; 2015).

Contesting perspectives on approaches such as constructivism and social cognitive theory condemn the behaviourist view point to teaching, learning and content for promoting passiveness of students in classrooms, crippling students' independent thinking about the subject matter, presenting discipline based content as isolated packages, confining students in tedious learning strategies which indulge them in reproducing factual content knowledge and rote learning and creating impression that knowledge of Life Science is not part of their day-to- day life (Muller,

2000; Young, 2006 and 2007, Killen, 2015, Luckett, 2009 and Sharma, 2017). Researchers point out that professional training of teachers in South African institution infused perspectives and the view point of the behaviourist into the pedagogical knowledge of the teacher education programme called Fundamental Pedagogics. Morrow (1989); Muller, (2000); Hoadley, (2000); Higgs 1993) condemned the curriculum content as well as the pedagogical approach of the Fundamental Pedagogics for instilling passive acceptance of knowledge and encouraging knowledge reproduction in Life Sciences teachers. The indulgence in content-driven methodology and reliance on the transmission of knowledge from prescribed books is what critics associated Fundamental Pedagogics pedagogical approach with on teacher education and training (Muller, 2000 and Morrow, 2001). In the context of this, critics' perspective provides the clue on background against which this study understood the reluctance of some participants' stance regarding the maintenance of the *status quo* in the curriculum content for Life Science education and training. The analysis of documents and responses to interview questions pointed to the traces of beliefs and thoughts that embraced principles of the Fundamental Pedagogics programmes.

(ii) Views of the Progressive theories and their influences on the views of pedagogical approaches to Life Science curriculum

The synthesis of sources of information pointed to the trajectories adopted by the liberal academics such as Kallaway (1990), Nkomo (1991), Morrow (1989) and Christie (1990 and 1991) to contest the conservative and traditional approaches to teacher education and training. The call for the discourse in pedagogies according to Hoadley (2000) began with the movement called 'People's education for People's power' which advocated ideas of democracy, freedom and liberty in education in South Africa. The proponents of this perspective challenge the

indoctrination of Life Sciences student teachers with conventional ideas that purpose to inculcate apartheid through the science of education called ‘fundamental pedagogics. In contrast, the liberal academics pioneered the principles of constructivism and social constructivism theories (Marrow, 2007, Muller, 2007 and Harley and Parker, 1997). These two theories have a different view point to pedagogical content knowledge for teacher education and training pioneered by fundamental pedagogics. Ornstein and Hunkins (2014: 86) state that progressive theories in education aspire to:

- Promote values of democracy, freedom and equality in education.
- The production of knowledge leading to growth, development and active participation in learning
- Promote independence of learners in the teaching and learning environment.
- Ensure that teacher educators play the facilitation role and guidance in the scientific inquiry and problem solving.
- Promote learner-centred approaches whereby learning is driven by students’ interests and focused on addressing human problems and affairs.
- Ensure that subject content knowledge is interdisciplinary allowing students to broaden their understanding of the interrelatedness of the systems in life.

The study used this conglomeration of theories to seek an understanding of the manner in which academics in the Higher Education Institutions (HEIs) dealt with divergence of viewpoints in the process of developing the institutional Life Sciences curricula. The interview questions and probing questions were crafted with the purpose of eliciting attitudes and perceptions that dominated the process of curriculum design and development and theoretical views which were prevalent in the discussions.

3.3 Brief Overview of Epistemological Approaches Influencing Curriculum Design and Development in Life Sciences

The model of ‘Knowledge Reproduction and cultural transformation’ and ‘pedagogic discourse’ described in Bernstein’s theory advocates the importance of codes as regulative principles for knowledge production in respective fields or subjects. This theory claims that the legitimacy of knowledge production in each discipline is classified according to specific codes or modalities which recognise rules and syntax of knowledge generation. This theory declares that knowledge production is driven by three forces; the labour market in society, socio-economic development and political environment. In keeping with this theory’s assertion, Levy and Murnane (2005), Stewart, 2010 and Wilmarth, 2010 reiterate the fact that a rapidly changing world and pressures of competitiveness are re-defining skills and expertise for the 21st century.

Davis (2001) and Young (2013) point out that, although Bernstein’s theory focuses on research in sociology, it has had a substantial influence upon educational research in the 21st century. According to Davis (2001), pedagogic discourse is an integral part of knowledge production. In his synthesis of pedagogic discourse, Bernstein concludes that this model has three fundamental levels: generation, re-contextualising and transmission of knowledge. In the context of this study, academics involved in teacher education and training should understand ideas of pedagogical discourse for integrated knowledge for Life Sciences. The purpose of applying Bernstein’s theory and Maton’s Legitimizing Code theory as lenses to search and analyse perceptions and perspectives of Life Sciences teacher educators, is to justify or question the legitimacy of the approaches to knowledge integration in the espoused Life Sciences curriculum, based on MRTEQ policy guidelines.

The purpose of this study is framed in a way to trace and explore how Bernstein's codes or modalities can regulate approaches to integrated knowledge production and the syntax or terminology used for a conceptual framework of integrated knowledge for teaching and learning of Life Sciences in Faculties of Education at South African universities. Pragmatic philosophies of curriculum emphasize a variety of subjects or disciplines based on a wide range of assumptions and used for many different ends (Gibson, 1994 and Biggs, 1999). Knowledge production is secured by a commitment to achieving goals such as effecting change, making a change in learners' lives and producing excellent skills and content knowledge depth in Life Sciences. DHET, (2011), states that the emerging trend in conceptualization of knowledge indicates a significant shift: away from traditional modes of knowledge production, and towards an inclusive and pragmatic mode. Kutti (2007) and Repko (2009) argue that knowledge production should be more humanistic oriented: as humans seek to find solutions to the challenges of the 21st century which is more technologically integrated than it is inclined to protect and maintain production of segregated patterns of knowledge (in silos). This societal change makes dogged adherence to traditional outlooks (pre-1994) inherently problematic. Pragmatism resonates with the notion of learner-centeredness; newer traditions and theories for organizing information and designing a curriculum for successful learning. Schubert (1997) asserts that some educationists advocate careful attention to experiences of learners or students. Researchers, Gibson (1999) and Biggs (2007), emphasise students' psychological interests and the fact that students should resolve meaningful problems by moving toward the logical; which knowledge is generated and organized by human culture.

Klein (1998) charges in his model that the qualitative dimension in curriculum design and development prioritizes the following stages in ensuring that there are no loopholes in the

process: first, is description of present practices; second, identification of decision makers or an array of relevant stakeholders; third, the rationale for decision-making. In keeping with this theory's assertion, Levy and Murnane (2005), Stewart, 2010 and Wilmarth, 2010 reiterate the fact that a rapidly changing world and pressures of competitiveness are re-defining skills and expertise needed for the 21st century.

3.4 Summary

The focus of this chapter was to discuss the ideas and views that played a pivotal role in the development of theories, models and approaches to curriculum development and particularly, to the conceptual knowledge of pedagogical approaches to Life Science Education in universities. The synthesis presented in chapter provides a platform for discussing the data collected by means of interview (Appendix, C) and data elicited from document analysis (Appendix, F). Further, the contesting perspectives established from the theories were applied as a mirror against which responses of the participants to probing questions and to research question on their perceptions and beliefs about the models of Life Sciences curriculum and their views on integrated knowledge in the Life Sciences teacher education presented in chapter five and six of this document.

Chapter 4: Research methodology and data collection procedures.

4.1 Introduction.

This chapter presents discussion of research paradigms and methods that were chosen to carry out the empirical study. The chapter outlines the procedures adopted to collect data, the research design, as well as sampling strategies. The synoptic results of the pilot study conducted at two universities are presented in this chapter under the sub-heading of validation of the research instrument.

The discussion in chapter 1 indicates that this chapter focuses on obtaining information from participants for answering the three research questions:

How do Life Sciences teacher educators regard conceptions and perspectives of knowledge integration?

Why do Life Sciences teacher educators hold such conceptions and perspectives of knowledge integration?

How do Life Sciences teacher educators view integration of disciplinary knowledge in the espoused Life Sciences curriculum for teacher education and training as stated in the policy (MRTEQ)?

The objectives of the study were a critical issue that was taken into account during the empirical research. The objectives of this study were:

- To highlight teacher educators' patterns of thought regarding integration of knowledge in Life Sciences Education.
- To identify how Life Sciences educators view the principle of integrated knowledge in the Life Sciences curriculum changes for initial teacher education and training.

The stated aim of the study was the focal point in the planning for the empirical study. The aim was:

To explore how Life Sciences teacher educators designed their curricula based on the principle of knowledge integration.

4.2 Research paradigm and Methodology.

4.2.1 Interpretive paradigm.

The problem statement, research questions and the aim of the study provided guidance into the choice of paradigm the empirical study ought to adopt for research design, sampling strategy and developing research instruments. Therefore, interpretive paradigm was adopted on the grounds that it is appropriate for qualitative research design and qualitative methods for data collection and analysis of data. Babbie and Mouton (2007) and Babbie (2002) recommend interpretive paradigm for the research that sought to apply, ethnographic studies and multiple case studies.

Henning *et al.* (2004) describe interpretive modes of knowledge production as those approaches which are suitable for seeking views, attitudes, experiences and perceptions of participants. In order to understand the phenomenon of Life Sciences curriculum design and development from the perspective of academics closely involved, the researcher engaged in interpersonal verbal

interactions with a sample of academics involved in teacher training. As part of an interpretive approach which is in keeping with Henning *et al.*(2004:20), the researcher interrogated academics and generated information from texts to extend frames of inquiry into the phenomenon.

4.2.2 Qualitative Research Method.

The qualitative research methodology chosen for this study is based on the assertions of Babbie and Mouton (2007) and Cohen *et al.* (2010) who proposed the use of qualitative inquiry methods for collecting data. The researcher took into account suggestions made by Henning *et al.* (2004), Kumar (2005) about conducting a qualitative study: appropriate strategies for selecting the sample, proper design and selection of research instruments, and explicit and clear strategies for data presentation and analysis. Interpretive guidelines proposed by researchers into qualitative paradigm enable this researcher to have a clear understanding of what research design for qualitative inquiry entails. The use of in-depth interviews, idiographic and unstructured observations are recommended as means of collecting qualitative data in interpretive methodology (Babbie, 2002, Henning *et al.*, 2004, Cohen *et al.*, 2010).

4.2.2.1 Research Design for qualitative study.

The idea of organising universities into multiple case studies in the sampling was informed by the views of Henning *et al.* (2004) on research design for qualitative studies. According to Henning *et al.* (*ibid.*: 41), multiple case studies are distinguished from other types of qualitative research in that, “they are intensive descriptions and analyses of a single unit or bounded system such as an individual, a program, event, group, intervention or community”.

This study perceives of each institution of higher learning that participated in the study as a distinct entity in terms of its historical background, contextual factors and geographical location. The particular phase in the process of curriculum review and development at which each institution was involved was taken into consideration in defining each case. The cases, activities or studies in the process of data collection were *inter alia*: reflections on experiences in teaching Life Sciences [before Outcomes-based principles and transformation of Institutions of Higher Education were effected] and critical analysis of approaches to Life Sciences curriculum design and development from Norms and Standards for Educators and from NSE to Minimum Requirement for Teacher Qualification (MRTEQ).

Rhetorically, Kumar (2005:112) reiterates that a multiple case study method is a useful approach for studying a social phenomenon through analysis of an individual case out of a group of selected cases. Kumar (*ibid.*) asserts that all data are perceived as being relevant to the case and should be gathered and organised in terms of relevance to the case being studied. The advantage of using a case study method in this research was that it provided an opportunity for the researcher to engage more deeply in analysis of data. Such data provide opportunities for intensive interrogation of specific details often overlooked by other methods.

The multiple case study research design was used for collecting data to answer the three research questions that this study aimed to answer: What are Life Sciences teacher educators' conceptions of knowledge integration? Why do Life Sciences teacher educators have such perceptions of knowledge integration? How do Life Sciences teacher educators view the integration of disciplinary knowledge in the espoused Life Sciences curriculum for teacher education and training (MRTEQ)?

4.2.2.2 Target Population

Welman *et al.* (2005) explains, the population encompasses a total collection of all units of analysis about which the researcher wishes to draw specific conclusions. The sample was derived from the population of all universities that offer in-service teacher education and training both in rural areas and cities in South Africa. The history of the universities involved was taken into consideration when this study was conceptualised: in terms of (i) traditional universities or (ii) universities which assumed a new identity during the process of rationalisation of higher institutions of education or those which went through the process of merging two or more institutions of higher learning, including colleges of teacher training. This dynamic was considered because in curriculum design and development there has been an aspect of contesting perspectives which affects the process of curriculum development. Teacher educators in such institutions demonstrate conflicting ideas: based on their background and how they view the envisaged changes in curriculum.

4.2.2.3 Sampling strategy.

Purposive sampling strategy was selected as the strategy that would enable the researcher to select participants who had made a contribution in the process of curriculum design and development. Participants needed to purposefully meet the following criteria: (i) having taken part in developing and designing curriculum for an integrated knowledge approach to Life Sciences; (ii) be currently involved in Life Sciences Education Curriculum design, and (iii) be Life Sciences Teacher Educators who will roll out the curriculum they developed.

According to Kumar (2005), in a multiple case study or case studies design, individual cases are treated as units. The universities participated in the study were categorised and classified

according to their current and historical socio-political background, for instance, the historical white Afrikaans institutions of higher learning, historical white liberal universities and the historical homeland institution of higher learning. The other features added on the criteria to classify these cases were their current status in accordance with Higher Education Act of 1996. The merger of Higher Education Institution (HEIs) in South Africa resulted in the creation of new institutions such as; universities of technology which currently offer teacher education and training; the former colleges of teacher education and training were merged with universities.

The sampling of took these features into account for the purpose of dealing with each cluster as a case on its own. In keeping with the ethical clearance stipulation the names of the participants and their institutions are not revealed instead thereof, the pseudonyms are used. The following are the multiple cases and samples;

Case Study A

Higher Education Institution from historical white Afrikaans background that merged with other institutions that offered education and training to non-whites students, were in this category and they are referred to as [X] in the discussions in chapter five and chapter six. There were two participants selected from this institution. The institution provided the researcher with names of lecturers in the Life Science Education department. The selection of participants targeted senior staff members of the department for their experience and knowledge of curriculum changes was considered significant in this study. The participants were given [A] and [B] pseudonyms in chapter five and chapter six.

Case Study B

Higher Education Institutions (HEIs) in the sample were historical white liberal universities which merged with former colleges of teacher education that catered for non- whites (blacks, coloureds and Asians) in townships classified under this category [B]. In this category as well, two lectures from the Life Science Education department in the faculty of education were requested to participate in the sample. The pseudonyms used in the discussion for the participants were [C] and [D] and for the institution it is referred to as [Y].

Case Study C

This category comprised a cluster of HEIs that offer teacher education from historical homeland background which merged after 1996. According to National Crisis Education Committee (1991) they were partially autonomous because the curriculum policy for teacher education was controlled and monitored by the Department of Education and Training during apartheid political and educational dispensation. The pseudonyms used in the discussion in chapter five and six, was [Z] and participants were referred to as [E] and [F].

Case Study D

This category comprises the institutions which lost their historical status of being technikons and colleges of education after merger, to be called Universities of Technology. According to Higher Education's Act of 1996 Universities of Technology were given a status of higher education institutions (DoE, 1996). Three institutions represented this category and they are referred to as [Q]. There were six participants from these institutions and they are referred to as [[G, H, from institution Q];

Case Study E

This category comprises of an institution which maintains the historical status of a traditional university. The faculty of Education have a school of Science Education. Participant from institution is referred to as [P].

This case study differs from others because it has a school of Science Education in the Faculty of Education. The school of Science Education has different specialisations in science knowledge domains such as: Physical Science (Chemistry, Biochemistry and Physics); Life Sciences (Zoology, Botany, Entomology, Environmental studies, Microbiology); Indigenous knowledge Systems (IKS).

The second criterion determining participation in the sample was involvement of lecturers in the teaching of Life Sciences in the senior phase (SP) and Further Education and Training phase (FET). The rationale for this criterion is that the new policy on teacher qualifications state that the revised curriculum for teacher education and training should enable students to teach a subject from senior phase to FET phase. The implications of this policy are that a teacher prepared to teach Life Science at FET should be able to teach Life Sciences at senior phase.

Therefore, sample consisted of nine Life Sciences teacher educators, comprising a range of professors, senior lecturers and lecturers taking part in the study. Participating universities were treated as individual cases during data collection to acquire in-depth information on each of the three research questions. It was assumed that each university has its own contextual attributes that could have influenced conceptualisation of integrated knowledge in the teaching and

learning of Life Sciences teacher education programmes, as MRTEQ prescribes for Higher Education Institutions (HIE's).

4.2.2.4 Research Instruments.

Discussion presented under research paradigms indicated that for the qualitative study the research instrument proposed by researchers Henning *et al.* (2004), Kumar, (2005), Cohen *et al.* (2010) and Mouton (2013) are; in-depth interviews, observations, document analysis and recordings, and naturally occurring interactions or events.

In this study, data collection relied on two data collection methods: in-depth interviews conducted personally by the researcher at the identified universities and secondly, use of curriculum document analysis.

4.2.2.4.1 In-depth interviews.

According to Kumar, (2005) in-depth interviews are face-to-face engagements between the researcher and participants directed at understanding informants' perspectives on experiences or situations as they are expressed in their own words. The questions to be asked during interviews were prepared or structured before arrangement of interviews. Participants were asked the same sets of questions: to offer their views and perceptions on knowledge integration as well as their views on clustering of different subjects that have been integrated to form a multi-disciplinary subject (Life Sciences).

The next step was to contact interviewees by means of telephones and e-mails to secure dates of appointments. Dates were diarized and reminders were sent to participants. This process did not proceed as planned because interviewees kept changing appointments and in some instances the researcher had to travel to distant universities only to find the interviews were cancelled. The

other challenge faced in this study was red tape at some institutions as well as poor gate-keeping which hindered access to conduct interviews at some institutions. Having planned to interview two teacher educators at each institution, it was discouraging to go back and forth to locate two participants.

Permission to use an audio-recorder during interviews was sought from interviewees and was granted to the researcher by all participants in the study. Ethical considerations were spelt out before involving individuals in the study. Participants were assured that they can withdraw from the study at any given time and that their rights as participants in the study would not be infringed upon. Transcripts were developed after interviews were conducted for data handling and processing.

4.2.2.4.2 Document analysis

Analysis of the following documents were carried out: (i) Templates outlining proposed scope of content for Life Sciences curriculum, (ii) proposed Life Sciences course outlines for all year levels in the Bachelor of Education qualification and (iii) copies of minutes taken from meetings during the process of designing and developing Life Sciences curriculum informed by MRTEQ policy. Data collected by means of document analysis were used to triangulate information collected by in-depth interviews. According to Schumacher and McMillan (2006), triangulation in the process of data collection is meant to strengthen the data collected by means of qualitative tools. The purpose of document analysis in this study was to:(i) provide the researcher with critical information that covered certain aspects that might not have been covered through the other tools that inform data collection for the study as well as (ii) provide the researcher with the opportunity to make follow-up sessions with the participants if and when clarity in certain issues

obtained during the data collection was lacking in terms of the three questions that this study set out to answer.

The process of document analysis benchmarked the following:

Knowledge integration in the discipline

Integration of applied competence in the Life Science curriculum

Organisation and selection of learning experiences to enhance integrated learning

Integration of practical competences for subject pedagogical content knowledge

4.3 Ethical Considerations

According to Kumar (2005) and McMillan and Schumacher (2006), participants in the study should not by any means be coerced to divulge information. The rights of the participant should be respected by ensuring anonymity. Participants should sign a consent letter or form to indicate his or her willingness to participate in the study. Any information collected from participants should not be made public without permission of participants. The researcher understood that universities had gate-keepers and that their internal affairs should not be used in any study without prior approval. The researcher first sought permission from the university where he works by declaring the intention of the study and submitting all instruments to be used in the study for the purpose ethical clearance. The researcher wrote letters to the participating universities via e-mails. Visits to each university were planned according to dates provided by the academics who were keen to be part of the study. Interviewees were given a question a week

before each interview and confirmations were conducted through e-mailed messages. The confirmations were crucial because some participants lived in remote places from where the researcher worked and the mode of transport used was airplane. Interviews were recorded and arrangements for doing so were made prior to the date of interviews with participants.

4.4 Reliability and validity

According to Kumar (2005), in testing the validity of research instruments, validity is the ability of an instrument to measure what it was intended to measure. Hence, Smith (1991:106) in Kumar (200) defines validity “as the degree to which the researcher has measured what he has set out to measure”. It is crucial to this study to ensure that both interview questions and curriculum documents solicited for triangulation purposes are both tested for validity in answering the three research questions that this study is set out to address: the questions in the research instruments clearly state the compass and purpose of this study.

Reliability is referred to as a strategy for ensuring consistency and stability in using research instruments. Kumar (2005) states clearly that the instruments must be applied consistently: in applying the same instrument for a specific purpose under similar or same conditions the same results should be shown. In this study, the same interview questions and documents were used in the process of developing and designing curriculum: to measure the perceptions and perspectives of Life Sciences teacher educators on the principle of knowledge integration informed by principles imposed by the espoused curriculum (MRTEQ). The reliability and validity of research instruments were tested through the pilot study before the study was conducted on a full scale.

4.5 Pilot Study

According to Schumacher and MacMillan (2006: 202), a pilot study is recommended for testing instruments before they are used in a full scale study. Welman *et al.* (2005:148) concur with this view of testing reliability and validity of the instruments. The following could be detected during the pilot study; flaws in the research tools and procedures were detected; and unclear or ambiguously formulated items were eliminated from the instruments.

4.5.1 Synopsis of findings from the pilot Study.

The sample for piloting the instruments was organised among the researcher's colleagues at [Institution Q] who were approached and requested to participate in in-depth interviews conducted with three lecturers who were involved in the Natural Science curriculum development: one Physics teacher and two Life Sciences teacher educators. Data obtained from interviews conducted with colleagues were used to provide the researcher with feedback for improving interview questions to be used in soliciting data from the other institutions sampled for the study.

4.5.2 Analysis of data from the sub-sample (pilot study).

Data from five members of staff was analysed by first coding responses under each interview questions. Classification of data took place according to categories: with similarities and differences taken into consideration. Themes were organised to present perceptions and views of participants.

Issue#1: Curriculum introduces new clustering of subjects.

Participants indicated that the new curriculum disadvantages students who aspire to teach Life Science at FET level. The combination of two phases and the regulation that students should be

able to teach the subject across the phases elicited responses such as: *It is difficult for students who have not done other science subjects such as Physics and Chemistry to do Life Sciences in this new curriculum. Students registered for B.Ed. SP &FET programmes are not coping with this combination.*

Issue #2: Changes were unnecessary

Participants highlighted that realignment of the espoused curriculum designed by academics in order to cater for the needs of the students did not serve its purpose. Responses such as the following were noted with concern: *Curriculum designers did not consider that schools do not offer all these subjects at matric level: how can students all of a sudden register for new subjects at varsity. I strongly feel the curriculum for Life Sciences should change.*

Findings obtained from the study were tested through writing two publications that were presented at three international conferences: in October, a paper was published at the ICERI conference in Spain in November 2016 and published by IATED. The title of a publication was: ‘Implementation challenges of Life Sciences curriculum in the teacher education programme: a tandem between curriculum conceptualisation and implementation’. A second paper was published in the INTED conference proceedings held on the 3 March 2017 at Valencia, Spain, entitled: ‘Integration of knowledge: A neglected approach in teaching life sciences? Interviews commenced with the participants as planned. The pilot study was of value in that the researcher was able to allocate sufficient time for the interview. The researcher learnt from that experience how to manage the pace of the interview and how to ask probing questions effectively. Only in-depth interview questions were tested for validity and reliability; the document analysis tool did not require validation.

4.6.1 Analysis of data collected by means of in-depth interviews and presentation.

According to Henning *et al.*, (2004), analysis of qualitative data can occur through open coding which entails reading through the entire text generated from recorded information and identification of themes. These researchers suggest as part of open coding that the analyst could read the transcripts of all interviews conducted. According to Henning *et al. (ibid.)* ‘open coding’ is an inductive process; whereby codes are selected according to what the data mean to the researcher. The researcher in this case needed to have an overview of as much contextual data as possible (Cohen, Manion and Morrison, 2011).

Similarly, Mouton (2013: 108) asserts that textual data are rich in meaning and sometimes yield ‘multiple meanings’ or surplus meaning. These meanings are sometimes difficult to capture in a short and structured manner. However, this researcher found that qualitative transcripts or discursive data can be analysed by breaking it into units which crystallise into themes, patterns, trends and relations. The following observations were made during the breaking down of data into patterns and themes: relations between concepts, constructs or variables. The focus should not lose sight of patterns or trends that can be identified or isolated from data.

The researcher took heed of these guidelines in the process of capturing data which commenced immediately after the data collection process was completed. The researcher decided to develop transcripts independently. The rationale was that during interviews the researcher took down notes to be supplemented by recorded information for each interviewee. Transcribed data were broken down into units and codes which, in turn, were used to label concepts, constructs and variables. Relations between concepts and variables were organized into themes identified from the patterns and trends in the data. The data collected by means of in-depth interviews were presented under categorized themes, trends and issues. Interpretation of data followed.

4.6.2 Qualitative data analysis of data collected from document analysis and presentation.

The data gathered by means of document analysis were analysed qualitatively following suggestions made by Mouton (2013) and Henning *et al.* (2004). According to Mouton, the documentary sources are useful to provide evidence of the data already gathered. Data collected by means of document analysis should be analysed by integrating and collating views and trends in the patterns and layouts. However, Cohen *et al.* (2011) suggest data captured from documents should be analysed by creating meaningful categories within the units of analysis. This process begins with words, phrases and sentences: comparing categories and making links between them follows, and last, concludes by drawing theoretical conclusions from the text. McMillan and Schumacher (2006) propose that qualitative document analysis involves counting of concepts, words or occurrences in documents and reporting them in a tabular form. The final statements capture the essential features of the process of content analysis.

This study adopted the above methods to analyse data collected from various documents obtained from the universities. The process began by breaking down texts into units of analysis and some important features of the content were identified. The next step was to put new statements into categories. The issues were then discussed in line with the items the study sought to elicit from the documents.

4.6.3 Data interpretation and discussions of findings from in-depth interviews and analysis of documents

Data presented in the form of themes, trends and patterns were interpreted within the frameworks of the study: research questions, objectives and aims. The theoretical framework generated during the literature review was used to confirm or reject the assumptions of the study encapsulated in the problem statement of this work.

4.7 Summary.

This chapter outlines the theoretical framework within which the empirical study was conducted. The theoretical framework provides the researcher with suitable understanding of the interpretive study and qualitative methods relevant to the research design and data collection. The literature cited in this chapter provides a base for the procedure used during the analysis of data collected by means of in-depth interviews and document analysis. The guidelines and suggestions gathered from literature enable the researcher to work out means and strategies of presenting qualitative data and its interpretations as presented in chapter five and chapter six.

Chapter 5: Data Presentation, Analysis, and Discussion.

5.1 Introduction.

This chapter presents analysis of data collected by means of in-depth interviews and analysis of documents. The process of data analysis commenced soon after all documents were obtained and interviews were completed. Transcripts were developed from audio-recorded responses and raw data were coded manually. Classification of data followed after themes were identified. The findings and implications generated during data analysis were categorised and presented under each theme. Data were analysed through qualitative procedures discussed in chapter one and chapter four.

5.1 Responses of the participants [A&B, from Case Studies A], participants [C&D from case study B], participants [G&H in case study C] participants [E&F in case study D] and participant [J in case study E] to question One: (See appendix: C)

Question#1: Which approach or model does the department adopt for developing curriculum for Life Science teachers?

Case Study A: (*HEI from historical conservative Afrikaans background*)

Responses transcribed from interactions with participants from institution X indicated;

Participant [A]: Before these curriculum changes, teaching of Life Sciences in our university actually in most universities was of high quality. You know!

Quite frankly, I will say Fundamental Pedagogics prepared teachers of high quality, school principal in the vicinity of our institution attest to this. They are not happy with the quality of content our students have to teach Life Sciences.

Probing question: Do you believe that the content -driven curriculum for teacher education and training of Life Science was the best model?

Participant A: further argued: Of course yes! The other example to use here, are the PGCE students. Principals prefer PGCE students to B. Ed. students, and the reason is that the PGCE teachers are well equipped with disciplinary knowledge in Life Sciences. They take three years in the faculty of Science studying disciplinary content knowledge. In my view the faculty of Education and the department of Science Education so far do not have that capacity. This was the case in the era of fundamental pedagogics curriculum for teaching programmes in South Africa

Participant B: The transformation in teacher education and training became problematic in South Africa with the closing of colleges of education. This created problem for the faculties of education in general but particularly, for the department of Science Education as a whole. The migration of disciplinary content knowledge from the Science faculty in universities compounded the problem for teacher educators in the faculty. Do you know that one lecturer teaches both disciplinary knowledge and curriculum studies modules in the same semester to a crowd of students in this department? Can such a system really produce teachers of good quality? My

view is that, we threw the baby with the bath when these transformations were introduced.

Follow up question was: Do you believe that the content -driven curriculum for teacher education and training of Life Science was the best model?

Participant B: The issue of subject content knowledge is critical in any learning. During our days we attended courses from the faculty of Science. Year one of our study, the focus was on disciplinary knowledge and we majored in the field such as Zoology or Botany or Chemistry in the faculty which provided us with both knowledge and practical knowledge. Comparatively speaking, what we do for this B.Ed. Programme compromises quality of education hence; learners perform so poorly in Life Science school curriculum.

Case Study B (*University from a historical white liberal background*)

The similar key question and probing question asked to the Participants in institution [Y] to participants [C] & [D]

Participant C: As the institution that offers teacher education and training in our campuses in various locations in terms of settlements, we have not adhered to radical policies and guidelines of department of higher education and training (DHET). Please, get me clearly on this. I am not saying we are opposed to transformation in teacher education, however, we still uphold the view that as academics at local level we should apply our own minds about what change ought to be in teacher education and training. We have taken a stance that we will incorporate new to the current trend. All these years, we have been producing competent teachers in both

theoretical and applied knowledge in Life Sciences. So, rhizomatic theory suggests that shoots comes from the old rhizome, in this instance, this theory teaches us to make new shoots from what we have and what we have proven to be working.

Probing question: Do you have any specific model or approach for your curriculum development and delivery?

Participant C continues to say:

It may not necessary be about a particular model or approach per se. Instead or perhaps it is suffice, to say the curriculum in Life Science education for preparing competent teachers should reflect a balance academic disciplinary knowledge of Life Sciences and pedagogy. The academic disciplinary knowledge is key I must say however, this does not mean that they have to be content –driven in the sense that pre-service teacher should acquire knowledge through means of rote- learning. In my view, curriculum we as an institution aspired to have, promote acquisition of competences and skills and of course content knowledge is important.

Participant D:

In my view, our current Life Science curriculum for teacher education and training is informed by the elements which we considered imperative: the needs of the country, our stakeholder which is the department of basic education and the needs of the students. These elements are enshrined in attributes of a competent teacher in the DHET guidelines. In as far as the approach or model is concern; I can say the curriculum is more of a spiral in its layout and organisation. The first two

years focuses more on disciplinary content knowledge as our belief is that first year students require introductory level of knowledge at university which is at HQSF level 5 and in the second year the content level is offered at level 6. This allows students and academic to cover the threshold in all knowledge domains in the discipline.

Probing question: Do you have any specific model or approach for your curriculum development and delivery?

Participant D stated: I suppose, my response to the first question addresses this question. I will be repeating myself.

Case Study C (*university from the historical homeland background*). Institution [Z]

Participant E: Changes in the university curriculum as well as that of schools has cause a lot of uncertainty which actually has resulted in us losing of resilience. Not too long ago it was Norms and Standards. The process of accreditation of the curriculum and programmes took a long time. Our institution is still struggling to unpack the MRTEQ policy although we have managed to produce drafts. To address you on this question, I will say we have adopted a thematic approach and tried to modularise content that could enable student to cover subject content knowledge and methods in each year level of study. Our curriculum development was informed by the Life Sciences curriculum for schools it was against it that we identified areas of disciplinary knowledge we need to focus on.

Participant E on the probing question said:

On issue of delivery, I could say all what we are doing currently is not going to change in the new curriculum. The delivery, in my view is determined by the resources at your disposal. You know, the notion of historically disadvantaged institution actually in its real sense should be the currently disadvantaged institution because the status quo remains. It could be referred to as historical but in reality nothing has changes. Teaching and learning of Life Science is still textbook based and we lack resources such as laboratories let it alone equipment. Therefore, briefly I would say our Life Science teacher rely on books and computers for knowledge and information.

Participant F to the key question said:

Thanks for the question: I really want to be honest; the process of curriculum change is process that was overwhelmed with contestations. We as lecturers, in the first instance, we graduated for our degrees from various institution of higher learning where we acquired knowledge in different ways. I am trying to say to you we were exposed to different schools of thought. For example those of us who were educated and trained under Fundamental Pedagogics contested views of Life Science disciplinary content knowledge taught in the faculty of education. They want the B.Ed. programme to accommodate sharing of the workload with what we call sister faculty which is Science. There are some of us who raised the issue of Modularisation of content in the department of Maths Science and Technology education in the faculty of education. The debates on these issues prolonged the process; hence our programmes have not received accredited status from DHET.

Participant F to the probing question Do you have any specific model or approach for your curriculum development and delivery? The response was:

I would say yes, however, it was a matter of consensus as I indicated on contestations and debates but the compromise had to be reached. The Modularisation was accepted on the grounds that the budget allocation for the FTE's in the education faculty could not be divided to cater for students in the Science faculty. The Life Science Education for both disciplinary content knowledge and pedagogy are offered by us. Basically this is to say Modularisation was adopted.

Case Study D: (Higher Education Institutions *that have been merged*)

Institution Q: brief historical background about the institution. This institution received the status of a university after the former white technikon which offered teacher education and training merged with two historical colleges of teacher education and training in the province. It was thereafter called, a university of technology. The implication of amalgamation of these institutions was the sharing of physical and academic resources by individuals who have could have diverse perspectives of philosophical foundations of educations and theories underpinning curriculum. This information was important in this study, for providing the historical context to the data collected from this institution.

Participant: G responded to key question: In your view what is the model that could best address the curriculum to meet such expectations?

Before answering you question I want to, first outline how the process of curriculum development was undertaken, there were constituted committees to lead the discussions.

In the case of Life Sciences a senior staff member was asked by the faculty to oversee the process. The discussions were constrained by the fact that we were still grappling with the issues of merger. There was a group which had been using the physical facilities before the merger who carried a perception that members coming from other institution are intruders. This impacted the sharing of ideas in the sense that others opted to follow the seniors' voice and opinions, for peace and progress sake. If I were to be frank and honest, our Life Sciences curriculum from first year level to fourth year level in terms of content knowledge is driven by what students should know before going out to teaching practice. First year content is basically grade twelve content. The second year's disciplinary content knowledge is also based on what Life Science students will teach in the practicum lessons. From my experience as a former college lecturer the pattern or model resembles the one used by colleges of education.

I need to infuse some Chemistry and some little Physics, [some little bit of this and little bits of that] so that when they leave here after the four years they would have Life Sciences and at least they would have been exposed to the theoretical part or understanding; for instance the periodic table, atomic theory, a bit of optics and a bit of that...

In my view, Life Sciences in itself is integration of three main disciplines formerly known as subjects, which are still Zoology, Botany and Chemistry. Each one of these is a specialised field in all respects. This means they are distinct in terms of conceptual knowledge and practical knowledge. We could not begin to speak about integration of knowledge that could be applicable for school curriculum

With this concept of integration of knowledge coming to the fore when I am thinking environmental education but in Life Sciences it is not catered for. I see myself going back to compartmentalisation. It is difficult to integrate different disciplines because in one course, Life Sciences and Life Sciences, there are four different lecturers and the tendency is to look at your area of speciality.

Response to the probing questions was;

What I know during my own university education, traditional universities emphasised the content knowledge, which I also believe to be the right way. The content is acquired from the mother disciplines in the faculty of Science. Students acquired in depth knowledge of Botany, Zoology and Chemistry which enable them to teach Life Science curriculum in school more effectively. The thematic approach they adopted in our department does not do that because of the limited time we have in the faculty to teach content. The teaching practice weeks in between interrupt continuous teaching and soon after school practicum students write tests. I hope this will be reviewed, in my view this is not taking us anywhere.

Participant H response to the key question

I will first point to the issue of contestation being the main thing that overwhelmed discussions about what content? And how delivery will be made? The issue of ideological beliefs and theoretical principles took a long time to resolve, particularly because of the divergence in the views informed by our backgrounds. Really, I would say, in this regards that the unanimous conceptualisation of curriculum held during discussions appears to have been ignored in what is in the document. The curriculum

officer who was an overseer of the process had dominant influence on the product. The curriculum model, I would say is more of a fragmented modularised content knowledge which disregards the original draft wherein the thematic- approach was preferred.

Probing question:

Participants H response to the key question:

My response to this question will be more of the repetition of some of the things I have already said, however, I can say content supersedes the pedagogy. Students do require intensive knowledge of the disciplinary knowledge.

time constraints is also an issue, big classes for laboratory work make it difficult to assist students who are challenged. In my view, such challenges have an effect on training a successful science teacher. Another challenge is that students who want to teach Life Sciences do not understand the academic content offered at the university. Some of them have not done some of the [central] themes of disciplinary knowledge. For example not all students enrolled for Life Sciences teaching have done Physics and Chemistry.

Case Study E:

Participant J response was;

The model that we use is a thematic approach that caters knowledge across disciplines. Our focus as a school science is based on fusing Indigenous Knowledge to the Western Science Knowledge and this is done through teaching various

sciences domains thematically integrating indigenous knowledge to western science knowledge. Models are used to demonstrate to students how they can form linkages between disciplines.

Responding to the probing question about the issues of content and delivery, the participant stated;

Ok! (*..Showing enthusiasm and passion of curriculum changes*), There had been a desire to in cooperate all knowledge systems into our disciplinary content knowledge in Life Sciences curriculum. The historically marginalised contexts and world views in the Field of Life Science are now provided space in our Curriculum. With regards to pedagogy, as the members of the department we have been exploring the Dialogical Argumentative theory to allow students opportunities to explore various scientific phenomena. This approach facilitates creative thinking and production of knowledge: students learn to discern and identify common or overlapping concepts and transferable skills through integrating knowledge across and within various knowledge divides in designated Fields of Science. Characteristics of Concept Mapping are consistent with those of Dialogical Argumentation Instructional Model (DAIM) which was found to be particularly suitable for teaching an integrated science and indigenous knowledge system. This model presents stages in a teaching continuum:

5.1.1 Responses to question two of the interview. This question solicited data regarding perceptions and conceptions of knowledge integration

Question#2: How was the concept of integrated knowledge emphasised in the Minimum Requirement for Teacher Educational Qualification (MRTEQ), perceived in by the developers of the Life Science Education curriculum?

Case Study A

Response was;

For me personally, I do not subscribe to the school of thought that promotes teaching across knowledge specialisation in Science Education. I think that, is taken care of in the pedagogical content knowledge studies. There are so many methods that can be used to teach that pre-service teacher can be trained in to impart knowledge to learners. In each of the specialisation they should know how to teach a lesson in Chemistry, Botany and Zoology and so on.

Participant B responses

It is very difficult to construct a programme, so that at least there can be some kind of knowledge depth in each of these disciplines. And we still have that kind of challenge. MRTEQ proposes guidelines such as one you are asking me about, the issue of compliance to these principles I believe is up to an the members and the institution to decide upon what they approaches to the form of integration.

Response to the probing question, the participant B stated;

During our days we were trained to be confident teachers. The only thing the teacher needs to have confidence is knowledge of the subject and methods of teaching it finish. All these fancy concepts borrowed from other countries will not produce good teacher of Life Science in particular. The educational changes in South Africa brought about chaos which resulted in the production of teacher of very low quality. The decline in the quality grade 12 results in Life Sciences.

Because we start in the first year with basics of the scientific method, basic biochemistry, and basic ecology, first these topics are best for them to get prepared for what is coming in the second year in terms of topics like photosynthesis and respiration in plants. It is a strength meaning that the students are better and it lays a very good foundation for the next lecturers to build on the foundation already laid... then they get to see the bigger picture of the curriculum of Life Sciences over these 3 or 4 years.

Case Study B

Participant C responses

This implies that knowledge will be diluted to accommodate disciplines that are clustered to form a multi-disciplinary subject or a broad-field subject which has been formed through knowledge integration. The teaching of Life Sciences content knowledge in themes would help student to understand that knowledge of Life Sciences can be integrated. For instance, themes from Chemistry and Botany can be clustered to enable students to understand connections or integration. It is in that sense that I view the implementation of integration. Inquiry methods such as

experiments or research are also suitable for integrating knowledge across sub-disciplines in Life Science Education. This is my view.

Participant: D

Life Sciences discipline is a basket science because we draw from different disciplines and sub-disciplines. It is a philosophy-driven subject. Taking a bit from different disciplines makes the subject unique and currently, social sciences play a pivotal role in science teaching (social sciences, social justice, language and philosophy) feeding in the teaching of science hoping to get credible, viable, products that will enrich somebody as well as me, as a teacher educator. Science is not factual and as such there are so many disciplines acknowledged in the sciences. Life Sciences is not exactly like other sciences ... Social aspects are taken into consideration and acknowledging these aspects within the discipline adds value to the uniqueness in Life Sciences. There is quite a lot that is feeding into Life Sciences to make it an integrated discipline

Case Study C

Participant E

I am thinking now of the educational perspective, especially the people we are now sending out as students into the education world. We need someone to be an expert in Physics and an expert in Chemistry and in Geography. In order to integrate those, so that students or learners in front of them will have the best preparation in order to be empowered to choose subjects well in grade 10. Because that is the biggest purpose of integrating those knowledge areas in order for grade 9 learners to know that at the

end of that year, what their interests are and to lay foundations so that if they want to choose Physical Science, the basics of Physics and Chemistry are covered.

It is like for example learners find it quite difficult to understand inertia, they say: 'ok, what is inertia?' And I say, 'you sitting there can you be there forever according to physics? And how can I make you stand up?' They say, 'I have got to apply force.' Then I say 'in your life you do not say apply a force, it is about me forcing you to leave that place. Why do you say force?' Then I say, 'whenever we use force in everyday language, it is about resistance. You are asked to do something you don't like. And that resistance in this example is INERTIA'. That can link on how we talk in everyday life and also the same concept includes what is in the school curriculum so that at least our teachers can cope with what is in the school curriculum at the moment

Participant F

To integrate things that cannot be integrated within the same discipline of Life Sciences, I refer to it as forced integration. You cannot integrate everything; there are certain themes that cannot be integrated

Case Study D

Participant G

Schools are still teaching fragmented sciences despite the presence of CAPS. The lack of qualifications and expertise to teach school science is one of the problems that have been highlighted as a challenge in the Eastern Cape. Lack of content depth

among teachers teaching integrated science subjects in grade 8 and 9 has been highlighted as a challenge; hence a program, Fundisa, was introduced through a joint venture between the Eastern Cape government Department of Education and one of the universities in the Eastern

As we start with the new curriculum, if it is physical science students, they must take Life Sciences and Geography. For Life Sciences you have to take Geography and Physical Science from the first year. We started this year, 2017, to implement this, because we had a problem in conceptualising the curriculum to meet the expectations of the policy MRTEQ and we are still continuing to fix it. The strength of integration of disciplines to form a multi-disciplinary subject is that you deal with many, different strands or variety of topics per term or in a semester.

I think there is a difference between knowledge integration and subject disciplines. Life Sciences have long been integrated for us in Botany and Zoology. Knowledge integration within Life Sciences has been done through Botany and Zoology. The question I am grappling with is that who are the curriculum developers? Even though it went for peer review, it was accepted. The policy was only given to us by the DHET at a later stage when curriculum was already designed and developed.

Case Study E

Participant J:

A lot of the disciplinary approach is what I prefer but the systematic approach is what I follow: i.e. Zoology, Botany, and Microbiology are organised in a systematic approach from species upwards to the most complex: i.e. Plant kingdom, animal

kingdom. It lays a good foundation with the principle of taxonomy but over the years this changed and the inter-disciplinary and integrated approach was introduced; becoming a thematic approach.

5.3 Presentation of data collected by means of document Analysis

Case Studies [A& D]: document analysis

The analysis of the document from the two case studies were juxtapose and the similarities of the following themes were identifies

Theme#1: Curriculum organisation and its layout

The data presented in the table below show the layout of the Modularised curriculum content of case study [D] from institutions Q and P. These are the institutions with the school of Science Education as well as Universities of Technology. The feature shared by these institutions is that the school in the faculty of education offers both disciplinary content knowledge and subject pedagogical content knowledge

First semester (Knowledge domains)	Second semester (Knowledge domain)
Life Sciences/ biology Chemistry	Physical sciences

Table1: The course outline provided details of content covered in each knowledge domain

The Life Sciences content includes: biomes, animal kingdom and plant kingdom as well as ecosystems. Under Chemistry the focus is on energy systems etc. The practical learning is about

laboratory experiments for both Chemistry and Biology. There was one course outline or guide for the Chemistry and Life Sciences and yet, two lecturers taught these knowledge domains, of science discipline, separately at different times. Life Sciences discipline is taught during the first quarter of the semester and Chemistry during the second quarter. In the traditional universities, faculties of education are situated within the main campuses. This arrangement allowed incorporation of other faculties which offer disciplinary academic content.

	Courses from Faculty of Science	Courses in Faculty of Education
First year	Chemistry1, Physical Science, 1 mathematics 1 /Botany/ Zoology 1	Specialised pedagogical content knowledge 1
Second year	Chemistry2, physical science 2, and botany2 or Zoology 2	Specialised subject pedagogical content 2
		Work integrated Learning
Third year	Choice of two majors	

Table2: Course curriculum structure for case studies [A, C & D] institutions (X and Y)

The outline of the Life Sciences presented in table 2 indicates the similarities between case studies [A, C& D]. The data point to the adherence of ‘traditional’ [white under apartheid] universities to the Fundamental Pedagogics curriculum organisation and layout of the content. Contrary to the former curriculum organisation, the analysis of the documents from the, merged institutions have a different organisational structure.

Theme# 2: Pedagogical Approaches to teaching and learning in Life Sciences

Documents analysis indicated that Higher Education Institution adopted different approach of delivering their curriculum to students. The following approaches were identified from the Life Science document the researcher managed to get from the institutions [X, Y, Q and P]

Institution [X & Z]

The linear presentation of topics in the faculty handbook indicated that the focus of teaching was on content and practical work. The integration of theoretical disciplinary knowledge was complemented with practical knowledge of Life Science; however, this learning depicted disciplinary focused learning. This approach reflects view of content-driven learning and skills acquisition in a discipline.

Institutions: [Q & Y]

The data from documentation for case studies [D], the merged institution, did not indicate the strategies of curriculum delivery. The course guide provided a list of assessment methods which were: group discussion, oral presentation and assignment, examinations and test. Documentation from case study [D] mentioned, self-discovery, problem solving and group discussion as methods

This category embraces the thematic approach as a means of showing interconnections and interrelatedness in selection and organisation of academic content knowledge for Life Sciences teaching in schools. A thematic approach focuses on the vertical articulation of knowledge from basic, simple conceptual and theoretical knowledge to complex and advanced knowledge.

Institution: P

The analysis of document from this institution attested to the views of Dialogical Argumentative Instructional Model participant, J in case studies E that the Life Science lecturers preferred this approach to teaching and learning of Life Sciences in teacher education and training. The King

5 E's model that was alluded to pioneered the principles of *engage, explore, explain, expand and ensure*.

Theme#3: Organisation of Life Science disciplinary content knowledge.

The table below presents the sequence of modules in the espoused curriculum for Life Sciences teacher in case studies A and B. The juxtaposed comparisons indicate the similarities of the focus of the modules and their content knowledge.

Case study A Institution X)	Case Study B Institution Y
Modules and the scope of disciplinary content knowledge taught in the faculty of Science	Modules and the scope of disciplinary content knowledge taught in the faculty of Science
Ecological principles	Biology of the cell
The chemical level organisation in a living organism (inorganic and organic compound)	Genetic and molecular Biology
DNA-the genetic code/genetic expression (protein synthesis-transcription/ translation)	Evolution
Genetics (median inheritance and special issues)	Diversity of life on earth
Bio-diversity/taxonomic principles/classification; based	Plant form and function
	Animal form and function
	Ecology and behaviour

Table 1: This table presents data on the organisation of the disciplinary content knowledge in Life Science curriculum for teacher education and training from two institutions.

Case Studies C& D

The analysis of the content organisation below display the disciplinary content knowledge offered in the department of Science Education in the faculty. The document analysis from institution [Q] showed the organisation of modularised disciplinary content knowledge taught to across Science Education in their first, second and third year. The importance of this curriculum was that it obtained full accreditation from Higher Education and Qualification Council (HEQC) and DHET.

First year of study	Aim of the Course
<p>This elective subject comprises an introduction to the role and responsibilities of the beginner teacher in the field of Natural Sciences. It includes:</p> <p>Contextualizing Natural Science teaching and learning within CAPS, teaching and learning theories, the Nature of Science and Biology;</p> <p>Deliberating what science is about and the role of science teaching in the Senior Phase;</p> <p>Formulating an initial personal view of what his/her views, role and responsibilities will be as a future science teacher;</p> <p>Processing skills applicable to science culminating in an elementary investigation;</p> <p>Materials, media and safety in the teaching of Natural Science in the Senior Phase;</p> <p>Matching learners in the Senior Phase to possible teaching styles in the Natural Science classroom ;</p> <p>Designing basic lesson plans for teaching Natural Science in the Senior Phase;</p>	<p>The aim of this elective subject is to introduce the student teacher to the challenges of the field, Natural Science.</p> <p>Thus the purpose is to equip the student teacher with the basic knowledge, skills and values embedded in this field as well as an initial understanding policies and principles shaping the practical implementation of Natural Science in Senior Phase (SP) teaching.</p> <div data-bbox="821 1136 1430 1182" style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Learning Outcomes</p> </div> <p>Students must be able to:</p> <ul style="list-style-type: none"> Apply the introductory subject knowledge; Handle acquired knowledge with insight and thoughtfulness; Be sensitive to the different abilities and needs of the learners; Be alert to the challenges of a diverse and multi-cultural environment
<p>Second year of Study Life Sciences</p>	<p>Course Aim</p>

<p>This elective subject builds on the work presented and discussed in Natural Science 1. Natural science 2 is also divided into three disciplines of science namely Life Science, Physics as Chemistry.</p> <p>The work done in Natural Science 2 build on, for example, Diversity of life on earth which include the tree of life (classification) and will be extended to include microbes such as Viruses, Prokaryotes and Protists. Green plants will be introduced with specific reference to the fundamentals of noncoelomate invertebrates, coelomate invertebrates, Vertebrates will be introduced. Plant form and function will also be extended to include: Vegetative plant development Animal form and function will be presented and discussed under the following heading: musculoskeletal, digestive, circulatory and respiratory, temperature, osmotic regulation and the urinary system.</p> <p>The Chemistry part will focus more on the basic principles, theories and laws about liquids, intermolecular forces, introduction to Boyle's law of gases and electrochemistry where the focus will only be on redox</p>	<p>The purpose of this elective subject is to prepare students for further study in Life Science, Physics and Chemistry in the FET phase in the third and fourth years.</p> <p>This subject aims to promote and/or consolidate a thorough understanding of the fundamental concepts, theories and laws that govern the disciplines of science to produce a critical thinker who believes in lifelong learning.</p>
	<p>Learning outcomes</p>
	<p>Students should be able to:</p> <p>Have a good understanding of the biology of both plant and animal cells;</p> <p>Link all the different metabolic processes in both plants and animals with the disciplines of chemistry and physics;</p> <p>Have a basic understanding of the chemical processes that hold cells together and how cells function in their respective environments</p>
<p>Third year of study : Discipline Chemistry</p>	<p>Course outcomes</p>
<ul style="list-style-type: none"> • Chemical bonding: mechanism of structures rules, laws, theories and models about. This includes covalent bonding which is subdivided into polar covalent, non-polar covalent and dative covalent bonding. • Followed by ionic bonding as well as metallic bonding. • Chemical bonding: mechanisms of structures, Advanced stoichiometry: solutions, such as limiting reagent, excess reagent, theoretical and actual yield, volumetric analysis • Mining: Gold, Iron, Coal and Phosphate. Here the focus is on the chemical processes involved in the refinement of raw materials • Radioactivity: Alpha, Gamma and Beta 	<p>Chemistry 3 aims to equip students with knowledge and skills needed to understand the formal development of knowledge in chemistry. To this end, students will be introduced to both inorganic and organic chemistry in which the focus will be on principles, theories and laws which through empirical evidence explain the chemistry of objects around us. Where inorganic chemistry deals with the synthesis and behaviour of inorganic compounds, organic chemistry is concerned with a</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Learning Outcomes</p> </div> <p>Students should be able to:</p> <ol style="list-style-type: none"> 1. Demonstrate an understanding of the knowledge and skills needed to understand the formal

<p>radiation</p> <ul style="list-style-type: none"> • Introduction to organic chemistry: Alkanes, Alkenes, Alkynes, Alcohols, Carboxylic acid and Ketones 	<p>development of chemistry and to communicate this knowledge effectively in the chemistry classroom.</p> <p>2. Have a fairly good understanding of inorganic chemistry</p> <p>3. Have a fairly good understanding of organic chemistry</p> <p>4. Apply their understanding of the principles, theories and laws to their lived world experiences</p>
<p>In both these specialised disciplines of chemistry theory and practical work form the basis of the course? The practical part of the course is designed around the theoretical constructs in order for students to develop the required practical skills. The selection of content, teaching strategies and assessments will be designed to facilitate learning associated with the design principles of integration of knowledge; transformation of school science and the application and reflection of relevant knowledge.</p>	

Table 2: The data presented above show the organisation of Life Science disciplinary knowledge in institution [Q] in the school of Science Education.

The data on the table presents the Modularised content. The modularised content does not reflect vertical and horizontal progression in the acquisition of Life Science disciplinary knowledge. The first year of study in the Science Education indicates that the Natural Science topics are dominant. This could have implication on the competence of Life Sciences teacher disciplinary knowledge. The narration provided about the delivery of the curriculum content knowledge to equip students with basic Life Science disciplinary knowledge is not clear. The scope of knowledge in year two indicates that Life Science content knowledge is a mere appendage in the curriculum which is more biased to Natural Sciences.

Case Studies E

The institution [P] under this category was not able to provide their curriculum documents. The participant presented the document the department leadership had design portraying their thought about pedagogical content knowledge.

5.6 Categories of findings identified from the data collected by means of interview

The raw data presented in this chapter under each case study was critically interpreted in order find divergence and convergence in the perceptions and views of the Life Science teacher educators. There were identified categories were classified as follows:

Category A: Perspective of Life Sciences curriculum for teacher education and training that support content- driven approach.

The perceptions and views classified under this category emphasised that Life Science curriculum for teacher education and training should equip students with disciplinary content knowledge in each of the subject specialisation. The issue of focusing on each Life Science knowledge domain (Zoology, Botany, and Biochemistry) in this perspective is pivotal for producing competent Life Sciences teachers. The strong view held by the participants was, the education of teachers who will be specialist in each of the knowledge domains that comprise Life Sciences which they referred to as a school subject not a university discipline.

Category B: Perspective of Life Science curriculum for teach education and training that promote two centres of knowledge offering (disciplinary content knowledge and pedagogical content knowledge

The data indicated a strong view held by Life Science in the sample regarding the quality of disciplinary content knowledge. The perception of removing students from the faculty of science to a school of Science Education in the faculties of education is total rejected by participants who do not subscribe to it. The concern highlighted is, on the quality of content knowledge in knowledge specialisations. The data indicated that lecturers who teach Science Education could be biased in teaching the content knowledge, given the fact that the lecturer's specialised in certain disciplines of Life Science, for instance, some specialised in Botany and not in Chemistry or Zoology. In this perspective, the lack of balance in the offering of adequate disciplinary content knowledge from the specialised disciplines in Life Sciences could compromise the quality in the teaching and learning of the school Life Sciences subject curriculum. The lecturers with the view that specialised knowledge of disciplines required to teach the school subject (Life Science) have to be acquired from the Science faculties. And general subject pedagogical content knowledge about classroom should be offered in the Science Education department in the faculty of Education.

Category C: Perspective of pedagogical content knowledge for delivering Life Science curriculum

The data indicated that views and perceptions on the adequate and suitable approaches to delivering Life Sciences differed but somehow implicating the same in practice. The convergence of views was identified on the beliefs held by the academics in the Science Education department who participated in the sample, about experimentation, inquiry-based approaches and problem-based learning, active participation. This trend indicates that lecturers in the sample considered learner- centred or student-centred approaches. In the light of

transformation in teacher education these approaches are relevant to develop independent and critical thinkers in the field of Life Sciences

Category D: Perspective of knowledge integration in the organisation and delivering Life Science disciplinary content knowledge and subject pedagogical content knowledge

The view and opinions presented in the raw data, which comprise this category were distinct from others case studies. The perception of integrating indigenous knowledge systems (IKS), into the main stream traditional western knowledge in Science Education was identified from the data. The issue of the approach to delivery of the integrated knowledge systems for promoting all scientific knowledge systems, was called Dialogical Argumentative Instructional Model (DAIM) which is underpinned by five action verbs (*engage, explore, explain, expand and ensure*). These 5E's were referred to as Big Five E's which enable students to interact with the phenomena in Life Sciences, interact with lectures and interact with one another in the process of knowledge acquisition.

5.7 Classifications of Issues identified from the analysis of data from document analysis

Issue 1# Organisation and presentation of disciplinary knowledge

The organisation of topics or themes in under Cases A and B in table 1 indicates adherence to the notion of content-driven curriculum. The sequential list of the scope in the form of topics points to the vertical articulation of learning progression in the faculty of Science. The scope of work

displayed in the curriculum document shows that topics are aligned with specialised disciplinary knowledge in Life Science for example, Chemistry, Biochemistry, Zoology and Botany.

The contrast was noticed in the documents representing the distribution of content knowledge in the school of Science Education in the education faculty (Cases D & C). The topics presenting the scope of disciplinary knowledge indicated that the content is more bias, to Natural Sciences than Life Sciences. Data shows that in the first year scope of disciplinary content knowledge focuses on Physical Sciences and Chemistry and second year scope reflect scattered topics from Biology.

Issue2# Distribution of topics or themes in the curriculum

Data analysis identified patterns and trends of thought which indicated that some of academics participating in the sample emphasised that themes and topics selected for academic content in sub-disciplines [in the field of Sciences such as, Physical Science, Chemistry, Geography, animal Kingdom and Plant Kingdom in Life Sciences] should be vertically articulated.

Issue 3# Knowledge integration

Perceptions of knowledge integration were identified with views linked to teaching across disciplinary knowledge integration in curriculum design and development. The data, in table 2 reflect the maintenance of heterogeneity in specialised knowledge domains for acquisition of in-depth knowledge in Life Sciences. This implies that academics in the department of Science Education construed integration of knowledge to imply mixing topics (themes) form different specialised disciplines in Science Education. The scenario presented in table 2 indicates the mixture of themes and topics taught to students in the school to enable them to teach Life Science competently in Further Education and Training phase.

Data classified under this category indicate that academics who shared this pattern of thought understood at least the importance of aligning the curriculum for preparing Life Sciences teachers with the needs of students, the expectations of the work place and the national Life Sciences curriculum for schools called (CAPS) although their distrust of integration was a concern.

5.8 Summary of findings

Finding: Learning outcomes identified from the curriculum documents presented learning outcomes as assessment criteria: for example, ‘after completion of this module, students will be able ‘to’, ‘or ‘describe the characteristics/discuss the structure and functions of’... etc.

Implication: The finding manifested that non-alignment of learning outcomes and content as well as assessment criteria has negative implications for implementing the curriculum. The discrepancy noticed in other curriculum documents was the omission of assessment criteria or the fact that only assessment methods were highlighted.

Finding: The first item that was highlighted by the data was the fragmentation of subject content into discrete realities. There is a possibility that students are not able to link the concepts with conceptual knowledge acquired from subject content which is taught on a quarterly basis.

Implication: The organisation of knowledge in this case could create the impression, to students, that these disciplines are distinct or taught in silos

Finding: data highlighted that academics represented in this view in the sample were resisting the international trend in knowledge production which proposed a shift from heterogeneous

subject content knowledge to hybridisation of knowledge from various related disciplines (Gibson, 1994 and Fogarty, 1991).

The implications: This pattern of thought that appeared to be negative towards adoption of such international trends in knowledge production was not held by the overwhelming majority of participants in the sample. In this study such a reactionary, retrogressive trend is concerning: all academics should provide Life Sciences teacher trainees with knowledge that enables them to implement changes and meet the objectives of the espoused curriculum. Contestations about knowledge organisation and selection of subject content knowledge in the curriculum for Life Science education and training are viewed in this study as detrimental to the production of competent Life Sciences teachers in South Africa.

Finding: The concept of integration emphasises organisation of Life Sciences education themes from related sub-disciplines in a vertical order; whereby simple and basic conceptual knowledge is presented during the first semester. The complex content from some sub-disciplines was set for second semester modules.

The Implication: Each discipline should be handled differently. A contrast was identified in other responses which indicated that four components, Geography, Physics, Chemistry and Life Sciences are to be treated as sub-disciplines taught in two semesters in each year

Findings: data presented under this category indicate that academics may differ in their thinking with regards to knowledge integration but work towards a common end, which is integration. Fogarty (1991) provides a wide range of approaches to knowledge integration: that it is concerned with interrelatedness and interconnections which could be exploited by aligning of themes or linking up overlapping concepts. The idea of a modular approach was popular among

academics and this finding pointed to the fact that this is the common practice among academics which could solve the problem of finding appropriate and competent academic knowledge required by teachers to teach Life Sciences effectively.

Implications: The patterns of thought revealed by academics in the sample about integrated knowledge imply a shift: away from conceiving of knowledge in terms of heterogeneity, and towards hybridization of knowledge. The implementation of this shift is viewed in this study as a positive signal towards producing internationally competitive Life Sciences teachers who will make teaching and learning of Life Sciences knowledge more meaningful in schools. Exposition of academic content knowledge for Life Sciences teaching could benefit teachers and learners in schools. For teachers, this could mean they demonstrate competence in playing their roles fully in terms of; phase specialisation, programme interpretation and programme planning as well as subject specialists. Learners of Life Sciences at schools could benefit from teachers who present Life Sciences subject content knowledge in an interrelated manner. Learners can understand knowledge as an integrated system which requires transferability of conceptual knowledge as well as skills (Gibbons, 1994, Kutti, 2010 and National Qualification Framework, 1996).

Data from documents showed that the curriculum blue print did not reflect clear and explicit learning outcomes. Learning outcomes, according to pioneers of OBE (Spady, 1993; Killen 2003; 2005 and 2015; and Biggs, 1994) comprise a broad statement which encapsulates competence and abilities, the planned subject content which learners develop. Biggs (1994) proposed alignment of learning outcomes, content and assessment criteria in the Module or course outline. Assessment criteria are the proof that outcomes were attained.

Finding: Semester courses, modularisation and thematic approaches identified from data and indicated a positive inclination towards knowledge integration which emphasised modularisation of themes across disciplines in the broad field of Life Sciences: Geography, Physical Science, Chemistry and Life Sciences such as observed in the plant kingdom and animal kingdom. Participants who shared this view highlighted in their responses that themes should be organised on a semester basis to enable students to navigate through related themes from a subject's knowledge.

The data associated with this pattern of thought points out challenges encountered by students teaching broad knowledge of Science at schools. Such challenges informed the design and development of the Life Sciences curriculum in the reviewed program. Consideration of the need for infusion of topics into the reviewed curriculum came into being because there were gaps in student knowledge.

Finding: Conception of integrated knowledge as a component of subject pedagogical content knowledge other than academic subject content knowledge was identified with progressive school of thought that support socio-cultural perspective in Life Science knowledge production.

A small minority of participants raised critical arguments about integrating knowledge in preparing teachers for teaching Life Sciences at school. The patterns of thought classified under this category indicate strong support for the idea of a discourse in pedagogy employed in training students in applied competences. This view advocate ways of integrating heterogeneous disciplinary knowledge that enable students to participate actively in identifying related themes, overlapping concepts and transferable cognitive skills necessary to present integrated knowledge in Life Sciences teaching and learning. Participant (participant [J]) argued that:

A Dialogical Argumentation Instructional Model suggests that Pedagogy must be linked to required knowledge; there must be active involvement in the learning process hence prior research should be brought into class. Engage students in the sharing of information.

The model that was identified, from data to reflect thought about the nature of curriculum design for preparing Life Sciences teachers, emphasises teaching and learning cognitive spaces..

Processes of data analysis identified that this pattern of thought perceived DAIM to be an ideal approach to implement Outcomes Based Education in Higher Education because it advocates learner-centeredness and active participation in knowledge production

Implication: This finding could be a great value for the dynamic discourse in pedagogical approaches in Life Sciences teachers Education for effective teaching and learning of the school subject.

Finding: Emphasis on clustering of themes highlighted that that this pattern of thought considered students' psychological needs as expressed in Bruner's Theory of Knowledge processing. The principle of starting with simple or basic concepts and working up to complex conceptual knowledge speaks to the view of Bruner's spiral Model for curriculum design and development.

Implication: Consideration of students' psychological and cognitive needs implies that academics' conception of curriculum development is informed by research and theoretical principles on curriculum design and development. This study perceives this trend to be of crucial importance: addressing students' needs, particularly at first-year level: research shows that many students dropout when they fail to cope with content and pedagogical approaches in Higher Educational Institutions (HEI's).Academics advocate that knowledge integration is only possible

if students are exposed to distinct or disciplinary knowledge first; before they are engaged in any form of integrated knowledge. Such Science teachers are likely to face challenges in implementing Life Sciences school curriculum. By contrast, however, proponents of knowledge integration for effective knowledge acquisition claim that learners should be encouraged as early as possible in their schooling to make links between subjects which are otherwise artificially separated into stifling and unimaginative silos of specialist learning.

Finding: Linking academic content knowledge with Life Sciences content knowledge benefits Life Sciences teacher trainees: to acquire in-depth subject content as well as its specialised pedagogical content knowledge.

Implication: This study regards this approach to be of benefit to Life Sciences teacher trainees in applying theory in their practice of teaching of the Life Sciences curriculum. Integration of theory learning and practical learning could equip Life Sciences teachers with competences that contribute to specialist subject knowledge and specialised pedagogical knowledge which relate to: knowledge of the learner, teaching strategies, learning styles and assessment procedures (Killen, 2005 and 2015).

Finding: Models for knowledge integration: There were several ideas noted during the process of data analysis that pointed to models for implementing knowledge integration. Data revealed that academics in their practice of knowledge organisation, tried models that in one way or another relate knowledge integration; as advocated by researchers, Gibbons, (1994), Fogarty, (1991) in Mode 2 knowledge production theory. The responses associated models such as the King 5E's and Dialogical Argumentation Instructional Models: on the basis that they expose students to approaches to learn across main

disciplines. Such models emphasise problem-solving learning, inquiry-based learning as well as deductive and inductive principles underlying knowledge generation by students. The possibility arises of integrating indigenous knowledge systems in knowledge production with mainstream theories which enjoy recognition in South Africa.

Implication: The implication of this finding is that integration of knowledge systems in Life Sciences is a form of incorporating concepts across culturally diverse forms of knowledge. This synthesis could benefit previously marginalised scientific discoveries and inventions that did not enjoy the same recognition as their Eurocentric counterparts. Consideration of indigenous scientific knowledge brings equal recognition of all cultures and recognises significance of previously under-represented cultures in South Africa, Africa and across other parts of the world.

Implication: The implication of this finding is that integration of knowledge systems in Life Sciences is a form of incorporating concepts across culturally diverse forms of knowledge. This synthesis could benefit previously marginalised scientific discoveries and inventions that did not enjoy the same recognition as their Eurocentric counterparts. Consideration of indigenous scientific knowledge brings equal recognition of all cultures and recognises significance of previously under-represented cultures in South Africa, Africa and across other parts of the world.

Finding: According to this view, the product that resulted from the process of the Review of Life Sciences did not introduce any substantial changes.

Implication: This implies that the Curriculum Review for preparing Life Sciences teachers was just ‘pouring an old wine into a new glass’. This shows that recommended attributes of a competent Life Sciences teacher, as promulgated in the policy for minimum requirements for teacher education qualification (MRTEQ), were ignored.

Data point to contrasts that surfaced from utterances that appeared to be in support of this perception.

The way I see it, we are taking the field of Science as integrated knowledge but at the same time we look at the learners as a homogenous group. There are areas where you need a person to focus on one discipline; particularly a specialist in a certain Area of Life Sciences.

Finding: A contradiction was noted in the responses classified under this category. The statements highlighted that the curriculum that was developed integrated Botany and Zoology. In contrast, other significant areas necessary for teaching Life Science subject content knowledge (SCK) were disregarded.

Implications: The selection of Botany and Zoology content knowledge from other significant areas of disciplinary knowledge indicated that academics focus on those areas that they feel confident to teach, and leave out those that they do not care about or know much about. This neglect is viewed in this study to have negative repercussions for Life Sciences teachers and, in particular, learners in schools.

Finding: critical synthesis of the data reveals that students are encouraged to generate their own kinds of mind-maps by means of dialogue and argument. Deductive and inductive attitudes of mind indicate critical thinking and advanced cognitive competences in subject knowledge.

Implication: The strength of this pedagogy is that it engages and incorporates learning; empowering and enabling students who, by virtue of deprived social backgrounds, may not have been exposed to certain crucial conceptual knowledge.

Finding: data indicate conceptualisation of knowledge as a source for learning concepts and understanding of systems in various contexts. The topics selected for each module do not indicate sub-disciplines but allow integration of knowledge within the fields of study in Sciences.

Implication: this finding is regarded as a positive response to the principle of integration advocated in the DHET curriculum policy for the training of Life Sciences teachers. It is an indication of a highly significant shift: away from the tradition of compartmentalisation of knowledge in unrelated realities. This trend in knowledge organisation could produce teachers who have broad knowledge of sciences and are able to teach Life Sciences competently and

Finding: Lack of interrelations between the description of the core subject content and learning outcomes was considered as a matter of great concern. However the topics, as presented, manifested vertical articulation as recommended by Bruner's spiral model.

Implication: Learning of linear topics, according to Killen (2003:90), does not add value in the acquisition of integrated knowledge. Killen (*ibid.*) states that: "packing the curriculum with many topics results in superficial understanding for many students".

5.5 Summary

The themes and categories presented in this chapter were the result of a complex process of data analysis. Coding data led to grouping of data according to patterns of thought and information developed from literature. Themes presented a summary of data and findings from in-depth interviews. The issues identified from summaries of data, findings and implications form part of the synthesis and discussions in chapter six, the next chapter.

Chapter 6: Synthesis of Findings and Discussions.

6.1 Introduction

This chapter presents findings identified from themes presented in chapter five. A summary of data presented under each theme includes issues that have implications for the problem statement, objectives and research question of the study. The issues discussed are the key statements indicating academics' perceptions of knowledge integration in the development of the curriculum for educating and training initial teachers for Life Sciences. The synthesis of findings points to certain divergent and convergent perceptions of curriculum models and approaches held by academics involved in teaching and training teachers for effective and competent Life Sciences teaching. Discussion of the findings drew from the conceptual framework and theoretical framework underpinning the empirical study reported on in chapter four of this thesis.

6.2 Issues that indicated progressive and critical paradigms in education and training of Life Sciences teachers.

6.2.1 Issue#1: Consideration of prior research on educational transformation: Situational analysis.

Some academics point to the issue of 'prior research' which is often interpreted to mean that teacher education and training is informed by the educational policies on school curriculum change, innovations or continuities. The issue of 'prior research' in the data could indicate that thoughts about any new curriculum for teacher education and training should begin with an analysis of needs. According to researchers such as Du Toit (2013) and Carl (2015), curriculum development should take into consideration the needs of all stakeholders: communities, society,

students, and employers. Tyler's model of curriculum design and development in (Ornstein and Hunkins, 2014) entails: psychological needs of learners; cognitive needs; affective needs and psycho-motor needs. Social needs imply the learning milieu, resources, accessibility and issues of equity and equality. All these elements are revealed by 'prior research'. According to the Taba model and Carl model, prior research findings, besides informing the curriculum design and development process about needs, provide guidelines for selecting, organizing and planning, and sequencing of subject curriculum content and pedagogical approach suitable for the needs of the recipients of the curriculum.

6.2.2 Issue#2: Engaging students in the sharing of information: critical and hermeneutic paradigms.

This issue implies that students' daily life experiences and examples should form the context and content to be used in developing skills for knowledge production. This notion of knowledge context embraces principles of social learning theory and social interactions as a mode of knowledge generation. Killen (2010) emphasises the importance of such social context for the effective learning of concepts and content.

6.2.3 Issue #3: Deductive, Inductive and Inquiry Learning: critical paradigms

In the light of this study's objectives, issues of deductive and inquiry learning point to the fact that academics contemplate any shift away from a content-driven paradigm to either competence or outcome-driven paradigms for curriculum development and adaptation. Interpretation of a deductive approach, as conceived by the Participants in learning and knowledge generation, entails logic and reasoning in the acquisition of disciplinary content knowledge and subject

pedagogical content knowledge. In this view, a deductive approach could be suitable for enabling students to teach Life Sciences effectively in the classroom. The perception of the curriculum design and development held by academic proponents was that a deductive principle should underlie the selection and organisation of Life Sciences - disciplinary content knowledge as well as its subject pedagogical content knowledge. It may be inferred that academics who employ the Dialogical Argumentation Instructional Model (DAIM) prefer vertical articulation of knowledge for skills and competences development to rote learning through content-driven approaches (Killen, 2015, Morrow, 2007, and Slomnisky and Shalem, 2006).

According to Zalaghi and Khazaei (2016), deductive principles in learning emphasise the identification of objectives which are based on definitions of assumptions. Deductive thinking was identified as an issue in analysis and interpretation of data because it provides a clue to what academics consider to be integration of subject content knowledge (SCK) and subject pedagogical content knowledge teaching of Life Sciences as a broad field of study or Learning Area (LA). Zalaghi and Khazaei (2016) explain that a deductive approach enables students to identify various components of the phenomena and their interrelations; using logical reasoning. This argument indicates that students are able to draw their own conclusions through inquiry learning and experiential learning while they unpack definitions and assumptions presented by theorists in subject content knowledge. Beiske (2007) emphasizes that assumptions are generated through argumentation which begins with a theory and leads to new assumptions which are tested via comparison with observations, and finally accepted or rejected. This process implies that Life Sciences students should be engaged in the argumentations so that they will generate their own assumptions based on theoretical knowledge.

The other critical aspect in this discussion is the inductive approach which was highlighted during data analysis.

6.3 Issues identified regarding resistance to implementation of transformation in the academic and professional training of Life Sciences teachers.

Interpretation of findings presented in chapter five showed the emergence of a certain pattern of behaviour exhibited by those who appeared to be against amalgamation of academic content knowledge across the disciplines. Academics representing this trend of thought supported maintaining discrete concepts and conceptual knowledge in the organization of knowledge for educating and training of Life Sciences teachers. This trend of thought militates against the opinions and recommendations of policy makers of the Higher Education Qualification Framework (HEQF) of DHET (2011 and 2015). According to the policy framework for the design and development of curriculum for teacher qualification, academics are expected to ensure that the principle of integration is sustained. The reason for integration as stated in the policy is to ensure that students acquire knowledge that enables them to demonstrate applied competences through integrated learning: academic learning, situational learning, practical learning and foundational learning. Reviewers of the Department of Higher Education and Training point out that the cohort of teachers prepared during Norms and Standards curriculum are not competent to implement changes introduced in the school curriculum. Institutions of higher learning were provided with guidelines necessary to design and develop curriculum that complements the attributes of a competent teacher. The inclination to resist change was identified in statements such as: 'I was thrown in the deep end; obliged to develop a curriculum for Life Sciences and honestly, it is a replica of its predecessor'. This finding indicates that

academics whose thoughts are represented in this statement ignored the recommendations and guidelines for transforming the curriculum for Life Sciences teachers. The implications of this refusal to change could be that certain academics adhere to their traditional approaches. The disregard of curriculum change disadvantages both Life Sciences as a subject area and learners of Life Sciences in schools.

6.3.1 Issue #1: Reproduction of incompetent teachers for Life Sciences.

Interpretation of data highlighted that academics at universities are still showing allegiance to conservative or traditional approaches to production of knowledge; as if it were a fixed objective entity, or body of facts. By contrast, Morais and Neves (2001) underline Bernstein's theory which emphasises the uniqueness of knowledge as defined by its subjective formation in the mind of the individual knower [or teacher/student in the case of this investigation]. Knowledge production models provided by Bernstein's theory in Davis (2001) explain that modalities in subject knowledge production generate a unique syntax and semantics. Bernstein (2000) emphasises the distinctive features of each subject: each subject has its code modalities and those are the determinants or principles regulating knowledge production. Similarly, Maton (2007) in agreeing with Bernstein argues that the Legitimizing Codes theory confirms that knowledge is classified according to specific codes which provide recognition rules.

Moore and Young (2010) challenge the schools of thought that promote the view of subject knowledge as distinct realities. These researchers point out that certain models of curriculum design and development [those dominated by a set of assumptions about knowledge production as neo-conservative traditionalism and technical-instrumentalism] serve a cognitive and technical agenda. Students or teachers 'produced' by such curricula are seldom competent creative and critical thinkers: key abilities required in the 21st century. The differences between knowledge

integration in Mode 1 [which is a heterogeneous discipline or taxonomy of disciplines] to mode 2, amalgamation of disciplines, are particularly significant in South Africa which has a long history of attachment to mode 1 education of unquestioning obedience under apartheid. In respect of Life Sciences teaching, Sharma, (2017) and Ahmad, (2014), assert that teachers should be grounded in a plethora of themes: Biological sciences (animal and plant anatomy and human physiology), Paleontological studies and biomedical studies, Ecology and Biochemistry. Conceptualisation of Life Sciences in the school curriculum indicates that knowledge of Life Sciences entails a broad field of knowledge: the animal kingdom, chemistry, biochemistry, microbiology and human physiology.

Neglect of knowledge integration in the university curriculum deprives teachers of Life Sciences of an opportunity to learn about the interrelatedness and interconnections between the subject content areas in Life Sciences. Killen (2005:91) points out that “school learners cannot be expected to integrate knowledge within and across the subject boundaries without considerable guidance of the teacher who is competently trained”. Jansen and Christie (1999) note that hybridisation of knowledge in teacher education introduces a paradigm for teaching and learning in universities which is a way of aligning teacher training with transformation in the school curriculum. The argument stresses that hybridisation of knowledge requires competences and expertise of teaching across traditionally heterogeneous zones of subject content.

6.3.2 Issue#2: Challenges facing organization of academic disciplinary knowledge for Life Sciences teaching.

Interpretation of data and findings show that academics are encountering challenges in implementing the principle of integration into the selection and organisation of academic content knowledge in the curriculum of education and training of teachers of Life Sciences. Analysis of

data identifies three main issues as impediments: (i) academics are more biased towards their specialisation, (ii) the small number of academics who specialised in more than two disciplines. Most lecturers specialised in Mathematics, Physics or Chemistry. According to the findings, that state of affairs makes it difficult to include themes while knowing that they will not be taught by anyone. (iii) Students enrolled in the Science Education Department find it difficult to learn themes not linked to knowledge of their Grade 12 subjects: for example one Participant commented that first-year students find it difficult to do Physics and Chemistry for the first time at university level; subjects which were introduced in the reviewed curriculum in 2016.

This finding implies that the curriculum change for the Minimum Requirements of Teacher Qualification in higher education institution (HEIs) does not solve the problems which necessitated the review of Life Sciences and led to equipping teachers with appropriate academic disciplinary knowledge required for improving learner performance at schools. Another concern is that teachers of Life Sciences would not be rated as 21st century teachers. Barreteau (2010), Bocking (2007), Brunet *et al.* (2014) and Nowotny *et al.* (2003) argue that the emerging trend in knowledge production aims at equipping students or learners with expertise and skills required to solve global challenges of the 21st century. This view emphasises that knowledge integration enables students to solve social, economic and environmental problems through integrated multi-disciplinary, inter-disciplinary or intra-disciplinary theoretical and practical knowledge and transferable skills.

6.3.3 Issue #3: Academics not complying with the Higher Education Qualification Framework Policy.

Findings from analysis of data highlight that, although curriculum blue prints were approved by the Higher Education Qualification Committee (HEQC) of the South African Qualification

Authority (SAQA), implementation of such approved curricula remains a difficulty. Another problem highlighted by findings related to selection of academic disciplinary content as well as pedagogical content knowledge. The issue of reviews of school curriculum was regarded because it affected teacher education and training. Debates and contestation regarding what should be part of curriculum design and development for Life Sciences unfairly delayed the process of curriculum review at some institutions. Alignment of teacher education and training with changes and continuities of school curricula was promulgated in the DHET (2011 and 2015). According to this alignment, curriculum for teacher education should be designed and developed in such a way that Life Sciences teachers can teach across the two phases in different bands. This means that a Life Sciences teacher should be able to teach subject content from senior phase (SP) grades (7, 8 and 9) in the General Education and Training Band (GET) and further education and training phase (FET) grades (10, 11 and 12). The implications for these changes in school curriculum obliged academics to think carefully about the model to be adopted in the organisation and selection of subject content to meet this critical need of schools as legitimate stakeholders. Selection and organisation of content knowledge required academics to ensure that teachers who taught at their institutions met conditions of employment.

Contestations in curriculum design and development of the discipline by researchers such as Carl (2014), Schubert (1986), and Kelly (2009) are informed by philosophical and theoretical paradigms. Academics adopt different philosophical foundations for a curriculum. According to Ornstein and Hunkins (2012), academics could propose the adoption of an essentialist philosophy to underpin the curriculum for the purpose of ensuring that a particular curriculum is relevant to:(i) the essential needs of a society and (ii) the expectations of all stakeholders. According to researchers such as Ornstein and Hunkins, there are academics who strongly

believe in the perennial philosophy and the interest of these academics in curriculum design and development is to pursue the view of knowledge as a product of absolute positivism. Pedagogical proponents of this philosophy promote acquisition of what they take to be factual knowledge; without questioning it. Schubert (1986), comments that a perennialist curriculum emphasises an analytic-empirical paradigm in knowledge production, teaching and learning.

Critics of the perennial philosophical foundation in curriculum design and development condemn it, however, for serving a technical interest which prepares teachers who will perform reproductive teaching (Grundy, 1994, Kelly, 2009 and 2011). A technicist curriculum in teacher education and training is criticised by Ornstein and Hunkins (2014) for reproducing teachers who are transmitters of knowledge; from sources to learners, without any critical interventions or interpretation; as a result, learners become passive recipients of what they are told is ‘factual’ knowledge.

Findings in this investigation indicate the prevalence of patterns of thought that are informed by perennial philosophy. During the process of data analysis, certain dispositions manifested an inclination in support of perennial philosophy and an analytic-empirical paradigm: for example, ‘We often want to teach content of our own specialisation instead of this jargon and different views leading to endless curriculum revision. Teaching these disciplines in silos had produced good and competent teacher over many, many years. We were not going to be where we are if we did not specialise’.

Conclusions concerning such contestations and acrid debate indicate that the curriculum that was approved by the DHET for these institutions could not be effectively implemented due to the fact that the implementers were not unanimous or in full support of the philosophical foundations and

the theoretical paradigm underpinning the curriculum. It was concluded that the possibility existed that such destructive contestation over these critical issues could itself cause misunderstanding and obstruct effective implementation of up-to-date curricular changes. There is the possibility that stubborn resilience to change may be caused by ignorance: those defending an old curriculum are doing so because they inherited certain modes of thinking about curriculum without any awareness that such models were based on philosophical dispensations which are subject to change. Such defenders of old ways often suffer from intellectual inertia: they are not conscious apologists for a particular school of thought at all.

Significantly, policy guidelines concerning design and development of curriculum for teacher education and training explicitly indicate that integration should be the leading, principle conceptualisation behind a curriculum: the intention was to address the problem of a technicist approach to teacher education and training. Under Christian Nationalist education (1948-1994), teacher training had to adopt a pedagogic schema of rote learning, unquestioning acceptance of textbooks prescribed to endorse government prejudices and obedience to propaganda. Post-1994 revisions aimed to remove such indoctrination and patterns of unreflective repetition. It was to be expected that remnants of such an entrenched mode of reproductive pedagogy would re-emerge and signal a return to old, familiar ways without any real engagement with new ideas of liberal international trends in education.

6.3.4 Issue #4: models that influenced certain patterns of thought identified from findings.

6.3.4.1 Tyler Model

The findings of this investigation pointed to the dominance of, and adherence to, the Tyler Model in the conceptualisation of curriculum design by academics. Adherence to Tyler models manifested in such comments as: “A lot was more predetermined; the time curriculum was designed and developed in a systematic way.” According to proponents of the Tyler model, Carl (2015) and Ornstein and Hunkins (2014), this model advocates a systematic process in curriculum design and development. This model emphasizes, first and foremost, a formulation of aims and objectives. Schubert (1986) confirms that advocates of this model view curriculum development as a linear process that begins with clearly-articulated objectives which predetermine the outcome of the process of learning and the intended learning performance resulting from learning. Selection of content is determined by stated objectives and aims. According to this model, content is described by Ornstein and Hunkins (2014) and Kelly (2009) as a vehicle or means through which objectives are attained. Interaction between teacher and learner is based on systematically organised content which, in this model, is inherent in philosophical foundations representing the purpose and aim of education as well as aspirations of the society; content is significant in the teaching and learning context. Grundy (1994) links this model with progressivist theories of learning; for example behaviourism. Ornstein and Hunkins (2014:86) claim that curriculum should transmit a society’s culture: acquisition of content knowledge and cognitive skills are considered to be the output of the learning process.

6.3.4.2 Evidence of Outcomes Based curriculum programming.

Findings of this research project revealed that principles of outcomes-based education influenced some of the thinking during the process of curriculum decision making. Two theories, in particular, King 5E's and Dialogical Argumentation Instructional Models, were cited by some Participants and indicated evidence of an emerging discourse; away from traditional trends that dominated teacher training from 1948-1994, conceptualisation which dictated curriculum design and development previously under white Nationalist government.

Emerging new trends responded constructively to proposals of the DHET policy related to progressivist philosophy and analytical-empirical paradigms. The Dialogical Argumentation Instructional model (DAIM) in its theory and practice points to a critical paradigm in knowledge production and pedagogical approach. According to Schubert (1986), Grundy (1994), Kelly (2009) and Pinar (2011), a Critical Paradigm as a theory of curriculum design and development regards curriculum as praxis: meaning that acquisition of knowledge occurs through active social interaction among individuals and learning takes place by sharing life experiences. Data highlight that the principle of this model emphasises problem-based learning, inquiry-based learning and dialogue. Pedagogy of this kind is associated with social constructivism; more specifically, the social learning theory of Vygotsky and the political concern for uplifting the poor by means of education which is advocated by Freire and which is of particular, urgent relevance to South Africa after 1994. Similarly, those advocates of King 5E's among the Participants explain that this model encourages active participation among students who engage, explore, explain, expand and ensure. In this study these two models speak to the principles of Outcomes Based curriculum programming theory and practice; as researchers, Killen (2005, 2007 and 2015), Marshall and Spady (1993) defined them: clarity of focus, highest expectations;

designing backward and delivering forward, learner-centred and expanded opportunities. Outcomes based curriculum programming encourages active participation, experienced-based and inquiry-based learning for attainment of learning outcomes. Proponents of Outcomes-based curriculum programming, Spady (1991), Killen, (2003 and 2005), Rowland (2007), Noll (2013) and Coil (2005), emphasise that learning outcomes reflect three things: (i) what the student knows (foundational competence), (ii) what a student can actually do with what s/he knows (application or practical competence) and last, (iii) the student's confidence and motivation in carrying out the demonstration (Reflexive competence).

In same argument, Spady (1994) introduces the issue of Subjective Epistemology which is the culmination of students' active participation. This view confirms that through the models (DAIM) and King 5E's, students studying to teach Life Sciences at national Faculties of Education develop their own conceptual understanding of integrated knowledge; drawing it from related disciplines. Fogarty (1991: 61-64) presents various approaches to knowledge integration; for example, the web model, integrating knowledge across the disciplines; the connected model, which entails connecting topic, skills and concepts within the same discipline and the threaded model or integration of 'big ideas' that promotes transfer of skills through related disciplines. Agreeing with the importance of students' active participation in knowledge production, Dancy (1991) argues that self-discovery and 'subjective epistemology' provide epistemic foundations for knowing about things which are essentially propositional. The implication for Life Sciences teacher trainees could be the development of competences to select and organise subject content appropriately for meaningful learning of Life Sciences.

6.3.5 Issue#5. Non-compliance with the principle of integration in curriculum development for teacher qualification.

Organisation of content knowledge into separate chunks does not resonate with the goals enshrined in the DHET curriculum policy of 2011 and 2015. The approach adopted by many academics did not provide a context for acquisition of applied competences which are the key elements for learning in higher education. According to DHET (2011 and 2015) applied competence is the overarching term for three interconnected kinds of competences: foundational, practical and reflexive competence. According to the policy, applied competences have to be demonstrated within the subject or phase specialist roles that define the qualification. The incompetence of students to organise content knowledge through concept mapping could result in gaps in their conceptual knowledge of Life Sciences. According to DoE (1997) and Killen (2005), integration can take place in two ways: integration across, and within a discipline. Clarke and Linn (2003) recommend that within-subject integration with reference to Science education entails adding new ideas and sorting through connections to develop a cohesive account of scientific phenomena. They suggest that developing a deep understanding of Science requires sustained design of interconnected material. They warn against packing the curriculum with many unrelated topics: which results in superficial understanding for students. Integration of knowledge across other disciplines entails breaking down barriers and enables students to navigate through themes when searching for solutions to real-life problems. Gibbons (1994), Kutti (2001) and Repko (2007) emphasise the notion of integration of knowledge when stating that ‘in the real world, there are no absolute barriers between fields of study – every field is related to some other field of study’. Understanding the interrelatedness and interconnections in

disciplinary knowledge enables learners to comprehend issues through various lenses developed from exploring solutions across various fields.

6.4 Discussion of the summary of findings in line with critical questions, objectives and the topic of this thesis.

The argument presented in the motivation and problem statement of the study in chapter one and chapter four pointed out that knowledge integration in the curriculum revision for educating and training Life Sciences encountered obstruction from academics because they were either (i) deliberately obstructionist or (ii) unconsciously so or (iii) simply so brain-washed by a century of white-dominated propaganda that they could not conceive of Freirean models of social upliftment through education for all or (iv) simply ignorant of the notion of philosophical underpinnings altogether.

The three questions set as guide-lines for the empirical study conducted at institutions of higher education provided qualitative data from which answers could verifiably be deduced. The first question sought to elicit information pertaining to academics' conceptions and perceptions of knowledge integration in the designing and development of curriculum for initial Life Sciences teacher education and training.

Objective #1: To highlight patterns of thought regarding integration of knowledge for Life Sciences Education.

CQ#1: How do Life Sciences teacher educators regard knowledge integration?

The findings presented in chapter five and the synthesis in this chapter, provide answers to this critical question. This study concludes that indeed the process of curriculum design and development for preparing competent Life Sciences teachers in the initial teacher education and training programme was not an easy task for academics. The difficulty was mainly caused by contesting views regarding selection and organisation of subject content knowledge across related disciplines. Converging views were identified concerning approaches such as modularization and thematic approaches. This was considered as a key pattern of thought in the context of this study's objective [as linked to this question]. The conclusion provides information related to the topic for this study: 'Teacher Educators' Perspectives of the principle of Knowledge integration in the curriculum for Life Sciences teaching'.

The chief conclusion drawn from the findings indicates that the perspectives held by teacher educators regarding integration are fluid; meaning that there are no specific approaches adopted. The models identified from data provide some hope, however, that fresh views and scientifically-tested models that inform knowledge integration in the new curriculum are coalescing. Some academics from the sample took the issue of teaching across disciplines seriously. This is considered in this work as a positive performance indicator.

Objective # 2: Dominant perspectives of how Life Sciences educators regarded the principle of integrated knowledge in the Life Sciences curriculum changes for initial teacher education and training.

CQ# 2: Why do Life Sciences teacher educators have such conceptions and perspectives of knowledge integration?

CQ # 3: How do Life Science teacher educators view integration of disciplinary knowledge in the espoused Life Sciences curriculum for teacher education and training as stated in the policy (MRTEQ)?

Synchrony of findings from all the data collected during the empirical study points to a diversity of interpretation of what integration in curriculum design and development entails. Because academics are involved in research for knowledge production, they provide guidance based on scientific understanding of what principles of integration imply for academic curriculum development.

Findings highlight that there are diverse perspectives concerning resistance to transformation of curriculum for teacher education. This diversity is considered in this study to comprise attitudes and negative dispositions pointed out in Fullan's Theory of Change. Fullan describes curriculum change as a process that brings discomfort to practitioners: change requires a paradigm shift from theoretical and practical knowledge which has become a revered tradition for some practitioners [especially in SA from 1948-1994]. Resistance is one of the mechanisms most used by recalcitrant curriculum implementers to maintain the *status quo* as a safe and convenient comfort zone for themselves. Fullan explains that change requires curriculum developers and implementers to undergo an attitudinal transformation; learning to accept change and own all the development brought about by such curriculum change.

The conclusion, based on the findings with respect to the objectives and the critical question as well as the topic set, is that the study convincingly demonstrates how and why the curriculum designed and developed for Life Sciences teachers is facing resistance of different kinds. First, the teaching of what is supposed to be related and connected disciplinary knowledge is at this

point in time, once again, being taught at many institutions to students as discrete knowledge. Second, preparation of Life Sciences teachers as envisaged for effective implementation of Life Sciences curriculum innovation in school remains a myth.

Third, the education and training in South Africa is not internationally competent to produce 21st century teachers. The National Educational Crisis Committee (NECC, 1992: 73) ‘regards the preparation of teachers as the crucial point: ... teachers require a theoretical basis ... to knowledge integration, educational aims and methods of the programme. Competences required from teachers to implement integration include; abilities to analyse information from various resources, formulate learning objectives that enhance integration and select learning experiences in a manner that learners are able to transfer skills across the disciplines in that field and to assess adequately’.

The findings and conclusions of this investigation into Life Sciences curriculum identify certain problems facing the design and development of a curriculum to prepare teachers for integrated disciplinary learning. These findings were predicted by researchers (NECC, 1992) before hybridization of subjects was introduced. It was, and is, however, expected of universities, as spaces of knowledge production, to find solutions to the difficulties of implementing integrated studies; through commitment to principles of social transformation, liberal thinking and unbiased pedagogic research.

6.5 Conclusions

The difficulties highlighted by the findings in this study indicate that the chief problem lies not with teachers but emanates from the curriculum on which Science teachers are trained. Science teachers do not demonstrate applied and practical competences in areas of theoretical and practical knowledge because they have not mastered these skills in their basic education and training. The diverse interpretations of curriculum change postulated in the National Curriculum Policy for teacher education and training could be a threat to the transformation of education in South Africa. If the curriculum for Science education teacher training fails to complement the changes and innovations introduced in the national school science curriculum, there is likely to be chaos. The result of this chaos could manifest in the high failure rate of students in the subject: researchers at universities could start blaming schools and provincial and national departments of education for failure to design an effective school curriculum. Schools and departments could well retaliate by blaming universities for educating and training teachers who are not competent to teach school subject content. Science teachers are expected to teach Natural Science and Technology in senior phase and Life Sciences in Further Education and Training phase.

The importance of life-long learning and openness to learning is crucial for Science academics; particularly those who are involved in teacher education. The paradigm of interpreting the unfolding realities in various spheres of world systems (economic, social, environmental and political) require re-thinking and re-conceptualised knowledge systems in the teaching and learning of Science. Knowledge Integration through hybridisation of related disciplines permeates research in South Africa and globally. Since their inception in 1997, the South African

Qualification Authority (SAQA) and (NQF), advocate educational and curriculum change. These bodies propound transformation in a democratic South Africa; embracing and pioneering integration of knowledge and learning. This liberal stance indicates that research and life-long learning should define transformation in all sectors and structures at educational institutions: universities and other institutions of tertiary education and training.

For the sake of pre-service Science teachers and the realisation of national educational goals, the science education specialist and teacher educator should find common ground for conceptualising the needs of Science teachers in a reviewed curriculum. Such common ground would overcome the issue of lack of uniformity in the education and training of competent Science teachers for National Science school curriculum and its changes. Any consensus on issues of philosophical beliefs and fundamental foundations for Science education curriculum would greatly benefit South African Science teachers of the 21st century.

It is the nature of academe that it allows contestations and robust debates and generation of contending theories: academics are known for intellectual engagement about issues related to the nature of things, structures and operations. But blatant lack of conformity to curriculum policy is not helpful: some academics continue to claim that there is nothing wrong with the maintenance of heterogeneity in disciplines in Science education. This stubborn, and often ignorant, perception of knowledge integration has detrimental effects for science teachers nationally and impedes learners' understanding that Science is about exploring new ways of thinking and testing structures in order to understand their connections and relations. For example, contemporary issues raised in the United Nations Organization's millennium goals could provide a focus for integration of Science curricula: poverty and unemployment, environmental sustainability, child mortality, HIV/AIDS, malaria and other diseases. Deductive approaches to

learning could enable students to navigate concepts within the disciplines including indigenous knowledge systems. Skills and competences acquired through engagement could enable science students in teacher education to produce knowledge, verify new findings through testing or experimentation and explain them in an appropriate context.

Knowledge integration is a paradigm shift for developing Science education curriculum for teacher education and training. Integration can act as a principle underpinning implementation. The synthesis of the findings of the study highlighted issues that typify confusion and uncertainty regarding interpretation of the DHET (2011 and 2015) notions of integration and integrated Science education. Questions raised by the study are: How can academics and teacher educators hold such diverse conceptions about fundamental issues underpinning the curriculum and yet hope to produce quality Science teachers fit to implement the school curriculum? Are there possible ways in which academics from Science education departments can debate and engage with each other constructively to establish common ground on the vexed issue of knowledge integration?

The study concludes that there are academics at Science education departments who still adhere doggedly to traditional ways of teaching their own specialised disciplines. They remain adamant that their practice is informed by renowned educational theories and philosophies. The findings of this study convincingly show that there is a worrying disjuncture in the interpretation of the notion of knowledge integration. The theoretical and practical implications of knowledge integration received diverse interpretations from academics in some Departments of Science Education which differed from those of formulators of the National Curriculum guidelines for minimum requirements for teacher education (MRTEQ).

The second conclusion is that science teachers educated and trained in the context of heterogeneous, specialized academic disciplinary content knowledge could experience challenges in teaching Science across domains and epistemologies. The espoused national school science curriculum and policy statement expect teachers to present content knowledge across other related subject domains: for example Life Sciences and Technology (NST).

The issue of non-conformity to curriculum policy creates a grave division between teacher education and training, and expectations as well as needs, of South African schools after 1994. The clustering of subjects in the field of Science in the school curriculum requires qualified teachers to teach across knowledge domains: for example in Life Sciences the teacher in senior phase (grade 7,8 and 9) should have knowledge of Physics, Technology, Chemistry and Life Sciences. This implies that a Science teacher should be able to present conceptual and factual knowledge in an integrated format for senior phase learners to understand interconnections and interrelations between concepts; so that learners can transfer knowledge and skills across knowledge domains and epistemologies. This integration enables learners to acquire basic conceptual knowledge for lifelong learning through the transfer of knowledge and skills.

This study confirms the claim expressed in Fullan's theory of change that characterizes the fears and obstructive behavior of implementers: change of curriculum introduces new beliefs, objectives and values which threaten the old guard. Adaptation of curriculum forces implementers to move out of their comfort zones and adjust to new thoughts, concepts and actions. Fullan (2006) points out that resistance is inevitable during implementation of curriculum changes and innovations.

This study advises that a collaborative and collegial deliberation among science education teacher educators and experts in various knowledge domains could be a way forward: to find common ground on issues highlighted in this study. Re-thinking and re-conceptualising knowledge organisation for science academic knowledge appropriate to the needs of the school could be of great value in equipping science teachers with knowledge and competences for effective teaching of knowledge, skills and values in the subject. Through research and conferences, academics engage in scholarly networks to share and exchange ideas: so that issues of integration in Science instruction may be resolved by open debate and constructive networking. Institutions of higher education in many countries provide guidance for transforming education and producing teachers of high quality. The situation revealed by this study indicates that universities have not transformed their fundamental systems of thought: particularly with regards to teacher education and training. The findings indicate that the National School Curriculum and the National Curriculum Policy for teacher education point in the same direction yet, by contrast, academics in their Faculties of Education face in the opposite direction.

The historical background to higher education and the ideological beliefs behind its racist genesis in South Africa, create an environment for resistance. Conflicting schools of thought manifested themselves sharply in some responses; even though they could not be highlighted as the main findings. There was strong evidence of entrenched pedagogy that strove for the maintenance of the *status quo* of teaching Science as heterogeneous subjects. Defending conservatism and traditional schools of thought in Science Education Departments implies that knowledge systems of marginalised communities and their cultural context are not integrated into the knowledge production of a united South Africa. Malcom and Stears (2005: 22) cite Gao (1997) to emphasise the critical role of indigenous culture in the learning of Science: ‘culture, as

a contextual lens through which people view and understand the world, has a direct influence on learners' cognitive processes and understanding of science.' Zarry (2002) confirms that a curriculum that includes learners' cultural and everyday experiences greatly assists learners to own scientific knowledge and re-create it in new and profound ways.

6.6 Summary

This chapter, as indicated in chapter one, presents a summary and synthesis of findings. In chapters two and three, it was indicated that presentation and synthesis of data are presented within conceptual and theoretical frameworks. The conclusions drawn in this chapter were presented in line with the critical questions as well as the objectives stated in chapter one and chapter four. It was on the basis of these conclusions and findings that the recommendations were made.

Chapter 7: Recommendations and proposals for future research.

7.1 Introduction

This chapter presents recommendations and suggestions that arise from findings and data presented in the study. A synthesis of this material is provided in reply to critical questions and the topic set for investigation. Recommendations presented in this chapter are linked to findings and conclusions. Diagrams illustrate what integration in Science education entails for the development of curriculum for educating and training competent Life Sciences teachers. Such diagrams can be used to facilitate and encourage teachers in Science education to acquire enabling knowledge. Emerging trends in knowledge production commonly known in literature as Mode2 knowledge production were perceptible. Recommendations made in this study are informed by well-established conceptual and theoretical frameworks as well as data collected from the empirical study conducted.

7.2 Recommendation #1: Sustainable Development Goals (SDGs) to provide the contexts for multi-disciplinary and interdisciplinary knowledge organisation in the academic curriculum for Life Sciences teacher education and training.

Conclusions and findings show that teaching of Science education persists as separate ‘silos’ in teaching and training of Life Sciences. By contrast, this study recommends integration of overlapping themes and topics across disciplines in Science Education. This study suggests that contexts for integrating themes and topics could be informed by the United Nations Science and Education Organisation’s millennium goals of 2005.

7.3 Recommendation # 2: Consideration of the needs of the 21st century Life Sciences teacher.

Conclusions and findings indicate that prevailing patterns of thought among some academics remain fixed in outdated, conservative paradigms of knowledge production for teacher education and training. Such academics need to be apprised, in a sensitive and diplomatic manner, of the various new modes of progressive educational theory; especially the socially accountable priorities of Paulo Freire or more recently Bernstein in an attempt to open their eyes to the need for transformation: in a society still suffering the after-effects and privations of apartheid and in urgent need of relief from poverty through lack of education; especially in the Sciences. This study suggests that academics in the field of Science education should consider the urgency of this situation and incorporate the needs of the 21st century Life Sciences teacher into a re-conceptualisation of the curriculum for educating and training Life Sciences teachers in this generation. According to contemporary researchers such as Gibbons (1994), Paton (2010), Semetsky and Masny (2013), the qualities of a competent teacher for the 21st century are congruent with those enshrined in the Curriculum Policy on Minimum Requirement for teacher qualifications (MRTEQ):

- Innovative and independent thinking
- Reflective practice and life-long learning
- Research
- Transformation, social responsibility and change
- Community building

A competent teacher is able to: reflect on, analyse and adapt educational and personal attitudes in a responsive and responsible manner according to social conditions; improve both individual practice and communal situations and be involved in school-based curriculum development.

7.4 Recommendation #3: Paradigm shift for conceptualizing a competent Life Sciences teacher for effective implementation of Life Sciences curriculum innovations.

Findings and conclusions reveal a worrying diversity of views among academics concerning the attributes and qualifications of a competent Life Sciences teacher. This diversity of opinion was a concern in this study: all Life Sciences teachers educated and trained at various institutions of higher education (HEIs) are expected to teach the same Life Sciences school curriculum yet views of how they should be trained vary too widely to ensure alignment between the school curriculum they are all expected to teach and the training they receive. This disparity of training places teachers in an untenable situation. If they have not trained in problem-based, inquiry-based learning, because of training in old-fashioned (behaviourist and absolutist) modes (entrenched pre-1994) they find it almost impossible to teach the Science syllabus. Such obstruction and obstructionist behaviour at the training level in universities (i) is grossly unfair to trainee teachers (ii) impedes implementation of the prescribed Science syllabus, (iii) compromises performance of learners in the subject and (iv) frustrates goals of social revision and transformation.

Given the nation's pressing need for scientific and technological advancement and the call for teacher training in the sciences, this study suggests that collaborations and partnerships are

urgently and immediately required among academics in the field of Science Education to conceptualise and broadly agree on, the characteristics and training of competent Life Sciences teachers. Principles of integration in the organisation of knowledge and a learner-centred approach to delivery of curriculum should be a main priority.

7.5 Recommendation #4: Discourse in pedagogical approaches in the education and training of Life Sciences teachers.

Findings and conclusions indicate that there is at least some evidence of emergent, enlightened patterns of thought among a few academics which signals a welcome departure from stifling traditionalist restrictions upon teaching and learning of Sciences in higher education. Instead of transmitting knowledge from textbooks, a few lecturers are designing activities around themes and topics which enforce dialogue, argumentation, engagement, exploration, explanation and development of new, integrated strategies of teaching. These strategies are recommended by pioneers of Mode 2 knowledge integration (Killen, 2005, Repko, 2007, Kutti, 2010 and Gibbons, 1994).

This study recommends adopting the Dialogical Argumentative Instructional Model and the King 5E approach in the education and training of Life Sciences teachers. Such enlightened and flexible pedagogical schemata allow for the acquisition of applied competences as prescribed in the curriculum policy for teacher education and training. In Science Education, in particular, such approaches have been tested and found suitable in enabling students to develop conceptual knowledge of sciences across cultural and disciplinary divides. This study argues that integration of knowledge should focus on, and begin building, knowledge from the point of the real-life experiences of students. This argument is influenced by the Critical paradigm and the theory of

curriculum called Praxis which emphasises liberation of the mind through teaching and learning; especially the minds of those oppressed by poverty who are not aware of the rich stock of life-knowledge that they already possess; a resource which provides a ready platform for educational development. Barriers created by keeping knowledge in separate ‘silos’ are broken down by identifying broad themes and topics across subjects. Academics, students, teachers and curriculum designers need to find consensus. Fullan (2006) and Ornstein and Hunkins (2014) refer to such agreement as a first step to building up Professional Learning Communities. The context for organising, selecting and sequencing of knowledge for integration can be determined by the members representing these communities. This proposal is presented in the following models:

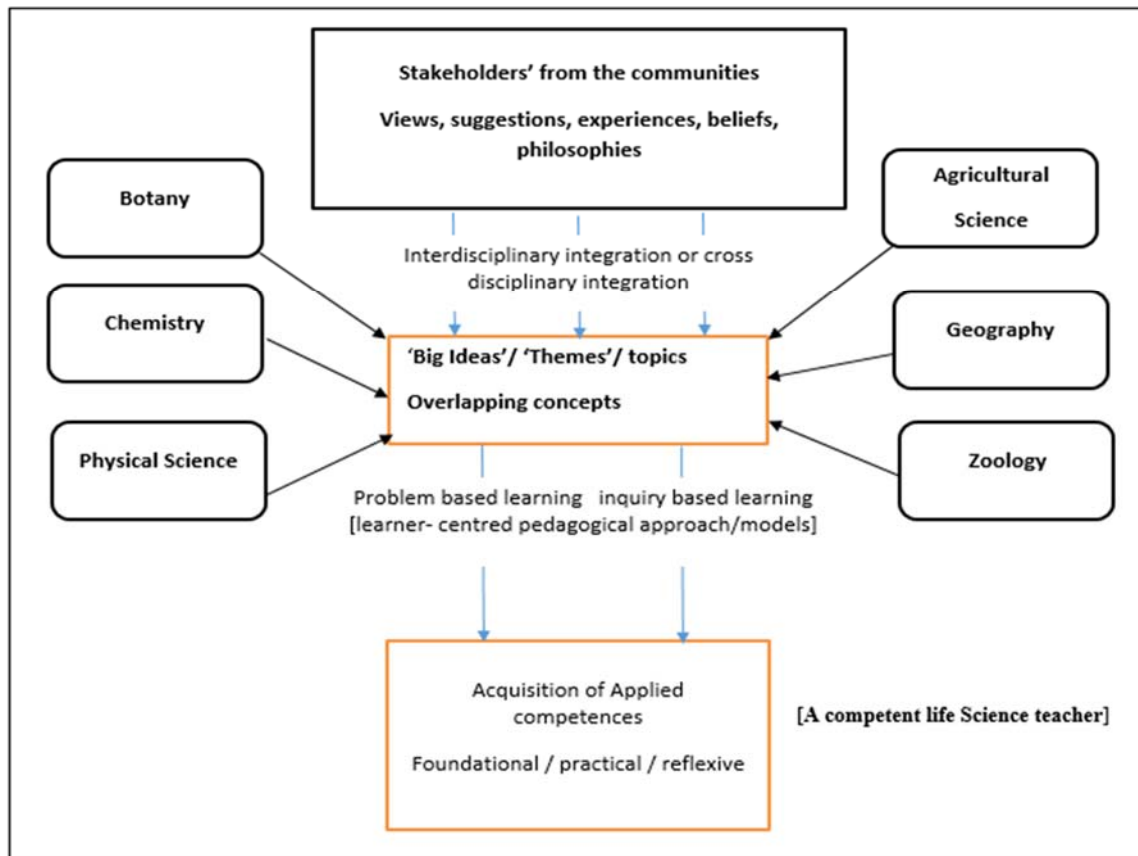


Figure: 3 Illustration of integration of knowledge and pedagogical approaches to teaching and learning for integrated knowledge acquisition.

7.5.2 Diagram illustrating knowledge integration for Life Sciences indicating interrelations and connections for enabling knowledge (knowledge application).

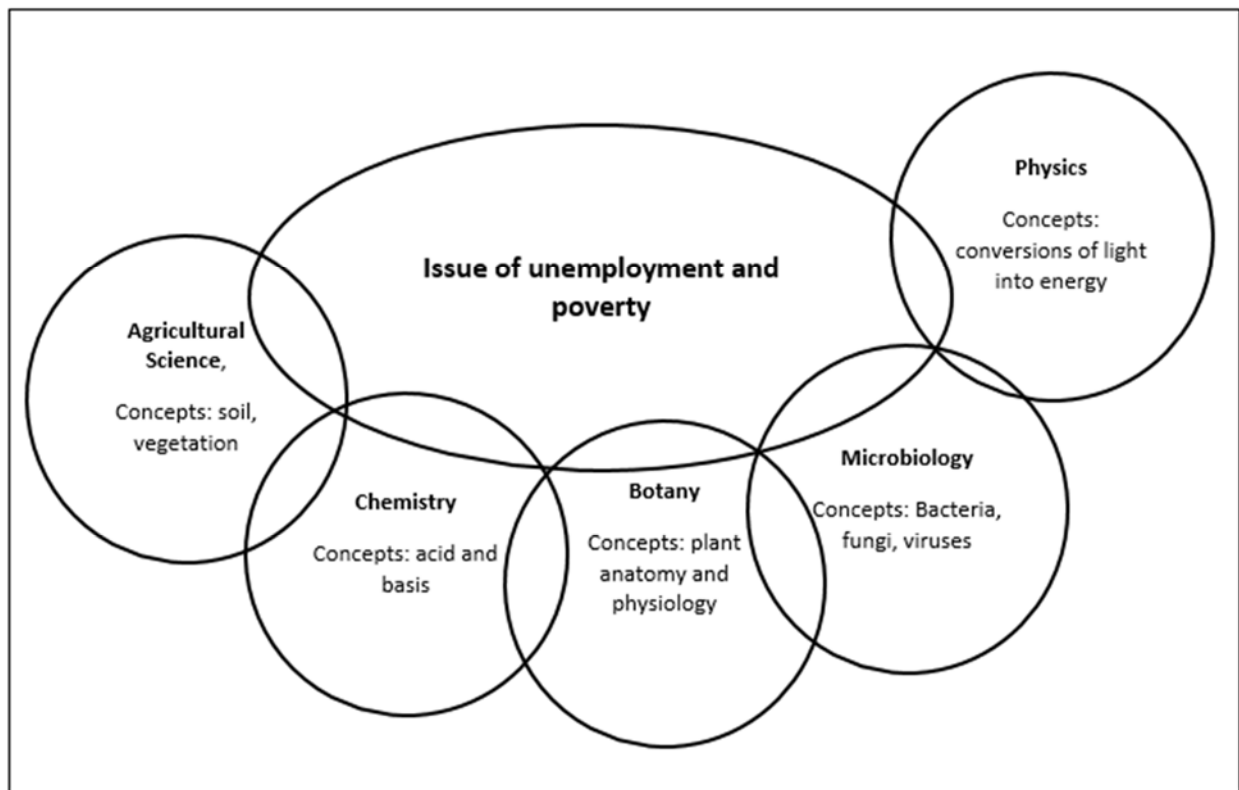
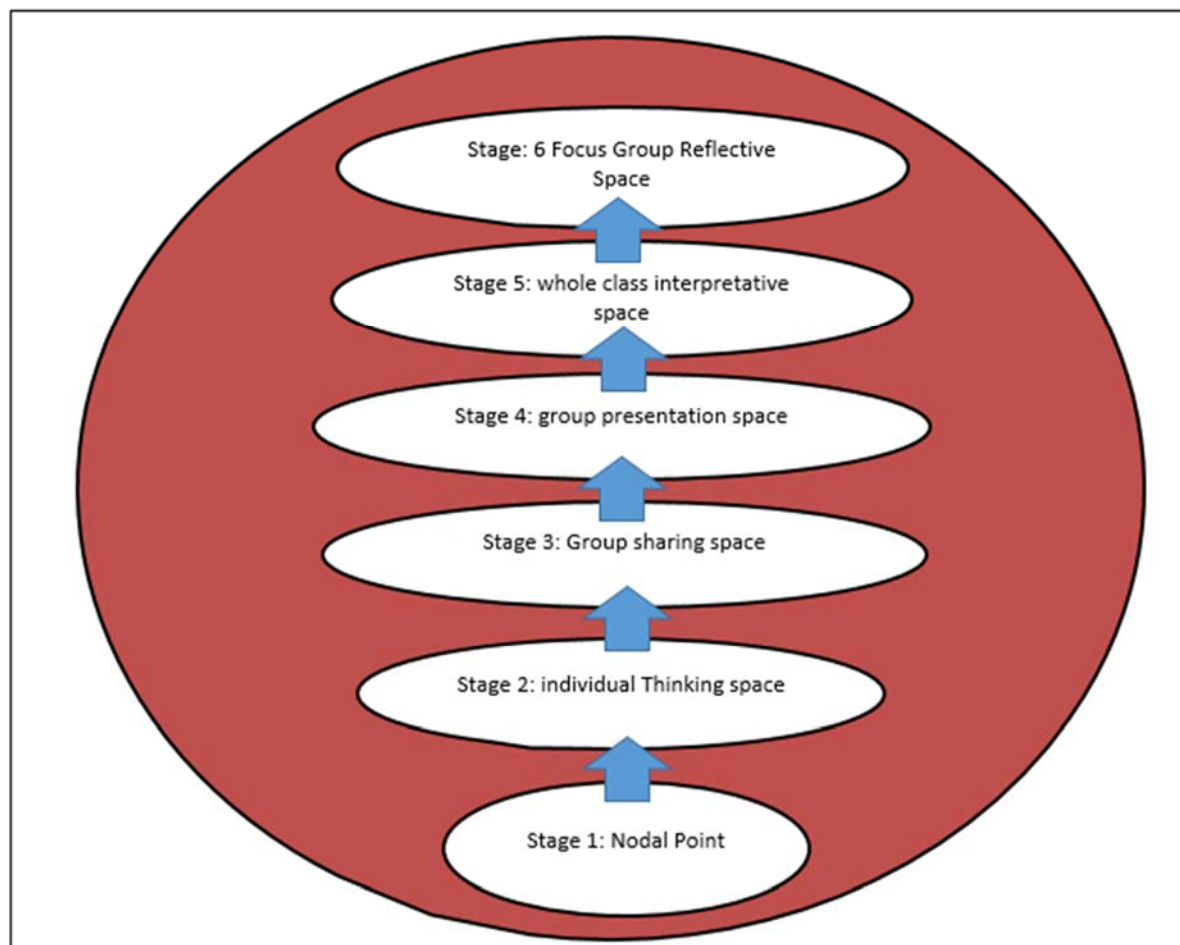


Figure 4: Illustration of knowledge integration; focusing on real-life experience for meaningful learning and acquisition of enabling knowledge.

7.5.3 Concept mapping in facilitating integration of knowledge.

According to Mintzes (2000), Meyer (2004) and Kirschner *et al.* (2006), concept mapping developed from Davis Ausubel's theory, can be usefully deployed to explain the significances of meaningful learning: according to this theory 'learning of concepts is primarily a discovery learning process, where the individual discerns patterns or regularities in events or objects and

recognises these as the regularities in a phenomenon'. In the context of knowledge integration for Life Sciences pedagogy in teacher education and training, concept mapping enables trainees to identify and work out cross-connections between concepts in various knowledge domains in the Field of Science, and beyond.



Adopted from Langenhoven and Ogunniyi (2009)

7.6 Limitations related to arrangements of interviews and collection of documentation.

The study was undertaken during a period of fractious and intense curriculum design and development nationally. Although the researcher was able to secure appointments with

academics at institutions targeted in the sample, delays in curriculum development meant documentation was not available at all institutions at the same time. However, the researcher did follow up on documentation which came late; but as a result of delays, analysis of documents was slowed. Another difficulty was caused by the fact that interviews with academics took longer than planned; responses sometimes were too long for each question which cost the researcher time and money. The researcher was forced to hire individuals to make the transcriptions from the audio tapes. Henning *et al.* (2014) recommend that it helps the researcher to identify themes while the process of transcription is taking place. In the case of this study, that was not possible because the researcher depended on others, was frequently otherwise employed and the responses were too long. The study was supposed to be completed earlier in the year 2017, and would have been, if it was not for this delay. Volatile conditions at institutions of higher education constrained the study so that the researcher had to re-schedule appointments which caused a further delay.

The findings of this research initiative were based on a reasonably representative sample; however, that does not mean that further research should not be conducted in the same area for probing into other areas which this study could not cover. For example, students' perspectives as recipients of the curriculum could form part of another extensive and valuable study. The perspective of those policy formulators who have the authority to approve or disapprove the final curriculum designed by an institution is another area of interest for further research.

7.7 Summary

This chapter presents recommendations in relation to: (i) data and information provided by the empirical study and (ii) the critical questions set out for the study at the start. Recommendations

made in this study are subject to further research and debates. Recommendations made in this investigation could be of benefit to academics in Science Education who intend to take part in the teaching and training of Life Sciences teachers. The recommendations made could assist in the establishment of platforms for debate and discussion for improving education and training of Life Sciences teachers generally.

References

- Ahmad, J. (2014). *Teaching of Biological Sciences*. 2nd Edition. Raj Press: New Dehli.
- Allias, S. (2003). The National Qualification framework in South Africa: A democratic project trapped in a neo-liberal paradigm? *Journal of education and work* 16(3), 135-148.
- Apple, W. (2004). *Ideology and Curriculum*. 3rd ed. New York: Routledge Falmer.
- Ausubel, D. P. (1978). In defence of organizers: A reply to the critics. *Review of Educational Research*, 48 (2): 251-257.
- Ausubel, D. P. (1968). *The Psychology of Meaningful Learning: an introduction to School Learning*. Gune and Stratton publishers: Boston.
- Babbie, E. (2002). *The practice of social research*. 9th ed. Belmont, California: Wadsworth.
- Babbie, E. and Mouton, J. (2007). *The practice of social research*. 7th ed. London: Oxford University Press.
- Bantwini B. D. (2011). District officials' assumptions about teacher learning and change: Hindering factors to curriculum reform implementation in South Africa. *International Journal of Education* (3) 1.
- Bansilal, S., Brijlall, D., and Mkhwanazi, T.W. (2014). An exploration of the common content knowledge of high school mathematics teachers. *Perspectives in Education*, 32(1), 34-50.
- Barnett, R. (Ed). *Academic community: Discourse or Discord?* London: Jessica Kingsley.
- Barreteau, O., Bots, P. W. G. and Daniell, K. A. (2010). A framework for clarifying “participation” in participatory research to prevent its rejection for the wrong reasons. *Ecology and Society*, 15(2), 1. [Online] URL: <http://www.ecologyandsociety.org/vol15/iss2/art1/> [15.09.2015]
- Berkes, F. (2008). *Sacred ecology*. 2nd Ed. New York: Routledge.

Bernstein, B. (2000). *Pedagogy, symbolic control and identity: Theory, research and critique*. Revised edition. Oxford: Rowman& Littlefield.

Biggs, J. (2000). *Teaching for quality learning at university*. Buckingham. Open University Press.

Bocking, S. 2007. Science and spaces in the northern environment. *Environmental History* 12(4), 867-894. <http://dx.doi.org/10.1093/envhis/12.4.867> [15.09.2015]

Bodrova, E. & Leong, D. J. (2007). *Tools of the mind: The Vygotskian approach to early childhood education* (2nd Ed.). Upper Saddle River, New Jersey: Pearson.

Bruner, J. (1960). *The Process of education*. Cambridge, MA: Harvard University Press.

Brunet, N. D., Hickey, G. M. and Humphries. M. M. (2014). The evolution of local participation and the mode of knowledge production in Arctic research. *Ecology and Society*, 19(2), 69. <http://dx.doi.org/10.5751/ES-06641-190269> [15.09.2015].

Bybee, J. (2010). *Language, usage and cognition*. New York. Oxford University press

Campbell, C and Rozsnyai J. (2002). Quality assurance and the development of course programme. Papers on Higher Education regional University Network on Governance and Management of Higher Education in South East Europe Bucharest.

Carl, A. E. (2005). *Teacher empowerment through curriculum development*. Theory into practice. 1st edition. Cape Town: Juta & Company Ltd.

Carl, A. E. (2012). *Teacher empowerment through curriculum development*. Theory into practice. 3rd edition. Cape Town: Juta & Company Ltd.

Carl, A. E. (2014). *Teacher empowerment through curriculum development*. Theory into practice. 4th edition. Cape Town: Juta & Company Ltd.

Carl, A. E. (2015). *Teacher empowerment through curriculum development*. Theory into practice. 5th edition. Cape Town: Juta & Company Ltd.

- Cohen, L., Manion, L. & Morrison, K. (2016). *Research Methods in Education*. New York: Routledge.
- Conbleth, C. (1990). *Curriculum in Context*. New York. Falmer Press
- Copleston, F. (2003). *A history of philosophy Vol. 1: Greece and Rome*. London and New York: Continuum.
- Council on Higher Education (CHE). (2010). *Report of the task team on undergraduate curriculum structure*. Pretoria: Government Printers.
- Council for Higher Education, (2010). *Annual report for Council for Higher Education: 2009/2010*. Pretoria:
- Dancy, J. J. (1991). *Introduction to contemporary Epistemology*. Massachusetts. USA. Blackwell publishers
- Davies B. (2001). *Introduction. Towards a Sociology of pedagogy: The contribution of Basil Bernstein to research*. New York. Peter Lang Press.
- Dede C. (2008). *Shifting to 21st century thinking: generating knowledge and possible wisdom*. Accessed June 27, 2015. Available at [http://www. Shifting thinking org](http://www.Shiftingthinking.org).
- Department of Education. (1995). *South African Schools Act, Act No 84 of 1996*. Pretoria: Government Printers.
- Department of Education. (1997). *Curriculum 2005: Lifelong learning for the twenty-first Century*. Pretoria: Department of Education.
- Department of Higher Education & Training, (1998). *Norms and Standards for Educators: Educators Employment Act*. Pretoria: Government Printers.
- Department of Education. (2000). *Norms and standards for educators*. Pretoria: Department of Education.
- Department of Education. (2002). *Revised national curriculum statement grades 10–12*. Pretoria: Department of Education.

Department of Education. (2005). Report of the ministerial committee on teacher education: A national framework for teacher education in South Africa. Pretoria Department of Education, 16 June 2005:

Department of Education. (2006). The national policy framework for teacher education and development in South Africa. Pretoria: Government Printers.

Department of Higher Education and Training. (2011a). Policy on the minimum requirements for teacher education qualifications. Pretoria: Government Printers.

Department of Higher Education and Training. (2011b). Integrated strategic planning framework for teacher education and development in South Africa: 2011–2025. Pretoria: Department of Higher Education and Training.

Department of Higher Education & Training, (2011). Minimum Requirements for Teacher Education Qualification. Pretoria: Government Printers.

Department of Higher Education & Training, (2015). Minimum Requirements for Teacher Education Qualification. Pretoria: Government Printers.

Drake, S. M. (2007). *Creating standards-based integrated curriculum; aligning content, standards, instructional strategies and Assessment*. (2ndEd.). Thousand Oaks, CA: Corwin.

Du Toit, G. (2011.). Conceptualising the re-design of curriculum for teacher education. *Acta Academia* (43) 107-131

Fogarty, R. (1991). *The Mindful School: How to integrate the curricula*. Palatine, IL. Skylight Publishing Inc.

Fullan, M. (2006). Change theory: a force for school improvement. *Centre for strategic education seminar series*. Paper no. 157, November 2006.

Fwu B. and Wang (2007). From uniformity to diversification: transformation of teacher education in pursuit of teacher quality in Taiwan from 1994-2000. *International Journal of Education Development* (22) pp.155-167

Glatthorn, A. A. , Boschee, F., Whitehead, B. M. (2006). *Curriculum leadership: Development and implementation*. Thousand Oaks: Sage.

Golding C. (2009). Integrating the disciplines: Successful interdisciplinary subjects. Centre for studies of Higher Education. University of Melbourne. Accessed in May 16, 2016. Available at <http://www.cshe.unimelb.edu.au>.

Goodson, I.F. (1994). *Studying Curriculum*. Buckingham: Open University Press.

Gordon, G. and Whitchurch, C. (Eds.). (2009). *Academic and professional identities in higher education: the challenges of a diversifying workplace*. New York: Routledge.

Gravette, S. and Geysler, H (2004). *Teaching and learning in higher education*. Pretoria: Van Schaik.

Grundy, S. (1994). *Curriculum: Product or Praxis*. Philadelphia: The Falmer press.

Harber, C. (2001). *State of transition. Post- apartheid education reforms in South Africa*. Oxford: Symposium

Harley, K. and Wedekind, V.(2004). Political change, curriculum change and social transformation 1990 to 2000. In Chisholm L. (Ed). *Changing class: Education and social change in post-apartheid South Africa*. Cape Town. HSRC Press pp. 339-518

Hartzler, D.S. (2000) *A Meta-analysis of studies conducted on integrated curriculum programmes and their effects on students' achievements*. Dissertation in partial fulfilment of requirement for doctor of education. School of Education, Indiana University.

Gao L. (1998). Cultural context of school science: Teaching and learning in the People's Republic of China. *Science Education* 82 pp. 3-13.

Grossman, P.L, Schoenfeld, A and Lee, C. (2005) Teaching subject matter. In L.Darling Hammond and J. Brandford. (Eds). *Preparing teachers for the changing world: What teachers should learn and be able to do*. San Fransisco. Jossey-Bass pp. 431-621

Henning, E.,Van Rensburg, W. and Smit, B. (2004). *Finding your way in qualitative research*. 1st ed. Pretoria: Van Schaik Publishers.

- Higgs, P. (2003). African philosophy and transformation of education discourse in South Africa. *Journal of Education*. (30) pp.5-22
- Hoadley, U. (2010). Tribes and territory: contestation around curriculum in South Africa. In F.W. Pinar (Ed). *Curriculum studies in South Africa: Intellectual histories and present circumstances*. New York. Palgrave MacMillan (pp. 125-176).
- Jansen, J. D. (2002). *The state of higher education in South Africa: from massification to mergers*. Pretoria: UNISA.
- Jansen, J. D. and Christie, P, (1999). *Changing Curriculum: Studies on Outcomes-based Education in South Africa*. Juta: South Africa.
- Kelly, A. V. (2009). *The Curriculum: THEORY AND PRACTICE*. 6th ed. Singapore: Sage.
- Klein, J. T. (2005). Humanities, Culture and Interdisciplinarity. *International Centre for Transdisciplinary research*.
- Kraak, A. (2000). Changing modes: A brief overview of the mode 2 knowledge debate and impact in South African policy formulation. In Kraak, A. (Ed) *Changing modes: New knowledge production in South Africa*. Pretoria. Human Sciences Research Council, 1-13.
- Kruss, G. (2008). Trajectories of restructuring: the changing context for initial teacher education in South Africa. *South African Review of Education*. HSRC.
- Kumar, R. 2005. *Research methodology*. 2nd edition. London: Sage Publications.
- Kutti, K. (2007). Design, Research, Disciplines and the New Knowledge Production. International Association of Societies of Design Research: *The Hong Kong Polytechnic University conference*, 12-15 November, 2007.
- Lemmer, L. S. (1998). A new context for the university? Postmodern strands in Institutional patterns of Higher Education policy and practice. *Progressio*, 20(1): 16-33.
- Levy, F., and Murnane, R. (2005). *The new division of labour: How computers are creating the next job market*. Princeton, NJ: Princeton University Press.

Linn, M. C., Lee, H., Tinker, R. and Chin, J. L. (2006). Teaching and Assessing Knowledge Integration in Science. *Journal of Science*. Accessed April 15 2016. Available at <http://www.sciencemag.org/content/313>. DOI:10.1126/science 1131408

Lipson, M., Valencia, S., Wixson, K. and Peters C. (1993). "Integration and thematic teaching: Integration to improve teaching and learning. *Journal of Language Arts* 70 (4) pp. 252-264

Maton, K. (2014). Building powerful knowledge: the significance of semantic waves. In Rata, E. and Barrett, B. (Eds.). *The future of knowledge and the curriculum*. London: Palgrave Macmillan.

Meyer M. (2004). Living Knowing Production; Indigenous. Accessed in December 11. Available at <http://www.uvm.edu.org>.

Minkler, M. and Wallerstein, N. (2008). Introduction to community-based participatory research: new issues and emphases. In M. Minkler, M. and Wallerstein, N. (Eds.). *Community-based participatory research for health: from process to outcomes*. (pp. 5-6). San Francisco: Jossey-Bass.

McNeil, J. D. (1990). *Curriculum: A comprehensive introduction*. New York: Harper Collins Publishers.

McNeil, L. and Valenzuela, A. (2001). "The Harmful Impact of the TAAS System of Testing in Texas: Beneath the Accountability Rhetoric," In Kornhaber, M. and Orfield, G. (Eds.). *Raising Standards or Raising Barriers? Inequality and High Stakes Testing in Public Education*. (pp.127-150). New York: Century Foundation.

McNeil, P. and Chapman, S. (2005). *Research Methods*. 3rd Ed. New York: Routledge

Morais, A. M., and Neves, I. P. (2001). Pedagogic social contexts: Studies for sociology of learning. In Morais, A., Neves, I., Davies, B. & Daniels, H. (Eds.). *Towards sociology of pedagogy: The contribution of Basil Bernstein to research*. (pp. 185-221). New York: Peter Lang.

Morais, A. M. (2002). Basil Bernstein at the Micro Level of the Classroom. *British Journal of Sociology*, 23(4): 549-569.

- Morais, A. M., and Neves, I. P. (2006). Teachers as creators of social contexts for scientific learning: Discussing new approaches for teachers' development. In Moore, R., Arnot, M., Beck, J. & Daniels, H. (eds.). *Knowledge, power and educational reform: Applying the sociology of Basil Bernstein (chap. 9)*. London: Routledge & Falmer.
- National Education Crisis Committee, (1992). Curriculum for post-apartheid education. Pretoria.
- Nkomo, M. (1997). *Pedagogy of domination towards democratic South Africa*. Thornton Africa: World Press.
- Noll, J. W. (2013). *Taking sides: Clashing views on educational issues*. (7th Ed.). New York: McGraw-Hill.
- Nowotny, H., Scott, P and Gibbons, M. (2003). Mode 2 Revisited: The New Production of Knowledge. *Minerva* 41, 179-194.
- Ornstein A. C. and Hunkins, F. P. (2014). *Foundations, principles and theory*. Allyn and Bacon: Boston.
- Palmer J. (1991). Planning Wheels Turn Curriculum Around. *Journal of Educational leadership*, 49 (2) pp.57-60.
- Patton P. (2010). *Deluezian Concepts: Philosophy, Colonization, Politics*. California .Stanford University Press.
- Pinar, W. F., Reynolds, W. M. Slattery P. and Taubman, P. M. (1995). *Understanding Curriculum: An Introduction to Historical and Contemporary Curriculum Discourses*. New York: Peter Lang.
- Pinar, W. F. (2012). *What is Curriculum Theory?* (2nd Ed.). New York: Routledge
- Rowland, S. (2006). *The enquiring university: Compliance and contestation in higher education*. England: Open University Press.
- Sato, M.S (2003). *Curriculum and Teacher*. Trans. By ZHONG, Qiquan. Beijing: Educational Science Publication Press.

- Schumacher, S. and McMillan, J.H. (2006). *Research in Education: Evidence-Based Inquiry*. 6th ed. Boston: Pearson Education.
- Semetsky I. and Masny D. (2013). *Deleuze in Education*. Edinburgh, University press
- Sharma, P. (2017). *Teaching of Life Sciences*. A. P. H. Publishers: Darya Ganj.
- Simister, C. J. (2007). *How to teach thinking and learning skills: A practical programme for the whole school*. London: Paul Chapman Publishing.
- Slattery, P. (2013). *Curriculum development in the postmodern era*. New York. Routledge
- Soudien, C. (2010) “What to teach natives”: A historiography of the curriculum dilemma in South Africa. In F.W. Pinar (Ed), *Curriculum studies in South Africa: Intellectual histories and present circumstances*. New York. Palgrave MacMillan. (pp. 19-50)
- Spady, W. G. (1994). *Outcomes Based Education: critical Issues and answers*. Arlington. American School Administrators.
- Stears, M. and Malcom C. (2005). Learners and teachers as co-designers of relevant science curricula. *Perspectives in Education*. 23 (3) pp 21-43.
- Stewart, V. (2010). A classroom as wide as the world. In H. Hayes Jacobs (ed.), *Curriculum 21: Essential education for a changing world*, (pp. 97–114). Alexandria, VA: Association for Supervision and Curriculum Development.
- Terwel, J. & Walker, D. (2003). *Curriculum as a shaping force: towards a principled approach in curriculum theory and practice*. New York. Nova Science Publishers
- Themane, M. J. (2013). Understanding curriculum: A challenge to curriculum development in teacher education programme. *South African Journal for Higher Education* (25) pp. 1639-1651
- Young, M. (2013). Overcoming the crisis in curriculum theory: a knowledge –based approach. *Journal of Curriculum Studies* (45) pp. 101-118
- Welman, C. Kruger, B. and Mitchell, F. (2005). *Research methodology*. Cape Town: Oxford University Press.

- Wilmarth, S. (2010). Five socio-technology trends that change everything in learning and teaching. In Heidi Hayes Jacobs (ed.), *Curriculum 21: Essential education for a changing world*, (pp.80–96). Alexandria, VA: Association for Supervision and Curriculum Development.
- Wilmsen, C. (2008). Negotiating community participation, knowledge and power in participatory research. In Wilmsen, C., Elmendorf, W., Fisher, L., Ross, J. Sarathy, B. and Wells, G. (Eds.). *Partnerships for empowerment: participatory research for community-based natural resource management*. (pp. 1-22). London: Earthscan.
- Wolhuter, C.C. (2010). Weaknesses of South African education in the mirror image of international educational development. *South African Journal of Education*.
- Woofolk, A. E. (1995). *Educational Psychology*. 6th Ed. Needham Heights, MA: Allyn & Bacon.
- Zalaghi H. and Khazaei M. (2016). The role of deductive and inductive reasoning in Accounting: Research and standard setting. *Asian Journal of Finance and Accounting*. (18) pp. 334 -345.
- Zarry, L. (2002). A multicultural science curriculum: Fact or Fantasy? *Education Research Quarterly* (25) 3-10.

1. Appendix A: Ethical clearance

2. Appendix B: Consent form

3. Appendix C: Research instruments

4. Appendix D: Permission to conduct research from Universities

5. PROOF OF EDITING