QUALITY OF THE GRADE 12 LIFE SCIENCES CURRICULUM: PERCEPTIONS AND POSSIBILITIES FOR LIFELONG LEARNING

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QUALITY OF THE GRADE 12 LIFE SCIENCES CURRICULUM: PERCEPTIONS AND POSSIBILITIES FOR LIFELONG LEARNING

by

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- Last but by no means least, my loving, tolerant and incredibly supportive husband **Selvan**, who through his recovery from a triple bypass, inspired and motivated me to persevere.

Dedicated To

Divioka, Shaylin, Kribashan

And

Selvan

ABSTRACT

The emergence of a highly competitive and integrated international economy, rapid technological innovation, and a growing knowledge base will continue to have a profound impact on the lives of communities. In recent years there has been an international movement towards educational reform, particularly in science education, to meet the need for a sustainable environment, economy, and society. Science education is a key element in developing scientific literacy among today's and tomorrow's youth. Recent decades have seen an exponential growth in scientific applications, and one would expect an accompanied increase in science interests in the classroom, as well as an increased understanding of basic science ideas and ways of thinking will follow. However, research has shown that this is not the case.

In this study, the researcher, through the research methodology, took an in-depth look at whether the curriculum reform in the Life Science curriculum was forthcoming to lifelong learning. The key questions guiding this study are as follows: (a) What are the perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning; (b) What are the perceptions and expectations of grade 12 learners regarding the their Life Sciences educators; (c) What are the perceptions of the grade 12 Life Sciences educators of the relevance of the grade 12 Life Sciences curriculum with a view to lifelong learning; (d) How does the grade 12 Life Sciences curriculum impact on lifelong learning of learners.

This study falls within the realm of mixed methods study. Mixed methods encompass both a quantitative and a qualitative study. The study was conducted in the district of Pinetown because in 2013 this district produced the best results in Kwa-Zulu Natal in the National Senior Certificate Life Sciences examination. This study used simple random sampling to obtain the learner participants. The researcher conducted the study in 16 schools and 25 learners from each school were randomly selected. The educator sample comprised 75 grade 12 Life Sciences educators. The SERVQUAL questionnaire was administered to the 400 learners that were randomly selected while; the educator questionnaire was administered to the sample of 75 educators.

The findings of the research revealed that educators experienced many challenges which hindered the successful implementation of the Life Sciences curriculum effectively. The quality of the Life Sciences curriculum itself did not that hinge on lifelong learning. It did not have very much relevance to the lives of the learners and as such the learners were learning about things that were abstract to them. Another finding was that educators found it challenging to relate the grade 12 Life Sciences curriculum to the everyday experiences of the learners because time was a limiting factor. The exam driven nature of Life Sciences had resulted in rote memorisation of scientific facts by the students without any or very little attention being paid to analysis and application of knowledge.

The inability to evaluate the process of curriculum implementation by curriculum developers could have serious consequences for the learners and communities at large. For any qualitative change to occur in Life Sciences education, the curriculum must undergo a paradigm shift. To encourage schools and teachers to implement this paradigm shift, fundamentally there needs to be an overarching reform of teacher empowerment. In essence, what is needed from the national educational policy makers is a shift towards more evolutionary policy planning which aims to improve the fit between the intention of the curriculum and the conditions on the ground, to blend top-down policy initiative and bottom-up participation and to promote continuous interaction between all policy actors.

TABLE OF CONTENTS

DECLARATION	**ii**
ACKNOWLEDGEMENTS AND DEDICATION	**iii**
ABSTRACT	**iv**
TABLE OF CONTENTS	**vi**
LIST OF TABLES	**xiv**
LIST OF FIGURES	**xv**
LIST OF APPENDICES	**xvii**
LIST OF ACRONYMS	**xviii**

CHAPTER 1: INTRODUCTION AND RATIONALE FOR THE STUDY

1.1 Introduction	1
1.2 Background to the study	1
1.3 Motivation for this study	3
1.4 Aim of the study	5
1.5 Significance of the study	8
1.6 Research methodology	9
1.7 Clarification of concepts	9
1.8 Summary of the chapters	12
1.9 Conclusion	13

CHAPTER 2: INTERNATIONAL PERSPECTIVES ON SCIENCE EDUCATION IN SECONDARY SCHOOLS

2.1 Introduction	15
2.2 Science in secondary schools	16
2.2.1 Importance of science education	16
2.2.2 Framework for science education standards	18

2.2.2.1 The vision of the framework 18
2.2.2.2 The practices of the framework 19
2.2.2.3 Integration of the practices into science and inquiry 21
2.3 Science education in developing and developed countries 23
2.3.1 Science education in Kenya 24
2.3.2 Science education in India 25
2.3.3 Science education in Canada 26
2.3.4 Science education in the United States of America 28
2.4 Declining interest in science education in schools 29
2.4.1 Causes of a declining interest in science 32
2.4.2 Impact of a declining interest in school science 36
2.4.3 Imperatives to sustain student interest in science 38
2.4.4 Correlation between interest in science and learning science 39
2.5 Conclusion 40

CHAPTER 3: QUALITY IN SCIENCE EDUCATION AND LIFELONG LEARNING

3.1 Introduction 42
3.2 Lifelong learning 43
3.2.1 Historical perspective of lifelong learning 43
3.2.2 Key competencies for lifelong learning 46
3.2.3. Key competencies for lifelong learning in science 49
3.2.3.1 Correlation between science objectives and competencies 50
3.2.3.2 Skills for developing competency in lifelong learning in science 51
3.2.4 Imperatives for lifelong learning 53

3.2.5 Imperatives for lifelong learning in science 56
3.2.6 Challenges facing lifelong learning 59
3.2.7 Challenges facing lifelong learning in science education 61
3.3. Quality 63
3.3.1 The concept of quality in education 63
3.3.2 Quality assurance 66
3.3.2.1 General perspective of quality assurance 66
3.3.2.2 Quality assurance in the context of education 67
3.3.2.3 Strategies for establishing quality assurance in education 68
3.3.3 Requirements for quality education 69
3.3.3.1 Quality and science education 70
3.3.3.2 Quality and lifelong learning 72
3.3.4 Total quality management 75
3.3.4.1 Origin of total quality management 75
3.3.4.2 Education and total quality management 77
3.3.4.3 Role-players of total quality management in schools 79
3.3.4.4 Total quality management for curriculum development 80
3.3.4.5 Total quality management and quality assurance 82
3.4 Education as a service 84
3.5 Service quality and perceived quality 85
3.5.1 The Servqual Model as a generic model 86
3.5.2 The Servqual Model as applied to education 87
3.6 Conclusion 89

CHAPTER 4: QUALITY AND LIFELONG LEARNING IN BASIC EDUCATION IN SOUTH AFRICA

4.1 Introduction 91

4.2 Apartheid education in South Africa 92
4.2.1 Foundations of apartheid education 92
4.2.2 Schooling in the apartheid era 92
4.2.3 Science education during the apartheid era in the realm of quality and lifelong learning 94
4.3. Transformation in education in South Africa 95
4.3.1 The National Education Policy Act 97
4.3.2 Legislation guiding transformation of education in South Africa 98
4.3.2.1 The South African Schools Act 98
4.4 Curriculum change in post-apartheid South Africa 99
4.4.1 The need for curriculum change in a new democratic dispensation 100
4.4.2 Outcomes based education 101
4.4.2.1 Biology under outcomes based education 103
4.4.2.2 Shortcomings of outcomes based education 103
4.4.3 National Curriculum Statement 105
4.4.3.1 Life Sciences education under the National Curriculum Statement 107
4.4.3.2 Shortcomings of the National Curriculum Statement 108
4.4.4 Shortcomings of the Life Sciences curriculum under Outcomes Based Education and the National Curriculum Statement 110
4.4.5 Curriculum Assessment Policy Statement 111
4.4.5.1 Life Sciences education under the Curriculum Assessment Policy Statement 112
4.4.5.2 Shortcomings of the Curriculum Assessment Policy Statement 115
4.5 Comparative analysis of the Life Sciences curricula under OBE, NCS and CAPS 116
4.6 Quality assurers in South Africa 119
4.6.1 Umalusi 119
4.6.2 Department of Basic Education 121

4.6.2.1 Challenges facing the Department of Basic Education in the realm of quality assurance 122
4.7 Lifelong learning 123
4.7.1The need for the development of lifelong learning in a South African context 123
4.7.2 Governance and the legal framework of lifelong learning 125
4.7.2.1 The National Education Policy Investigation Reports 125
4.7.2.2 The policy framework for education and training 126
4.7.2.3 White papers on education and training 126
4.7.3 Lifelong learning and Life Sciences education in the context of South Africa 129
4.8 Conclusion 130

CHAPTER 5: METHODOLOGY

5.1 Introduction 131
5.2 Research design 132
5.2.1 Quantitative research 133
5.2.2 Qualitative research 134
5.3 Research population 135
5.3.1 Target Population 135
5.4 Sampling 137
5.4.1 Probability sampling 137
5.4.1.1 Simple Random Sampling 137
5.4.1.2 Stratified random sampling 138
5.4.2 Non probability sampling 138
5.4.2.1 Convenience or purposive sampling 138
5.5 Sampling size 139

5.5.1 Surveys 139
5.5.1.1 Learner sample 139
5.5.1.2 Educator sample 141
5.5.2 Interviews 141
5.5.2.1 Learner sample 142
5.5.2.2 Educator sample 142
5.6 Data Collection 143
5.6.1 Questionnaires 143
5.6.1.1 Learner questionnaire 144
5.6.1.2 Educator questionnaire 147
5.6.1.3 Administration of Questionnaires 147
5.6.2 Interviews 148
5.7 Data analysis 150
5.8 Pilot Study 150
5.9 Delimitations 151
5.10 Limitations 151
5.11 Confidentiality and anonymity 152
5.11.1 Confidentiality 152
5.11.2 Anonymity 152
5.12 Reliability and Validity 153
5.12.1 Reliability 153
5.12.2 Validity 153
5.13 Ethical Issues 154
5.14 Conclusion 154

CHAPTER 6: ANALYSIS, INTERPRETATION AND DISCUSSION OF THE DATA

6.1 Introduction 155

6.2 Presentation of findings 155

6.2.1 Reliability Statistics 156

6.2.1.1 Cronbach’s alpha 157

6.2.1.2 Factor Analysis 157

6.2.1.3 Kaiser-Meyer-Olkin and Bartlett's Test 157

6.2.1.4 Rotated Component Matrix 159

6.2.2 Biographical details of Life Sciences educators 160

6.2.3 Biographical details of Life Sciences learners 162

6.2.3.1 Gender 162

6.2.3.2 Home language 163

6.2.3.3 Reasons for studying Life Sciences 164

6.2.3.4 Level of learner satisfaction with their achievement in Life Sciences 165

6.3 Learner questionnaire to assess service quality dimensions of teaching and learning 166

6.3.1 Section B: About your Life Sciences teacher 166

6.3.1.1. Assessment of reliability 166

6.3.1.2. Assessment of assurance 168

6.3.1.3. Assessment of tangibility 170

6.3.1.4. Assessment of empathy 171

6.3.1.5. Assessment of responsiveness 173

6.3.2 Section C: The Life Sciences curriculum 175

6.4 Educator questionnaire to assess quality dimensions of the Life Sciences curriculum 178

6.4.1 Relevance of the grade 12 Life Sciences curriculum 179
6.4.2 Topics for inclusion into the grade 12 Life Sciences curriculum 182
6.5 Correlations 184
6.6 Hypothesis Testing 186
6.7 Conclusion 186

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction 188
7.2 Conclusions of the study 188
7.2.1 Perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning 189
7.2.2 Perceptions and expectations of grade 12 learners regarding their Life Sciences educators 192
7.2.3 Perceptions of the grade 12 Life Sciences educators of the relevance of the grade 12 Life Sciences curriculum in the context of lifelong learning 194
7.3 Recommendations of the study 198
7.4 Proposed model for the preparation of effective curriculum development and implementation in Life Sciences 202
7.5 Limitations of the study 205
7.6 Conclusion 206

REFERENCES 208

LIST OF TABLES

Table 4.1 Codes and percentages for reporting in Grades R-12	114
Table 4.2 Integration between Life Sciences and everyday knowledge in grade 10	118
Table 5.1 Districts and circuits of Kwa-Zulu Natal Basic Education Department	136
Table 5.2 Circuits and number of public secondary schools in the district of Pinetown	139
Table 5.3 Table to determine sample size	140
Table 5.4 Cluster groups of the Mafukuzela-Gandhi circuit	142
Table 6.1 Cronbach's Alpha for Section B	156
Table 6.2 Cronbach's Alpha for Section C	157
Table 6.3 KMO and Bartlett's Test for Section B	158
Table 6.4 KMO and Bartlett's Test for Section C	158
Table 6.5 Capacity of educator appointment	160
Table 6.6 Educators teaching grade 12	160
Table 6.7 Items assessing reliability	167
Table 6.8 Items assessing assurance	168
Table 6.9 Items assessing tangibility	170
Table 6.10 Items assessing empathy	171
Table 6.11 Items assessing responsiveness	173
Table 6.12 Items assessing the Life Sciences curriculum	175
Table 6.13 Relevance of the grade 12 Life Sciences curriculum	179
Table 6.14 Paired Samples Test for Section C	186
Table 7.1 Characteristics of traditional and lifelong learning models	193
Table 7.2 Proposed Life Sciences curriculum for the FET phase in schools	201

LIST OF FIGURES

Figure 2.1 Three spheres of activity for science education	21
Figure 2.2 Participation rates for Maths and Science subjects in Australia	31
Figure 3.1 Framework for lifelong learning	45
Figure 3.2 Four pillars of learning	47
Figure 3.3 Science curriculum objectives	50
Figure 3.4 Skills for developing competency in lifelong learning in science	52
Figure 3.5 The schooling process	77
Figure 3.6 The customers of education	84
Figure 3.7 Determinants of perceived service quality of lifelong learning in science education	89
Figure 6.1 Gender of educator respondents	161
Figure 6.2 Gender of learner respondents	162
Figure 6.3 Home language of learner respondents	163
Figure 6.4 Reasons for learners choosing Life Sciences	164
Figure 6.5 Level of satisfaction with performance by learners in Life Sciences	165
Figure 6.6 Assessment of reliability	167
Figure 6.7 Assessment of assurance	169
Figure 6.8 Assessment of tangibility	170
Figure 6.9 Assessment of empathy	172
Figure 6.10 Assessment of responsiveness	173
Figure 6.11 Assessment of the Life Sciences curriculum	176
Figure 6.12 Topics of relevance as rated by educators of grade 12 Life Sciences	181

Figure 6.13 Topics for inclusion in the grade 12 Life Sciences curriculum 183
Figure 7.1 Roles of a relevant Life Sciences curriculum 190
Figure 7.2 Key role-players of curriculum development 197
Figure 7.3 A proposed model for the preparation of quality curriculum development, dissemination and implementation in the context of lifelong learning in Life Sciences. 203

LIST OF APPENDICES

Appendix 1	Letter of information for principals and educators	232
Appendix 2	Letter of information for parents and guardians	234
Appendix 3	Letter of information for learners	236
Appendix 4	Questionnaire for learners	238
Appendix 5	Educator questionnaire	243
Appendix 6	Interview questions for learners	244
Appendix 7	Interview questions for educators	245
Appendix 8	Letter of approval from DUT FRC	246
Appendix 9	Ethical clearance letter from DOE	248

LIST OF ACRONYMS

C2005	Curriculum 2005
CAPS	Curriculum and Assessment Policy Statement
DOE	Department of Education
EC	European Commission
FET	Further Education and Training
IC	Interim Curriculum
ICS	Interim Core Syllabus
ICASE	International Council of Associations for Science Education
IKS	Indigenous Knowledge Systems
MEC	Member of the Executive Council
NATED	National Assembly Training and Education Department
NCCA	National Council for Curriculum and Assessment
NCS	National Curriculum Statement
NEPA	National Education Policy Act
NOS	Nature of Science
NRC	National Research Council
OBE	Outcomes Based Education
OECD	Organisation for Economic Co-operation and Development
SASA	South African School’s Act
TQM	Total Quality Management
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund

CHAPTER 1

INTRODUCTION AND RATIONALE FOR THE STUDY

1.1 Introduction

This chapter outlines the research process. The background to the study is discussed, followed by a description of the role of science. Thereafter, the motivation behind this study is explored, leading to a discussion of the purpose of this study. The research questions that guide this study are also highlighted in this chapter. The research methodology used in this study is described. The concepts relating to the critical questions being researched are also clarified.

1.2 Background to the study

The emergence of a highly competitive and integrated international economy, rapid technological innovation and a growing knowledge base continue to have a profound impact on the lives of communities. Recently, there has been an international movement towards educational reform, particularly in science education, to meet the need for a sustainable environment, economy and society. Science education is a key element in developing scientific literacy amongst today's and tomorrow's youth. Recent decades have seen an exponential growth in scientific applications and one would expect a commensurate increase in science interests in the classroom, as well as an increased understanding of basic science ideas and ways of thinking to follow. However, research shows that this is not the case.

Since the dismantling of the apartheid regime, there have been a number of attempts to renew the Life Sciences curriculum. All these activities have however occurred in piecemeal fashion, mainly to address the concerns and issues arising from the field at different times. One of the main problems is that the Life Sciences curriculum as a whole is fragmented and lacks progression and attainment objectives for different grades in the Further Education and Training (FET) phase, which includes grades 10 to 12. There is also general public perception that standards are falling and that the Life Sciences curriculum does not prepare students for the world of work and for national citizenship. The researcher considered it relevant to make reference to Armstrong (1973:270), who recommended that learners be involved in choosing their curriculum topics. Today, more than forty years later, curriculum design is still based on the curriculum developer's notions regarding what is of interest to themselves, without even considering the views of the educators, let alone the learners (Carl 2005:223).

There is widespread concern about the outcomes of Life Sciences education at school. An international trend is appearing where the recruitment or enrolment of youth into the sciences is falling "*or at least not developing as fast as expected or planned for"* (Sjoberg 2010: 2). For example, representatives of industry say that they need more high-grade scientists, technicians and engineers if the United Kingdom (UK) is to compete successfully in technology-intensive global markets. At a recent Global Science Forum conducted by the Organisation for Economic Co-operation and Development (OECD), one of the objectives was to identify the underlying factors that affect students' choices in the hope of addressing the decline in students choosing to study science subjects (Sjoberg 2010: 22). The findings and recommendations from the 16 country forum working group incorporated a statement indicating a need for science curricula to be reformed. According to Wade (2011:245), the declining enrolment of students in the sciences was often attributed to the uninteresting content of science courses. This is not only an international trend. In South Africa, the enrolment in all science subjects in grade 12 has declined from 34% in 2011 to 31% in 2014 (Erduran and Msimanga 2014:33).

Various studies speak to interest as important for academic performance in Life Sciences. A study by Krapp (2010:390) shows that interest-triggered learning activity leads to a higher degree of deep-level learning. According to Baram-Tsabari and Yarden (2009:1001), interest is often defined in reference to the inner state of the student which relates to the characteristics of a learning situation. Interest is therefore *"specific, develops over time, is relatively stable, and is associated with personal significance, positive emotions, high value, and increased knowledge"* (Wade 2011:246). In relation to the curriculum, an interesting curriculum would therefore be one that arouses a feeling of interest in the student. When allowed to pursue their own interests, students participate more, stay involved for longer periods and exhibit creative practices in doing science (Seiler 2006:340). Jenkins and Nelson (2005:42) suggested that science curricula that enable young people to engage in science-related issues that are likely to be of interest and concern to them could be used to contextualise and personalise the formal Life Sciences curriculum.

Very few people opt for science at school once it ceases to be compulsory, irrespective of their career intentions. This results in fewer applications for science degrees, which ultimately reduces the supply of science graduates. Just as importantly, the number of young people entering non-graduate occupations involving science is reduced, which leads to skills shortages in many sectors.

1.3 Motivation for this study

Recent changes in science education in South African schools appear to mirror international trends. As noted by Donnelly (2006:625), in South Africa, a new school curriculum is currently being implemented that involved a radical transformation from an outcome-based curriculum focusing on the development of skills to a highly prescriptive, content-based syllabus which does not explicitly address the development of lifelong learning for both the Natural Sciences (taught up to grade 9) and the more senior Life Sciences curricula. Current educational problems need to be identified before they can be addressed in a new curriculum. An understanding of existing problems and the likely extent of the changes required provides vital information for stakeholders during curriculum changes, as well as identifying how extensive the need is for teacher support and curriculum materials. The motivation for this study is the widely held belief that it is important that curriculum changes be based on a thorough understanding of existing educational situations prior to the changes.

In South Africa, the poor performance of learners in sciences and mathematics education has attracted the attention of diverse stakeholders including universities, employers and parents (Hattingh, Rogan, Aldous, Howie and Venter 2005:20). At the beginning of his book, *Science Education for Everyday Life: Evidence-Based Practice,* Glen Aikenhead (2010:1) challenges readers with two critical philosophical questions: "*What is the purpose of science education? What counts as legitimate science education?"* These questions compelled science educators to rethink taken-for-granted school science practices and traditional science education. Issues of language and the cultural clashes between modern science and African traditions, including indigenous knowledge systems, have been advanced. Students' dwindling interest, low motivation to learn and poor performance in science can all be attributed to the lack of recognisable relevance of science and science teaching (Osborne and Collins 2010:450). There is no doubt that alienation of students from science may be due in part to the way science is taught and in part to the failure of the curriculum – specifically its purposes in meeting the interests and aspirations of students. Therefore, Trumper (2006:33) posits that education in science as advocated by many science educators ought to move progressively towards a real world, context - based approach to the teaching and learning of science at all levels of the school curriculum. The growing speed of technological change and globalisation influences the need to improve the population's scientific skills and competencies.

Lifelong learning has become a catchphrase in almost all countries because of its growing influence on education policies around the globalised world. Walters (2010:430) pointed to the extraordinarily rapid pace of social, technological, cultural, economic, legal and educational changes throughout the world which, combined with the increasing global connectedness of many societies and economies, emphasises the need for people who are adaptable and responsive. Education systems should therefore be aimed at developing lifelong learning in communities. The even more dramatic changes in South African society render it particularly important for the South African educational system to produce lifelong learners. The imperatives for lifelong learning in South Africa were driven by the country's reinsertion into the global economy and by the political and social necessities of equity and redress after years of colonialism, segregation and apartheid. It is therefore not surprising to find the discourse of lifelong learning infused into new policy documents.

People are now living in a fast-changing and complex social, economic and political world to which they need to adapt by rapidly acquiring new knowledge, skills and attitudes in a wide range of contexts. According to Torres (2008:171), an individual will not be able to meet life challenges unless he or she becomes a lifelong learner and a society will not be sustainable unless it becomes a learning society. Lifelong learning covers a whole range of learning that includes formal, informal and non-formal learning (Crowther 2004:124). It also includes the skills, knowledge, attitudes and behaviours that people acquire in their day-to-day experiences. Thus, lifelong learning incorporated into the curriculum helps people to achieve other goals such as taking an active part in civic life; leading a more sustainable lifestyle; and improving their health and wellbeing. It also benefits society and encourages community activities.

All students have experienced some form of science learning outside the classroom and bring the legacy of their cultural backgrounds to their studies. They bring to their learning a legacy of thoughts and feelings associated with earlier learning experiences and this history affects their engagement with the present and has the potential to influence the outcomes of the task. This means that they have their own attitudes towards science education and attention must be paid to them. There can be substantial discontinuities between what young people experience in their school science lessons and in the rest of their lives. Aikenhead (2010:12) has argued that school science expects young people to cross this border, which is more forbidding for some students than for others. Unless school science explicitly engages with the enthusiasms and concerns of the many groupings that make up today's students, it will lose their interest. Hence, school science education can only succeed when students believe that the science they are being taught is of personal worth to themselves. Accordingly, the science curriculum needs to grapple with how it can respond positively to the wide diversity of student concerns.

For the aforementioned reasons, the researcher is grounded in her view that Life Sciences curriculum developers should apply themselves as to how the curriculum would address those who hold strong religious views; those who have little cultural capital; and those whose current or recent roots lie outside western societies. That is, the element of lifelong learning must be given appreciable consideration. This research grew out of a concern for the poor performance of learners in Life Sciences; the decline in the number of students choosing Life Sciences; the poor teaching and learning methods used by grade 12 Life Sciences teachers and learners respectively; and finally, the lack of curriculum developers to develop a Life Sciences curriculum that incorporated lifelong learning.

1.4 Aim of the study

It is the intention of many a student to gain acceptance at a university upon the completion of their grade 12 examination. In South Africa, if students are to be successful in gaining entrance to universities, it is imperative for them to achieve academically in their final year of schooling. This results in a high degree of emphasis on academic excellence in the year - end examination. All teaching and learning throughout the year is geared towards this examination and educators work fervently to "prepare" their students. Very often the focus is on ensuring curriculum completion in respect of the knowledge aspect. Hence, there is very little, if any, time being spent on the development of skills. According to Erduran and Msimanga (2014:34), educators resort to the drill method of teaching, while learners employ the rote learning of content. In the subject Life Sciences, there is no exception. Life Sciences is unique amongst school subjects in that its curriculum aims to create future scientists rather than future citizens. This produces a foundation curriculum whose coherence only becomes clear for those who continue to further their studies in the same field. It is also dominated by an assessment system whose predominant demand is low-level cognitive recall.

In this study, the researcher, through the research methodology, takes an in-depth look at whether curriculum reform in the Life Science curriculum was conducive to lifelong learning and, in particular, whether there have been supported changes as they were envisaged in policy documents. The development of the Life Sciences curriculum did not involve Life Sciences teachers in any way, although teachers as professionals with appropriate educational qualifications could play a very important role in this context. This study found that teacher participation empowers teachers with knowledge, skills and expertise that render them confident and competent in curriculum implementation processes. The legitimate and necessary roles that teachers should be playing in the development of the curriculum must be clearly articulated if a quality curriculum is to be achieved. At the same time, teacher training and development has a pivotal role to play in terms of implementation, as the quality of the teacher often determines the likelihood of successful implementation.

The effect of curriculum change started many years ago in South Africa. In South Africa, four different curricula have been used for Life Sciences in the Further Education and Training (FET) phase. Until 1995, the 'apartheid' curriculum directed teaching; during the period 1995–2006 the Interim Curriculum (IC) was used; and in 2006, the National Curriculum Statement (NCS) for Grades 10–12 (the final years of secondary schooling) was implemented. Curriculum Assessment and Policy Statement (CAPS) was implemented in grades R-3 and grade 10 in the year 2012; grades 4-9 and 11 in 2013; and grade 12 in 2014 (Department of Basic Education 2011:6). During the adoption of OBE in South Africa, science teaching and learning approaches were changed and the adoption of a constructivist point of view was encouraged. This has highlighted the impact of learners' preconception on the process of developing new knowledge and the need for an instructional strategy that encourages active conceptual change rather than the passive transmission of knowledge (Yip, 2001:755). However, many teachers never shifted from the old approach with a positivist point of view in the teaching and learning of science in many schools in South Africa.

For curriculum changes to be implemented, the quality of the curriculum must be determined. Definitions of quality in the context of education abound, testifying to the complexity and multi - faceted nature of the concept. The terms efficiency, effectiveness, equity and quality have often been used synonymously. Considerable consensus exists around the basic dimensions of quality education today. Quality education includes outcomes that encompass knowledge, skills and attitudes, and are linked to national goals for education and positive participation in society (Bergmann 2006:582). However, the Department of Basic Education had been irresponsible in this regard in that it started the roll-out of a new South African schools' curriculum in 2012 even though quality assurance on the curriculum had not been completed by Umalusi - the statutory body tasked with monitoring standards for education. It was also revealed that the Department of Basic Education had ignored Umalusi's request to delay the roll-out of the new Curriculum and Assessment Policy Statements (CAPS) until quality assurance has been completed (Lovemore 2012:1). In essence, learners were used as guinea pigs to test the new curriculum.

Education in South Africa has always been faced with many challenges since the early years of apartheid to date. These challenges include resistance; inadequate teachers' knowledge and skills; educators' development and training; resources; disparities between rural and urban schools; and lack of support and monitoring. All these challenges might be the factors adversely affecting the teaching and learning of science in South Africa (Christie 1991:302). Rogan and Grayson (2003:1175) emphasize that, in South Africa, there appears to be a tendency to ignore existing differences and mandate complex and comprehensive changes in systems that may or may not be ready to cope with them. Furthermore, Wallace and Fleit (2005:188-189) point out that those factors affecting the success of curriculum reform include the inability of reform makers to accurately diagnose the problem or to accurately evaluate programmes before implementation.

The researcher identified two major reasons for undertaking this research. One was borne out of personal frustration experienced as a Life Sciences educator during the transformation of the Life Sciences curricula over the years. Much of this personal frustration stemmed from the fluidity of the Life Sciences curriculum; the rapid rate at which the curricula were changing; the lack of teacher involvement, as development and dissemination of the curricula involved a "top - down" approach; and finally, the lack of proper evaluation and support offered to educators during this curriculum transformation. Like the researcher, many educators experienced tremendous anxiety during the dissemination and implementation of the many different Life Science curricula. The learners thus bore the consequences of the state of flux in Life Sciences education as it obviously impacted negatively on them. Thus, the second reason for conducting this research was to highlight the plight of learners as they engaged with a Life Sciences curriculum that was deficient in preparing them for their role in society. Consequently, this research is an attempt to highlight the quality of the grade 12 Life Sciences curriculum in the context of lifelong learning. The frustrations listed have led the researcher to the formulation of some key questions: (a) What are the perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning?; (b) What are the perceptions and expectations of grade 12 learners regarding their Life Sciences educators?; (c) What are the perceptions of grade 12 Life Sciences educators of the relevance of the grade 12 Life Sciences curriculum with a view to lifelong learning?; and (d) How does the grade 12 Life Sciences curriculum impact on lifelong learning of learners?.

1.5 Significance of the study

According to McMillan and Schumacher (2001:99), the significance of a study tells the reader why the study is important and indicates the reasons for the researcher's choice of a particular study or problem. Grade 12 learners of Life Sciences face many constraints when it comes to Life Sciences education. The positive impact of curriculum change that was envisaged in Life Sciences after the dismantling of apartheid education in South Africa was to no avail. Put quite simply, the curriculum changes that followed in Life Sciences impacted negatively on the effectiveness of teaching and learning.

The research investigates the quality of the grade 12 Life Sciences curriculum in an attempt to determine whether the issue of lifelong learning within the curriculum has been addressed. An investigation into the attitudes of educators and learners would play a significant role in making the Life Sciences curriculum impact in a positive way. It is well beyond the scope of one thesis to provide a solution to any crisis in education. However, this research is aimed at providing answers to various concerns about the quality of the Life Sciences curriculum and it is hoped that this thesis will provide some insight into the questions being addressed. Therefore, conducting this research was that it will hopefully inform the participants in the research as well as other educationists who take the time to read it and, as such, in a small way, may contribute to the ongoing reform, that curriculum development is undergoing.

The study can make a significant contribution to improving practice because the findings of the study and recommended suggestions were made implicit in the discussion. This study has the potential to make a contribution to scholarly literature in the field of Life Sciences curriculum and lifelong learning as it provides an insight into the experiences of learners and educators in Life Sciences, with particular reference to the constraints of the curriculum that could impact negatively on the future engagement of learners with global environmental issues. This study attempts to develop an effective strategy for teacher involvement in curriculum development. Roles and mechanisms concerning the involvement of Life Sciences teachers in the curriculum development process were identified and described.

1.6 Research methodology

This study falls within the realm of a mixed methods study. Mixed methods encompass both a quantitative and a qualitative approach. The study was conducted in the district of Pinetown because, in 2013, this district produced the best results in Kwa-Zulu Natal in the National Senior Certificate Life Sciences examination. This study used simple random sampling to obtain the learner participants. The researcher conducted the study in 16 schools and 25 learners from each school were randomly selected. The educator sample comprised 75 grade 12 Life Sciences educators. The SERVQUAL questionnaire was administered to the 400 learners that were randomly selected, while the educator questionnaire was administered to the sample of 75 educators. Six learners participated in the learner interview while six educators participated in the educator interview. The data was then analysed.

1.7 Clarification of concepts

1.7.1 Curriculum

Curriculum is defined differently by different authors. Marsh and Willis (2007:19) argue that curriculum reflects the historical, social, economic and political context of a society. According to Ornsteins and Hunkins (2009:19), curriculum can be defined in five different ways. Firstly, they define it as plan for achieving goals; secondly, dealing with the learners experience; thirdly, as a system for dealing with people; and fourthly, as a field of study. Finally, they define curriculum in terms of subject matter (maths, science, English, history, etcetera) and content (the way information is organized and assimilated).

1.7.2 Teaching

Teaching can be defined in numerous ways. Since the curriculum started to change, teaching has been defined in some new and different ways. According to Du Plessis, Conley and Du Plessis (2007:2), teaching can be seen as creating opportunities for learning to take place, as well as a process of helping learners to learn.

1.7.3 Learning

According to Du Plessis, Conley and Du Plessis (2007:3), learning is a process of experience that changes the individual. They go on to point out that it entails change in a person with regard to the individual's insights, behaviour, perception or motivation which leads to added knowledge or the ability to do something that learners could not do before. This study looks at the learners' experience in class. It also looks at what the learners have gained through their experiences in the learning process.

1.7.4 Lifelong learning

Lifelong learning refers to learning both in the formal education system and through everyday life either in the home, through a social movement, through work or through local community activities. It includes formal, non-formal and informal education. The concept, therefore, is integrative on two dimensions: horizontally between home, community, the media and work; and vertically between different life stages. Belanger (1994:354) argues that lifelong learning provides an all-inclusive and holistic approach to education. In developing a lifelong learning curriculum in science, it is necessary to promote an interest in science and a sense of its significance in our society amongst pupils.

1.7.5 Science

When the word "scientist" is mentioned, the first thought that may spring to mind is a person in a laboratory coat, conducting an experiment. The word science comes from the Latin *"scientia,"* meaning knowledge. According to Cope and Kalantzis (2008:14), the definition of science is *"knowledge attained through study or practice, or knowledge covering general truths of the operation of general laws, esp. as obtained and tested through scientific method [and] concerned with the physical world."* It can therefore be concluded that science refers to knowledge about or study of the natural world based on facts learned through experiments and observation. In this study, the reference to science alludes to subjects like chemistry, physics and biology in schools.

1.7.6 Skills

An ability and capacity acquired through deliberate, systematic and sustained effort to smoothly and adaptively carry out complex activities (Schwartz 2007:195). In science teaching the first step in implementing a skills-based approach begins by carefully defining what one would like children to be able to do. According to McGlathery (1999:77), science skills may be organised into three separate groups, namely process skills, reasoning skills and critical thinking skills. These groups correspond to three distinct types of cognitive skills. He further proposed that process skills are used to gather information about the world; reasoning skills help children make sense of the information they gather by fostering an open mind, curiosity, logic, and a data-based approach to understanding the world; while critical thinking skills require students to apply information in new situations and in solving problems.

1.7.7 Knowledge

According to Popper (1975:33), knowledge in science refers to the facts and information acquired through experience or education and involves a theoretical or practical understanding of the subject. Knowledge production in science is an ongoing endeavour that usually happens gradually but, occasionally, knowledge and insights take a leap forward as new knowledge or a new theory replaces what was previously accepted (Popper 1975:33). As with all knowledge, scientific knowledge changes over time as scientists improve their knowledge and understanding and people change their views of the world around them. The science knowledge that is taught at school is static and most of it has been tested and has come to be generally accepted.

1.7.8 Attitude

An attitude is a hypothetical construct that represents an individual's degree of like or dislike for something (Carlson, 2010: 55). Attitudes are generally positive or negative views of a person, place, thing or event. Attitude influences an individual's choice of action, and responses to challenges, incentives, and rewards. Martin, Sexton and Franklin (2009:16) suggest that scientific attitude is a disposition to act in a certain way or a demonstration of feelings and/or thoughts. The authors further argue that attitudes are not innate but are dynamic results of experiences that act as directive factors when a child enters into new experiences. As a result, attitudes carry an emotional and intellectual tone, both of which lead to making decisions and forming evaluations. These decisions and evaluations can cause a child to set priorities and hold different perspectives.

1.7.9 Indigenous knowledge

The term 'indigenous knowledge' is used to describe the knowledge systems developed by a community as opposed to the scientific knowledge that is generally referred to as 'modern' knowledge (Mathias 2005:199). The basic component of any country's knowledge system is its indigenous knowledge. According to Grenier (2008:12), indigenous knowledge encompasses the skills, experiences and insights of people that are applied to maintain or improve their livelihood. Indigenous knowledge is the basis for local-level decision-making in many rural communities.

1.8 Summary of the chapters

The content of the various chapters in this study are as follows:

In Chapter 1, the researcher introduces the research study. This chapter highlights the reasons for choosing the topic and provides a brief background to the study. Included in this chapter are a few concept clarifications to help readers to better understand the content of this research. The introduction, rationale, purpose, scope of the study and the specific research questions that it sought to address are outlined.

Chapter two presents a review of international perspectives on science education in secondary schools. This chapter describes and analyses some of the causes and impact of a declining science enrolment by students in secondary schools. The imperatives to sustain student interest in science and the correlation between student interest in science and learning science is brought to the fore.

Chapter three focuses on international perspectives of quality in science education and lifelong learning. This chapter explores the constructs for and the context of the study, as well as providing a conceptual framework relevant to the study. This literature review chapter endeavours to provide an overview of theoretical issues which relate to the quality of science education and lifelong learning. The literature review encompasses an exploration of definitions related to quality and lifelong learning theories on total quality management.

In chapter four, the researcher interrogates literature on quality and lifelong learning in basic education in South Africa. In this chapter, the reader is briefed on the basic education system in South Africa. An exploration of how it evolved from the apartheid era through the post-apartheid era to its present system is presented. In tracing the transformation process, the study outlines the various policies and legislation that have impacted on the quality of basic education in South Africa, with special reference to the quality of the Life Sciences curriculum in grade 12 regarding lifelong learning.

Chapter five provides a description of the research methodology undertaken to address the research questions of the study. This chapter begins with a description of the design of the study. This is followed by a discussion of the research methodology, including the research instruments, questionnaires and semi-structured interviews. This chapter also deals with how educators and learners were selected for the administration of the questionnaire and focus group discussion respectively. The ethical issues, administration of instruments, limitations of design and methodology are presented.

In chapter six, the researcher analyses the qualitative and quantitative data that was elicited during the research process. This chapter interprets the data gathered from grade 12 Life Sciences educators and learners arriving, at general trends and tendencies in answering the research questions and uses statistical analysis to determine correlations and detect any uneven distribution, skew or bias.

In the final chapter, the researcher presents the conclusions and recommendations arising from this study. The researcher highlights the themes on learner perceptions and expectations of and experiences on the quality of Life Sciences in the context of lifelong learning. This part of the research will revisit the research questions; reflect on the research process that has been undertaken, offer conclusions based on the findings and present recommendations regarding further research. The limitations of this study will also be highlighted.

1.9 Conclusion

This chapter began by briefly presenting the historical background to this study, followed by a description of the motivation and aim of the study. The significance of the study is also discussed and the importance and reasons for the choice of the study are indicated. This chapter then went on to clarify the key concepts used in the study. The Life Sciences curriculum aims at providing a basis for continued learning in higher education; to lay a foundation for future careers; and to develop learners who are productive and responsible citizens and lifelong learners. If the challenges experienced by educators and learners with respect to the curriculum are not addressed, there will be far-reaching consequences not only for our education system, but also for the type of skilled learners that will be produced and for the economic growth of the country.

In the next chapter, the researcher interrogates literature in a more detailed manner to show how an inadequate Life Sciences curriculum impacts on the type of learner and future citizen that such a curriculum produces.

CHAPTER 2

INTERNATIONAL PERSPECTIVES ON SCIENCE EDUCATION IN SECONDARY SCHOOLS

2.1 Introduction

Societies are dominated by ideas and products from science and it is very likely that the influence of science on the lives of people will continue to increase in the years to come. Scientific knowledge, skills and artefacts invade all realms of life in modern society. The workplace and the public sphere are increasingly dependent upon new as well as more established scientific discoveries. Scientific knowledge and skills are crucial for most actions and decisions taken by people.

Modern society is driven by science and citizens acting as consumers and voters are confronted with a range of science-related issues. As consumers, people need to take decisions about food and health, the quality and characteristics of products as well as the claims made in advertisements. As voters, citizens need to take a stand and be able to judge arguments related to a wide variety of issues. Many of these political issues also have a scientific dimension. In such cases, knowledge of the relevant science has to be combined with values and political ideals. Issues relating to the environment and to a wide range of other matters including energy, traffic and health policy are of serious concern to all people. Therefore, broad public understanding of science is an important democratic safeguard against scientism and domination by "experts".

The preceding democratic argument for scientific education assumes that ordinary people have some understanding both of scientific concepts and principles and of the nature of science and the role it plays in society. The recognition that science is a cultural enterprise implies that there is no neutral perspective on science or on learning science. Recognition of this aspect of culture in science is critical in promoting science learning.

Science curricula are key factors in developing and sustaining interest in science. There seems to be a broad agreement about the shortcomings of traditional curricula that still prevail in most countries. This chapter maps out the importance of science education, focussing on a comparison of science education in developing and developed countries. Furthermore, some of the causes and impact of a declining science enrolment by students in secondary schools is analysed. The imperatives to sustain student interest in science and the correlation between student interest in science and learning science is brought to the fore.

2.2 Science in secondary schools

2.2.1 Importance of science education

Science education is very important for the development of any nation, which is why every nation must take it very seriously in all institutions of learning (Kidman 2010:360). Many developed countries were able to achieve much in science and technology because of science education. America invented the space shuttle, computers and submarines; and developed the hepatitis B vaccine; whilst Japan invented the fastest elevator which can move people through levels of a building in a few seconds. Science provides the foundational knowledge for those who will become the scientists, engineers, technologists and technicians of the future. According to the National Research Council of the United States of America (2012: 22), science education also develops competencies in students in preparation for their individual lives and for their roles as citizens in this technology-rich and scientifically complex world.

Science and technology will not be possible without science education. For instance, engineering, medicine and architecture will not be possible if there is no one to teach students the core subjects needed for these courses. An important personal reason for studying science for many scientists is that scientific knowledge enhances one's enjoyment and appreciation of the natural world. More profoundly, science offers an understanding of one self, of the universe and of one's place in it. Indeed, some knowledge of science is required to engage with the major public policy issues of today, as well as to make informed everyday decisions such as selecting amongst alternative medical treatments or determining how to invest public funds for water supply options. Furthermore, many of the problems currently confronting society, such as the looming energy and population crises, global warming and ethical issues involving biotechnology, require knowledge of science if they are to be dealt with rationally.

In addition, understanding science can be meaningful and relevant on a personal level, opening new worlds to explore and offering lifelong opportunities for enriching people's lives. In these contexts, learning science is important for everyone, even those who eventually choose careers in fields other than science.

In essence, science education aims to develop the following skills and perspectives (Alsop and Hicks 2010:13):

- **Problem-solving skills**

  With knowledge of science, one learns to think logically and solve problems. It is this problem-solving skill which is learnt in the early years that enables a person to solve problems. Areas like communication, medicine and transportation are mainly present because individuals have used their knowledge of science to create real - life applications.

- **Awareness about technology**

  Learning the basics of how certain devices work can help develop ideas and invent new technology. Even the knowledge of how to use telescopes, microscopes and other devices in a laboratory can help in examining objects and determining differences between them.

- **How to conserve natural resources**

  All aspects of the environment have a deep impact on human lives. Science helps one to learn about how the earth functions, how to make use of natural resources and promote a greener environment. It also teaches how the lack of these resources affects living things and how to conserve these resources. This knowledge is crucial to help save our planet for the future.

- **Instills survival skills**

  Since one learns about the characteristics of different objects that are used in day-to-day life, one will be able to distinguish between things that are safe and those that are not. Almost everything that a person does requires a basic knowledge of science, and logical reasoning. It is undoubtedly important to learn science from the early days of school.

The above skills are crucial for the practice of science in order to make sense of the world and construct understandings of it from primary observations and empirical evidence

(Zimmerman and Bell 2014:52). Science is concerned with seeking understanding through questioning about physical and biological mechanisms. Another practice of science is experimentation and making sense of the results of experiments, which includes a general curiosity to experiment on the world and reconcile anomalies as argued by Gidlow and Steel (2012:387). These practices are consistent with the recent recommendations of a core set of science practices in a new framework for science education standards by the National Research Council (Berland and Reiser 2011:191).

2.2.2 Framework for science education standards

2.2.2.1 The vision of the framework

According to the National Research Council (Berland and Reiser 2011:193), science permeates nearly every facet of modern life and it also holds the key to meeting many of humanity's most pressing current and future challenges. The National Research Council (Berland and Reiser 2011:194) created a widespread call for a new approach, the K-12 science education, in countries that are not achieving in science advancements. According to the National Research Council (Berland and Reiser 2011:194), the framework defines the core content that all students should learn in science from kindergarten until grade 12. It also emphasises that students with a strong interest in science should have opportunities to go beyond this "all students" base level. The overarching goal of this framework as proposed by the National Research Council (Berland and Reiser 2011:195) was to ensure that by the end of the 12th grade, all students would have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science to engage in public discussions on related issues; are careful consumers of scientific information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including careers in science. The National Research Council (Berland and Reiser 2011:197) also states that many recent calls for improvements in K-12 science education have focused on the need for science professionals to keep countries competitive in the international arena. Although this document was initially drawn up for implementation in the United States, many European countries, as well as Japan and Taiwan, have implemented this framework (Berland and Reiser 2011:199).

2.2.2.2 The practices of the framework

The National Research Council recommended a framework which included the following eight essential practices to better define scientific inquiry and to ensure that students engage in all these aspects during their science lessons (Berland and Reiser 2011:200) :

(a) Asking questions and defining problems

Science begins with a question about a phenomenon such as “Why is the sky blue?” or “What causes cancer?” and seeks to develop theories that can provide explanatory answers to such questions. A basic practice of the scientist is formulating empirically answerable questions about phenomena; establishing what is already known; and determining what questions have yet to be satisfactorily answered.

(b) Developing and using models

Science often involves the construction and use of a wide variety of models and simulations to help develop explanations about natural phenomena. Models make it possible to go beyond observables and imagine a world not yet seen. Models enable predictions of the form “if . . . then . . . therefore” to be made in order to test hypothetical explanations.

(c) Planning and carrying out investigations

Scientific investigation may be conducted in the field or the laboratory. A major practice of scientists is planning and carrying out a systematic investigation which requires the identification of what is to be recorded and, if applicable, what are to be treated as the dependent and independent variables (control of variables). Observations and data collected from such work are used to test existing theories and explanations or to revise and develop new ones.

(d) Analysing and interpreting data

Scientific investigations produce data that must be analysed in order to derive meaning. Because data usually do not speak for themselves, scientists use a range of tools - including tabulation, graphical interpretation, visualization, and statistical analysis - to identify the significant features and patterns in the data. Sources of error are identified and the degree of certainty calculated. Modern technology makes the collection of large data sets much easier, thereby providing many secondary sources for analysis.

(e) Using mathematics and computational thinking

In science, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analysing data; and recognizing, expressing and applying quantitative relationships. Mathematical and computational approaches enable predictions of the behaviour of physical systems, along with the testing of such predictions. Moreover, statistical techniques are invaluable for assessing the significance of patterns or correlations.

(f) Constructing explanations and designing solutions

The goal of science is the construction of theories that can provide explanatory accounts of features of the world. A theory becomes accepted when it has been shown to be superior to other explanations in the breadth of phenomena it accounts for and in its explanatory coherence and parsimony. Scientific explanations are explicit applications of theory to a specific situation or phenomenon, perhaps with the intermediary of a theory-based model for the system under study. The goal for students is to construct logically coherent explanations of phenomena that incorporate their current understanding of science or models that represent it and that are consistent with the available evidence.

(g) Engaging in argument from evidence

In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations; formulate evidence based on a solid foundation of data; examine their own understanding in light of the evidence and comments offered by others; and collaborate with peers in searching for the best explanation for the phenomenon being investigated.

(h) Obtaining, evaluating and communicating information

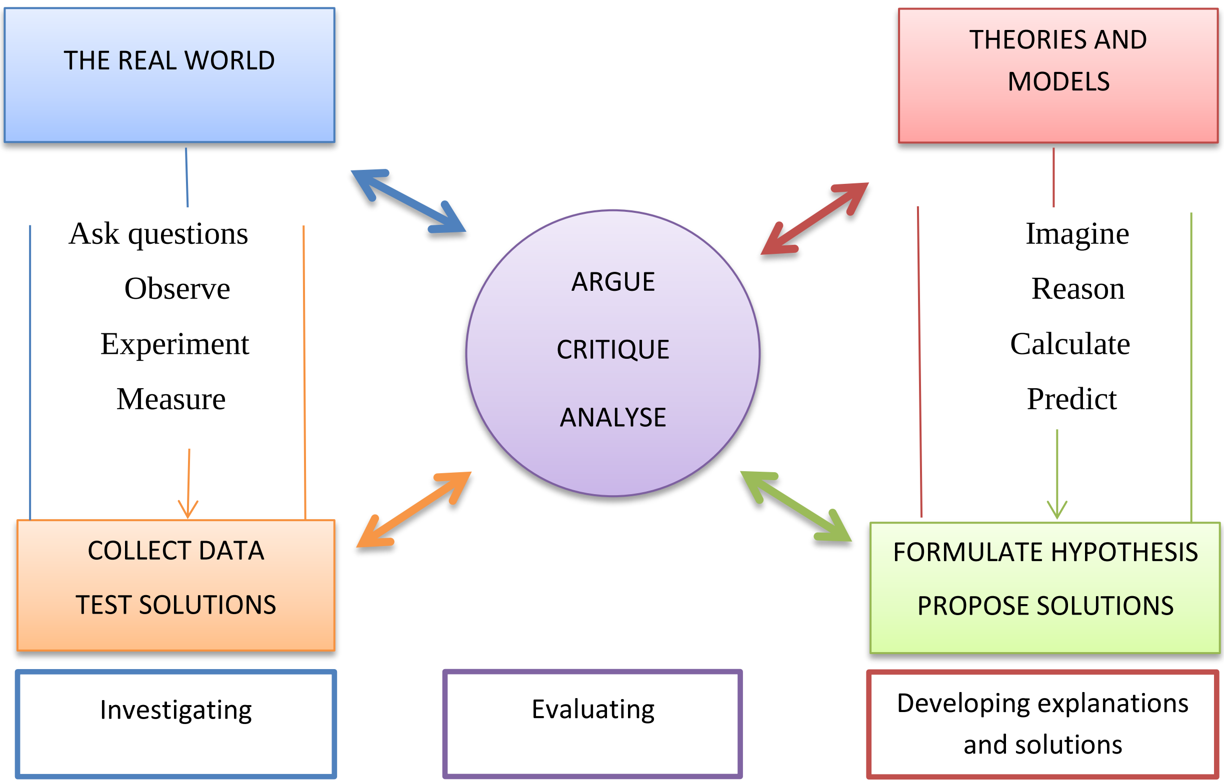
Science cannot advance if scientists are unable to communicate their findings clearly and persuasively or to learn about the findings of others. A major practice of science is thus the communication of ideas and the results of inquiry-orally, in writing, with the use of tables, diagrams, graphs and equations, as well as by engaging in extended discussions with scientific peers. Science requires the ability to derive meaning from scientific texts such as papers, the internet, symposia and lectures in order to evaluate the scientific validity of the information thereby acquired and to integrate that information.

Since the framework is suggesting what science knowledge all students should have obtained by the end of their schooling, it is in preparation for their individual lives and for their roles as citizens in this technology-rich and scientifically complex world. It is anticipated that the insights gained and interests provoked from engaging in these practices in the framework of science during their schooling should help students see how science is instrumental in addressing major challenges that confront society today. Thus, the framework seeks to illustrate how knowledge and the aforementioned eight practices are intertwined in designing lifelong learning experiences through science education.

2.2.2.3 Integration of the practices into science and inquiry

The focus here is on important practices such as modelling, developing explanations, and engaging in critique and evaluation (argumentation) that have too often been under - emphasized in the context of science education. One helpful way of understanding the practices of scientists is to frame them as work that is done in three spheres of activity, as shown in Figure 2.1.

Figure 2.1 Three spheres of activity for science education



Source: Adapted from the National Research Council -USA (Berland and Reiser 2011)

Figure 2.1, according to the National Research Council (Berland and Reiser 2011:201), identifies three overarching categories of practices and shows how they interact. In one sphere, the dominant activity is investigation and empirical inquiry. In the second, the essence of work is the construction of explanations using reasoning, creative thinking and models. In the third sphere, the ideas are analysed, debated and evaluated.

- To the left of the figure are activities related to empirical investigation. In this sphere of activity, scientists determine what needs to be measured; observe phenomena; plan experiments, programs of observation and methods of data collection; build instruments; engage in disciplined fieldwork; and identify sources of uncertainty.
- The activities related to developing explanations and solutions are shown to the right of the figure. For scientists, their work in this sphere of activity is to draw from established theories and models and to propose extensions to theory or create new models. Often, they develop a model or hypothesis that leads to new questions to investigate or alternative explanations to consider.
- Between and within these two spheres of activity is the practice of evaluation, represented by the middle space. Critical thinking is required, whether in developing and refining an idea or an explanation or in conducting an investigation. The dominant activities in this sphere are argumentation and critique, which often lead to further experiments and observations or to changes in proposed models or explanations. Scientists use evidence-based argumentation to make the case for their ideas, whether involving new theories, novel ways of collecting data or interpretations of evidence. These scientists then attempt to identify weaknesses and limitations in the argument, with the ultimate goal of refining and improving the explanation.

Understanding how science has achieved its many successes and the techniques that it uses is an essential part of any science education. Although there is no universal agreement about teaching the nature of science, there is strong consensus about the characteristics of the scientific enterprise that should be understood by an educated citizen, as stated by the National Research Council (Berland and Reiser 2011:201). It is important that the opportunity for students to learn the basic set of practices outlined also provides an opportunity for them to reflect on how these practices contribute to the accumulation of scientific knowledge. An education in science should show that new scientific ideas are acts of imagination, commonly created through collaborative efforts of groups of scientists whose critiques and arguments are fundamental to establishing which ideas are worthy of pursuing further.

Of significant importance is that students need to continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. Engagement in modelling and in critical and evidence-based argumentation encourages students to reflect on the status of their own knowledge and their understanding of how science works. Thus, they begin to appreciate meaningful learning in science. The understanding of the scientific status held by students leads to an understanding of the world in which they live and interact and helps them to better define their function in and contribution to society.

2.3 Science education in developing and developed countries

Different nations have embraced science and technology at different levels. According to Johnson (2015:267), the development and advancement of any society is directly proportional to the amount of investment and advancement it is making in science and technology. Therefore, the quality of science education has a great impact on the growth of a nation's economy, which in turn directly impacts the quality of life experienced by a particular nation. Studies by Onwuka and Equaveon (2007:48) noted that countries with a high technological level will ultimately enjoy more prosperity and a higher standard of living as they are better able to produce solutions to the issues faced by various sectors of their economy. The impact of science and technology on any nation has a ripple effect on society at large.

Science at secondary level in most education systems is generally taught to selected groups of secondary students, both because of the limited resources available and because of the prevalent belief that only relatively small proportions of the school population with a special aptitude for science could benefit. Olayinka (2009:73) states that for some developing countries, scientific literacy is still a distant goal as there are several challenges to science education namely, policy formulation, funding, infrastructure, economic instability, outdated curricula, inexperienced teachers and lack of learning resources. Having perused the extensive literature on science education in developing and developed countries, the researcher saw the relevance of mapping out science education in Kenya, India, Canada and the United States to this study.

2.3.1 Science education in Kenya

In Kenya, like in many African countries, the use of the English language which is a second language for most learners can possibly have a negative impact on science teaching and learning. However, according to Menjo (2013:433), the teaching of science subjects in Kenya has become a matter of debate due to poor performance in the national examinations by many candidates. This is an indication that the teaching and learning of these subjects in secondary schools has not been very efficient. The study by Eliud Menjo (2013) on *An Assessment of Effectiveness of the Secondary School Science Pedagogy and Curriculum Relevance to Students' Needs in Kenya* revealed that there are particular distinct changes that students are supposed to portray as a result of science instruction. The science education curriculum has been reputed as irrelevant to the needs and experiences of students. According to Kisangi (2006:965), the topics that are in the science curriculum tend to reflect a western orientation. It is argued that if students are studying topics that they could not relate to, then they will be engaging in science that would be abstract. Consequently, they would find science challenging. In circumstances where the content is exotic, the language being used for instruction is not native; then science in such countries is bound to suffer greatly unless efforts and strategies are put in place to indigenize the curriculum content. On the contrary, Tefera (2013:15) adds that there are situations when students in Kenya look down upon African science even when it has the credence to back it up. The inference that comes forth is that there are some students who hold negative attitudes toward scientific activities from the developing world.

Curriculum overload as a result of the content being too wide on some topics has also been reported in Kenya. Since independence, the Kenyan government has consistently shown a keen interest in the promotion of science education as a means to achieving the country's manpower requirement (Menjo 2013:433).The Commission of Inquiry into the Education System of Kenya, commonly referred to as the *Davy Koech Commission*, was a Government Commission established in 1998 by the President. The commission, led by Dr. Davy Kiprotich Koech, investigated the question of the appropriateness of Kenya's education system. The Koech Commission (Koech 2011: 22) recommended reduction of subjects offered at secondary level, to enhance quality at that level and to also make the curriculum manageable. It also reported that the curriculum was heavily loaded and needed to be downsized.

Additionally, the science content taught in Kenyan schools has been noted to be too academic and difficult for most learners (Verspoor 2011:12) and has remained unchanged for many years. In view of this, according to Verspoor (2011:15), there are efforts to revamp the science curriculum by reducing its content and integrating the subjects. In the context of these circumstances, curriculum designers should work hand in hand with teachers in the selection of content and the choice of teaching methodologies that are relevant (Fensham 2011:235). On the same note, Fensham (2011:235) posits that assessment procedures should be changed to enhance higher levels of learning and the achievement of intended outcomes in school science. Having interrogated the literature on science education in Kenya, one can purport that the objective of this recommendation would be to develop effective teaching and learning in science education in order to meet needs in the lives of students after school.

2.3.2 Science education in India

According to Rao (2014:180), the value system in India's society does not favour the development of science as a first-choice career option for bright students, since it gives greater importance to material pursuits and accomplishments over intellectual development. This has led to a career in science being devalued compared to other professions. Therefore, the input of energy and enthusiasm into the scientific search for solutions to the problems of their nation, which are in many ways common to large populations residing in other countries around the world, is greatly reduced.

Science curricula at schools in India tend to be highly theoretical and very dense in content (Tilghman 2010: 11). This poses two problems. The first is that theory is prioritised over application and the second is that time constraints do not allow teachers to explore all concepts in depth. Consequently, students in India are frequently being exposed to many concepts but fail to understand them in depth and explore their application. This structure results in "teach more and learn less". Rao (2014: 181) posits that many concepts taught in the classroom will never be used by many in their professional lives. It can therefore be noted that the curriculum in India should include only the core concepts and that these should be explored in detail and understood in greater depth. This will allow students to develop a solid grounding in different scientific concepts and provide a background to further develop their knowledge in some of those areas at their own pace and according to their own needs throughout their professional lives.

Even if schools cannot provide research projects in cutting edge areas and access to highly sophisticated instrumentation due to financial constraints, Cech (2011: 196) purports that the development of skills in identifying and solving problems; reasoning; organising scientific data; presenting results; and interpretations could be considered very influential in the development of scientific careers. A study by Varghese (2014: 22) on science education in India recommended that instructors must focus more on what students learn and how well they can use their knowledge about a subject than on "covering" a pre-designed syllabus. Further to this, Varghese (2014: 22) proclaims that problem - based and case - based approaches are the two instructional approaches which create opportunities for applying knowledge and that existing science courses must be improved by incorporating an active component of student engagement in the learning process. From the aforementioned literature, it may be argued that it is necessary to make science education in Indian schools and colleges relevant to the needs of society so that education becomes an effective contributor to solving the nation's problems and enhancing the employability of its large population of youth.

The common thread running through the science curricula of both Kenya and India is that they are both broad but found to be lacking in depth. The lack of depth of the science curricula could possibly explain the reason for developing countries lagging behind in scientific and technological advancements. However, this should be of grave concern to developing countries as it could lead to poor economic growth. The state of science and mathematics education in the developing world poses one of the greatest economic threats to equitable growth around the world. Effective science education can equip people living in extreme poverty with skills that will help them break away from poverty cycles.

2.3.3 Science education in Canada

In Canada, an alternative approach to traditional science originated largely from the philosophical writing of J.J. Rousseau (1712-1778). In his book *"Emile"* (1762), concerning the education of an imaginary student, Rousseau proposed that children should not be taught directly, but should be allowed to discover things for themselves, especially through play. Further, learning how to learn was of much greater importance than teaching factual information (Vanderwolf 2005:1). The significance behind referring to this book is to emphasise that at a very early stage in education, around 1760, educationists like Rousseau made critical statements about the merits of teaching science through creativity and discovery. According to Gibb, LeDrew, Osborne, Patterson, Poole, Roberts, Toor and White-McMahon (2012: 22), the aim of science education in Canada is to develop scientific literacy which is a combination of science-related attitudes, skills and knowledge which students need in order to develop inquiry, problem-solving and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. Having interrogated the literature, one could contend that to develop scientific literacy, students require diverse learning experiences which provide the opportunity to explore, analyse, evaluate, synthesize, appreciate and understand the interrelationships amongst science, technology, society and the environment that affect their personal lives, their careers and their futures.

As stated by Aikenhead (2010: 12), the science curricula in the different provinces in Canada are fairly similar if one simply lists the topics covered. In the first three or four years, there is an emphasis on local natural history in many provinces and on natural phenomena occurring in everyday life. According to Hackling (2009: 24), although the topics covered in the various provincial curricula are rather similar, the quality of the instruction suggested varies widely. He stated further that the way to interest students in science is certainly not to preach about experimental design, logic, measurement, and the control of variables, but rather to show them interesting phenomena. According to Gibb, LeDrew, Osborne, Patterson, Poole, Roberts, Toor and White-McMahon (2012: 22), every student should find his/her learning opportunities maximized in the science classroom. When making instructional decisions, teachers must consider individual learning needs, preferences, strengths, abilities, experiences, interests and values that learners bring to the classroom. Consequently, when a science curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally underrepresented in science and, indeed, for all students. The brief Ontario curriculum has the advantage that it encourages teachers to use their own professional judgment in developing effective approaches to their own particular classes.

The shortcoming of teachers developing the progression of science lessons in their classes in schools in Canada is that the quality of the science curricula in different provinces could vary rather widely (Hackling 2009: 24). To concur with this statement, a report by Brochu, Deussing, Houme and Chuy (2013:37) concluded that measures of student achievement in standard tests appear to be related to the quality of the curricula. The findings of this report indicated that the performance of students in all provinces varied with respect to the average scores. According to Brochu, *et al.* (2013:38), some students in many provinces in Canada performed at the average or above the average in science; while in other provinces students, performed below the average. Studies suggest that a root cause of this mediocre rating in a few provinces in Canada is due to a lack of specialist teachers (Brochu, *et al.* 2013:38). If teachers are not suitably qualified or if teachers lack in certain topics in science, then those topics will not be taught or may be completely left out from their science teaching. In this way, vitally important aspects of learning may not be dealt with adequately in some Canadian schools. This could result in the overall quality of the science curricula in different provinces varying rather widely.

2.3.4 Science education in the United States of America (USA)

In the USA, the Committee on a Conceptual Framework for the New K-12 Science Education Standards was charged with developing a framework that provides a broad set of expectations for students in science. This was as a result of K-12 science education focussing on the need for developing science and engineering professionals in the United States. According to the National Research Council (Berland and Reiser 2011:199), the goal of K-12 science education is to ensure that by the end of the12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including careers in science, engineering and technology.

The National Research Council (NRC) (Berland and Reiser 2011:201) envisages that the K-12 science education framework endeavours to move science education towards a more coherent vision. The framework recommends the following three ways in order to achieve this vision: Firstly, science is designed in such a way as to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. The goal is to guide their knowledge towards a more scientifically based view, as well as to guide the ways in which these views could be pursued and how their results can be used. Secondly, it focuses on a limited number of core ideas in science. This is to avoid shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth in order to achieve a greater understanding of the core ideas presented. Thirdly, the emphasis is on learning about science through the integration of the knowledge of scientific explanations (i.e. content knowledge) and the practices needed to engage in scientific inquiry. Thus, knowledge and practice are intertwined in designing learning experiences in K-12 science education.

It could therefore be argued that the insights gained and interests provoked from studying and engaging in the practices of science during their K-12 schooling should help American students see how science is instrumental in addressing major challenges that confront society today. These challenges include generating sufficient energy, preventing and treating diseases, maintaining supplies of clean water and food, and solving the problems of global environmental change.

It is interesting to note that the aims of science education from the various countries mentioned are similar, despite the fact that each country evolved independently of each other. It was noted from the reviewed literature that an informed public has the capacity to make reasoned decisions and take responsible action. Decisions and actions arise from both knowledge and values. An informed public will make their decisions thoughtfully by bringing their pertinent knowledge into focus with the values that guide their decisions and action. Therefore, it is imperative that the science curriculum of any nation be designed such that it equips its citizens with the knowledge and skills that are necessary for them to participate in global science - related issues.

2.4 Declining interest in science education in schools

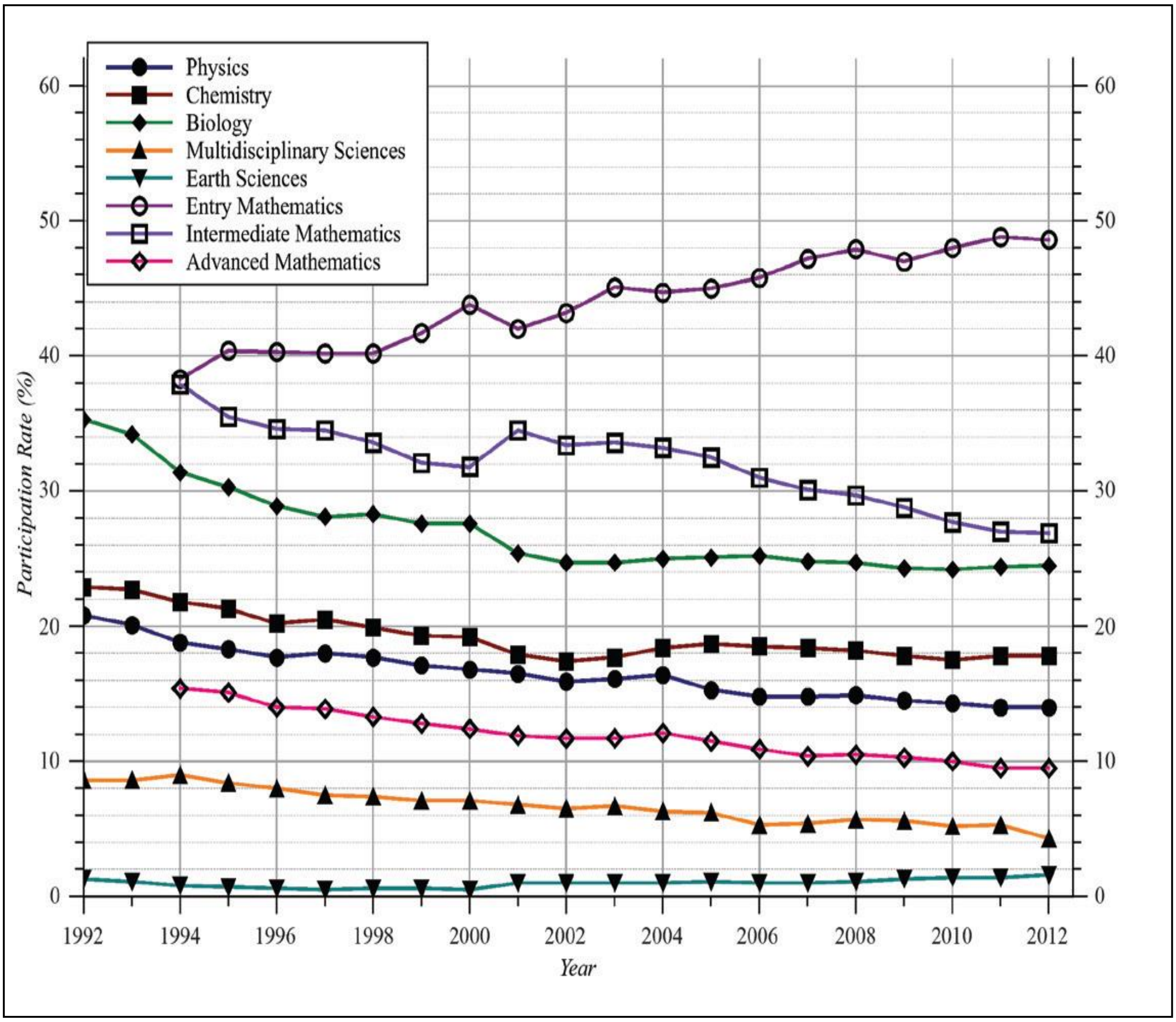
Governments in many countries, including South Africa are concerned about the declining interest shown by students in science (Kidman 2010:365). President Obama, in his address to the national Academy of Sciences in April 2009, stated that the United States - which has one of the most influential economies of the world - must increase its scientific activity and, above all, improve the quality of science education at all levels as a way for the country to overcome the financial crisis and its effects, as well as environmental threats. It is imperative for every society to pay particular attention to the scientific education of its future citizens.

The decreasing interest in school science shown by students across the world is a challenge and there are well-documented studies to support this argument. A study conducted by Randler, Osti and Hummel (2012:203) in Germany has revealed a decline in interest of about 10% in science education. This is of great concern because interest is seen as an influential predictor of learning. In another study conducted by Varghese (2014:23), a regressive trend has been observed in the past few years in science education in schools in India. Students seem to be excluding science in favour of other disciplines like economics and politics, which seem to be more attractive to them. The widespread impression amongst students is that a career in basic science is not lucrative.

Elias's (2010:382) study also showed that both Spain and the UK have developed comparably rich cultures in terms of literacy and art, but are not at the same level with respect to achievements in science. The UK, according to Elias (2010:382), has been a centre for scientific development from close to the beginning of the modern science age, whilst comparatively in Spain a crucial time for scientific development occurred a full two centuries later. According to Elias (2010:384), his study affirmed that not only were the great fathers of modern science British, but also that its number of recipients of the Nobel Prize was high in relation to other countries. While Great Britain had 23 laureates in Physics and 24 in Chemistry by 2009, Spain did not have a single Nobel Prize in these same natural sciences. The huge gap in scientific achievement between the UK and Spain is therefore very clear. Despite the differences in scientific achievement between Spain and the UK, Elias (2010:383) noted that there was something they have in common. There is a decline in the number of people interested in science in both countries. Statistics obtained from a study by Elias (2010:384) revealed that two main reasons emerge to explain the disinterest in science. A total of 32% of respondents pointed out that they were not interested in science and technology because they do not understand it, whilst a further 31% indicated that they simply do not care about science and technology. These downward trends will inflict significant negative consequences in the UK and Spain if not reversed, adversely affecting prosperity and the quality of life in these countries.

A study commissioned by one of Australia's Chief Scientists concluded that all the main high school sciences were experiencing continuing and dramatic declines (Kennedy, Lyons and Quinn 2014:34). According to Mack and Walsh (2013:5), participation in science courses by the Australian year - 12 students has been declining for the greater part of the last two decades and had continued to do so in 2012. The magnitude of this rate of decline can be noted in Figure 2.2, which depicts the participation rate of the Australian year - 12 students in mathematics and sciences.

Figure 2.2 Participation rates for Maths and Science subjects in Australia



Source: Adapted from Kennedy, Lyons and Quinn (2014)

It is clear from Figure 2.2, that all the subjects analysed depict a decline in their individual participation rates, except Earth Sciences which shows marginal growth and Entry Mathematics which exhibits steady growth. From the graph, it is evident that the period of decline occurred prior to 2002 and the rate of decline has been generally lower over the subsequent years. A potential explanation for the falling participation rates is that students who prior to their grade 12 year may have enrolled for two or more science subjects are now studying only one (Kennedy, *et al.*2014:43) due to the breadth of choice currently available to them. According to Kennedy, *et al.* (2014:45), further investigation of students in science education is required to understand why, when and how they make the decision to turn away from science subjects and to also understand what they elect to study to replace them.

The United States of America, according to Beard (2013:1), has fallen far from its place as a leader in mathematics and sciences. Beard (2013:1) affirmed that in order for the U.S.A to compete in the global market, schools need to a do a better job at inspiring children to develop the desire for discovery and encourage minorities and females, especially, to get involved in science. The report (Beard 2013:1) further stated that for both students and up-and-coming professionals, tests and studies continue to confirm that the U.S. is losing its competitive form when it comes to mathematics, technology and science because those students who are pursuing studies in science are chosen by default since the high achiever students would be attracted to other fields. According to the Organization for Economic Cooperation and Development (OECD), which surveyed more than 150 000 people between the ages of 16 to 65 in 24 different countries, America's results for literacy were disappointing. However, mathematics and problem - solving were areas that the sample was lacking in significantly.

Having interrogated the aforementioned literature, it is evident that the trend of declining interest in science education by students appears to be a global phenomenon. Interest in school science remains an important issue as it is linked to achievement and the intention to pursue studies or careers in science. Therefore, cultivating positive attitudes, motivation and interest in school tasks and scientific subject matter is not a futile issue. Thus, every government should engage its research in a careful analysis of the declining interest of its students to study science and find effective strategies for strengthening science education.

2.4.1 Causes of a declining interest in science

While science and technology are generally considered important for the economic well-being of a country, one might expect the increasing significance of science and technology to be accompanied by a parallel growth in interest in science subjects. However, having perused through the extensive literature already cited, this does not seem to be the case in both the developed and developing countries.

Sjoberg (2010:43), in an attempt to suggest underlying reasons for the declining interest in science from the perspective of European countries, presented the following factors:

- **Outdated and irrelevant curricula**

  Pupils perceive school science as lacking relevance. It is often described as dull, authoritarian, abstract and theoretical. The curriculum is often overcrowded with unfamiliar concepts and laws. It leaves little room for enjoyment, curiosity and a search for personal meaning and significance. It often lacks a cultural, social or historical dimension and it seldom addresses contemporary issues related to science and technology.

- **Science is difficult and unfashionable**

  Scientific knowledge is by its nature abstract and theoretical and it often contradicts "common sense". It is also often developed through controlled experiments in artificial and "unnatural" and idealised laboratory settings. Learning science therefore, often requires hard work and considerable intellectual effort. There is little doubt, however, that school science could, and should, be better tailored to meet the needs and abilities of pupils. In a world where so many "channels" compete for the attention of young people, subjects such as science and technology are readily perceived as unfashionable.

- **A lack of qualified teachers**

  The present decline in the recruitment of science teachers in many countries is particularly evident in secondary schools. The rather low numbers of students with scientific backgrounds are able to find more tempting and better paid jobs than teaching.

- **Stereotypical image of scientists and engineers**

  The perceived image of the typical scientist and engineer is stereotypical and problematic. Portrayed in cartoons, nurtured by some sections of the media and serving the plot of many popular films and plays, the image of the "crazy scientist" is commonplace. Scientists are perceived by pupils as authoritarian and boring, having narrow and closed minds, and somewhat crazy. They are not perceived to be kind or helpful or as working to solve the problems of humankind.

- **Dislike of an over - ambitious science**

  Many people dislike the image and ambitions of modern biotechnology and have an emotional and irrational fear about scientists who are "tampering with Nature" or

"Playing God". Scientists disagree about and debate many contemporary socio-scientific issues, namely the causes of global warming, the effects of radiation and the possible dangers of genetically modified food. These pertinent issues create uncertainties which are in conflict with school science where scientific knowledge is presented, especially in textbooks, as secure and never as controversial or contested.

- **Scientists and engineers are no longer heroes**
  Not very long ago, scientists and engineers were considered heroes. Scientists produced progressive knowledge and fought superstition and ignorance, while engineers developed new technologies and products that improved the quality of life. For many young people in these prosperous, modern societies, the fight for better health and a better material standard is unknown history. The generally high current standards of living are taken for granted, rather than understood as fundamentally dependent on advances in science and technology. What attracts the attention of these young people are often the present evils of environmental degradation, pollution or global warming. The triumphs of the past are set aside in the readiness to blame science and technology for many of the serious problems of the present.
- **New role models: Not in science and technology**
  The media provides global publicity for football players, film stars and pop artists. The lives of journalists and others working in the media seem interesting and challenging. Although few young people enter these careers, the new role models on either side of the camera create new ideals. Young people also know that lawyers and some of those trading in the financial markets earn more money than the physicist in the laboratory. They also know that a lack of knowledge of science or mathematics is unlikely to hinder those who pursue such careers, although a judge in court is often asked to consider evidence based on scientific arguments or statistical inferences.

The preceding reasons make it clear that the challenges facing contemporary science education are multi-faceted. In addition, those challenges, and the strategies for overcoming them, may be perceived differently by different groups with a legitimate interest in science education. The problems relating to interest in and attitudes towards science cannot be regarded as solely educational, but need to be understood and addressed in a wider social, cultural and political context. However, many of the concerns highlighted lend themselves directly to a transformation in school science education through policy and governance reforms.

Generally, there is a tendency for students to reject a school science that is disconnected from their own lives - a depersonalized science where there is no space for themselves and their ideas (Aikenhead 2010:21). The international review carried out by the International Council of Associations for Science Education (ICASE) and the Australian Science Teacher Association (ASTA) with the support of UNESCO comparing the views of 15 year-old students towards science with other subjects, concluded clearly why students might lose interest. These findings are illustrated below (Fensham 2011:14):

- **Science has an abstractness that makes it irrelevant**

  So much of what is taught in science is uninteresting because it is not related to everyday life. Science in films and in the media is often exciting, but that is not an aspect of the science that is heard about in school. There are science topics that would be interesting. However, these are not in the school curriculum.

- **Science teaching is predominantly transmissive**

  As a student, learning science is simply a matter of being like a sponge and soaking up this knowledge as it comes from the teacher or from the textbook. There is no room for discussions or debates to cater for differing views or opinions.

- **Science knowledge is dogmatic and correct**

  There are no shades of grey about science. The search for universal laws and theories may encourage an image of science as abstract, unrelated to and disconnected from a simplified understanding of society at large. Knowledge is presented in a way that is exclusive to the understanding of scientists, which the lay person cannot interrogate. In these circumstances, science comes to be perceived as 'cold', uncaring and lacking a human face.

- **Learning science is relatively difficult**

  For both successful and unsuccessful students, learning science concepts is daunting. Science is more difficult in comparison with a number of the other subjects, which students find easier. Concentration and sustained hard work do not seem to be a dominant feature of contemporary youth culture.

- **Science careers are not financially rewarding**

  Many non-science careers are more financially rewarding. A white-coated, hardworking and not very well paid scientist in a laboratory is thus not a role model for many of today’s young people. Young people also feel that lawyers and some of those trading in the financial markets earn more money than the physicist in the laboratory.

Schooling systems should accept that part of their role is to prepare children for their future lives. To achieve this aim, school systems and their stakeholders need to take cognisance that affective and motivational aspects of science learning are important not only in the classroom but also in wider societies. Science taught at schools should therefore be aligned with the interests of the student and encourage them to continue studies in science.

2.4.2 Impact of a declining interest in school science

In many countries, there is a noticeable decrease in the number of students choosing science. In order to analyse the impact of a declining interest in science amongst students, it is imperative to understand the role of science in the lives of people. The processes and ideas of science are of great importance to everybody in three ways. The first is in their personal lives so that they can, for example, validly identify the components of a healthy life-style. The second is in their civic lives so that they take an informed part in social decisions such as future options for electricity supply. The third is in their economic lives, where they need to be able to respond positively to changes in the science-related aspects of their employment (Christidou 2011:117). While the preceding discussion highlights the importance of science to people in general, one also needs to understand the importance of science education to a country in a broader sense.

The impact of a declining interest in science amongst students can result in countries producing fewer professionals in the science field. Literature in the field of declining interest in science alluded to the following areas that low student enrolment in science can impact on:

- **Industry-** People with a high level of qualification in science are required in industry. Modern industry is high-tech and is often referred to as a “knowledge industry”. According to Sjoberg (2010:45), the need here for highly qualified scientists and engineers for survival in a competitive global economy is crucial.

- **Universities and research institutions** – According to Aikenhead (2006:32), universities have a need for researchers (and teachers) to maintain research at a high international level and to train future generations of experts, researchers and teachers. Industry, universities and other research - based organisations therefore need to recruit the highly skilled elite. A decline in this field of science can lead to universities producing a workforce - be it teachers, engineers or medical personnel - that lacks competence and skill.
- **Schools** - According to Stigler and Hiebert (2009:87), well-qualified and enthusiastic teachers are the key to any improvement in the teaching of science in schools, not least in laying the foundations for the future development of the knowledge, interests and attitudes of ordinary citizens once they have left school. Science teachers are also influential in recruiting people to the science sectors of employment. Therefore a lack of interest shown by students in science would lead to a shortage of science teachers. The long-term effects of a shortage of good science teachers can be very damaging, although this may not be as immediately evident as a comparable shortage in industry and research.
- **Labour market** – A progressive labour market, according to Bybee and Fuchs (2006:351), requires people with qualifications in science. They reiterate that this need is great and growing fast, as knowledge and skills based on science become prerequisites for employment in new or emerging sectors of the labour market (Bybee and Fuchs 2006:351). It is not only doctors, pharmacists, engineers and technicians who need a scientific education. For example, health workers handle complicated and dangerous equipment and lawyers and juries in court trials have to understand and critically judge evidence and statistical arguments in which knowledge of science plays an increasing role. Thus, a decline in the enrolment of students in science would aggravate shortages in the labour market.

In many countries, recruitment for scientific studies is dropping or, at least, not developing as fast as expected or planned for. This lack of interest in science often manifests itself at school level at the age where curricular choices are made. The increasingly low enrolment in science in many schools should be of grave concern to schools, institutions of higher education and the public. In many countries, the situation has attracted political attention at the highest level, and, in some cases, projects and counter-measures are planned or put in operation.

Some of these programmes have also initiated research and prompted discussion and other efforts directed at improving understanding of the dimensions of the problem.

2.4.3 Imperatives to sustain student interest in science

To enhance student interest in science, Christidou (2011:18) advises that the careful selection of topics and a revised science curriculum should emphasize those topics that contribute to students' lifelong learning. In so doing, activities that are familiar are readily adopted by them. Cheng (2003:210) cautions that despite the fact that stakeholders may be satisfied with educational services; if education does not cater for future needs and challenges then it is still ineffective and "useless" for the new generation. One of the challenges facing students is that they are inundated with scientific content and terms that are beyond their comprehension. The implication of this is that students may not study a science from which they are disconnected.

Some imperatives that could be considered for science education reforms have been identified by Sjoberg (2010:47) and are discussed briefly below:

- **Towards science for all:** More emphasis should be given to those aspects of science that can be seen as contributing to the overall goals of schooling. In other words, less importance should be attached to the traditional academic content of school science and greater importance should be attached to school science as a preparation for more advanced studies. Specialisation should not be postponed to the last few years of schooling.
- **Widening perspectives:** More attention should be given to the cultural, historical and philosophical aspects of science in an attempt to portray these as human activities. This increased attention may enhance the appeal of these subjects to those pupils who are searching for some meaning to their studies, rather than the acquisition of factual information and established, orthodox explanations of natural phenomena.
- **Nature of science (NOS):** The nature of science should become an important concern in the curriculum. This means a rejection of the stereotypical and false image of science as a simple search for objective and final truths based on unproblematic observations. The emphasis on an understanding of the nature of science which attempts to give more attention to its social, cultural and human aspects must be considered. Science should be presented as knowledge that is built on evidence as well as upon arguments deployed in a creative search for meaning and explanation.

- **Context becomes important:** Increasing attention should be given to presenting science in contexts that have meaning and relevance for the learner. Themes or topics that illustrate scientific or technological principles should be drawn from everyday life or current socio-scientific issues. The inference that could be drawn is that science at school must include aspects that students could relate to so that they will be engaged meaningfully.

Studies by Holbrook (2009:11) found that a science curriculum ought to move progressively towards a real world, context-based approach. The curriculum is therefore at the centre of student learning. Concurring with Holbrook, Hirning's (2002:28) studies on secondary school science in Portugal and Spain revealed that the following areas need to be addressed:

- Science curricula need to continuously incorporate new discoveries in their particular specialisation field in order to enrich science teaching and these discoveries should be taught with the aid of learning resources that help students to better understand and enjoy Science.
- Science curricula should involve co-operative work experiences with other scientific professionals and researchers who may help to update knowledge.

An underlying concern, when 'everyone' attends school for 12-13 years is that science should contribute to the more general aims of schooling. The tendency, therefore, should be to gradually redefine what counts as valid school science by broadening the perspective to give attention to some of the social and ethical aspects of science. In order for the essence of science to be appreciated by students and the community at large, science taught at school must be in tandem with issues that will benefit the community.

2.4.4 Correlation between interest in science and learning science

Children at a very young age are actively curious about the world around them, asking questions and engaging in theory building and scientific - sense making (Driver 2005:803). Like young scientists, preschool children ask questions, seek out new experiences, gravitate toward new objects, recognise patterns and try to reconcile anomalous information (Bonawitz and Schulz 2012:227). As pre-schoolers, the curiosity, inquisitiveness and hunger for knowing amongst children is profuse. Yet as children age, much of their experience in school science does not allow for self-expression or opportunities for sustained engagement in pursuing one's curiosities about the world because science learnt at school is prescriptive (Engel 2011:777). According to Hidi and Renninger (2006:113), individual interest in science is based on having a knowledge base in science and valuing science. One can argue that when students do not see a connection in the learning activity and the informational content, they soon lose interest and disengage. The desire for students to maintain engagement with science and acquire further knowledge in science thus declines.

To aid in efforts to ignite persistent engagement in science learning specifically, one needs to understand more about students' science-relevant curiosity; how they express it; and how their "expressions of curiosity" may relate to their interest in science learning. Early conceptions of curiosity in the psychological literature include references to personality characteristics, traits and general dispositions (Jirout and Klahr 2011:974). Drawing upon recent research in learning sciences by Azevedo (2013:488), a premise is that children's curiosity can be expressed differently across contexts and is capable of being shaped by their experiences, social interactions and environment. While children exhibit general curiosity at an early age, Engel's (2011:27) studies also suggest that children's expressions of curiosity, if not fostered, may become dampened in secondary school. Curiosity can also be extinguished by schooling practices in which mismatched teaching approaches can affect a young learner's development and identity in science (Engel 2011:30).

An analysis of the literature reveals that there is a positive correlation between students' interest in science and their level of desire to learn more. Hence, from this perspective, students who experience interest while working on a science topic are engaged with the topic content and are likely to express a desire to continue their engagement with the topic. One can argue that understanding the curiosity of children outside of the school science contexts goes a long way in understanding more about what kinds of thinking and information they get curious about and could potentially be used for engagement in school science.

2.5 Conclusion

The literature cited alludes to the idea that students of science should also understand the relevance of scientific discoveries, rather than just concentrate on learning scientific facts and theories that seemed distant from their realities. Science education has to undergo transformation in several ways: as a field of study; as an applied body of knowledge; as a way of living; and as a competitive tool and strategy important to achieving national goals. The learning of science is essential for sustainable development in the future and for active participation in society and societal issues. It is therefore essential to note that all students must obtain a certain level of scientific knowledge in order to play a meaningful role in society and, thus, to be able to participate in debates that affect society and the environment at large. Every effort must be made by educationists through research, to increase the interest of students in science education. By engaging in science through this way students see and understand the relevance of science and its role in their daily lives thus leading to lifelong learning.

CHAPTER 3

QUALITY IN SCIENCE EDUCATION AND LIFELONG LEARNING

3.1 Introduction

This chapter reviews literature in an endeavour to provide an overview of the theoretical issues which relate to the quality of science education and lifelong learning. In order to gain insight, the researcher reviewed a wide variety of literature to obtain a deeper understanding of quality in education and lifelong learning. The literature review encompasses an exploration of definitions related to quality, lifelong learning theories and total quality management. In recent years, interest in quality management in lifelong learning has become a key issue in the delivery of lifelong learning. This renewed interest in quality arises, on the one hand, from the need to increase competitiveness in a global economy and on the other, from the need to demonstrate accountability in public services and the ability to achieve results.

Learning is considered lifelong, implying that it is life wide and occurs in many different settings - not only formal, but also non-formal and informal (Rubenson 2011:117). Formal learning involves an identified teacher who is an authority on a curriculum based on an established body of knowledge. Non-formal learning, which involves teachers or mentors responding to emergent community needs is equally important, as is informal learning which occurs when people engage individually and collectively without direct reliance on a teacher or an externally organised curriculum (Livingstone 2005: 2). Lifelong learning, as interpreted in documents such as Kharas and Rippin (2013:120); UNICEF (2009:13) and UNESCO (2013:16) is oriented towards producing a highly skilled and flexible labour force to enhance national competitiveness.

Quality assurance on a continuous basis forms an integral part of evaluating the curriculum in order to improve and attain the desired goals of education. Quality assurance allows for curriculum developers to identify gaps in the curriculum; gather further information to fill these gaps; deliberate on it; and finally make recommendations on improving the curriculum. Not only has science progressed, it is also a growing body of new knowledge which should inform a revision of standards and revitalize science education. In the absence of quality assurance mechanisms, this new understanding, both in science and in teaching and learning science, would not be incorporated into the curriculum. Integration of these ideas of science with engagement in the practices of science to build students' proficiency and appreciation for science would thus be lacking if there are no quality assurance mechanisms in place.

3.2 Lifelong learning

The lifelong learner is defined as one who is able to engage critically with his or her world, in addition to commanding competencies that are required for survival in it, especially the ability to adapt to new roles and situations (Ahmed 2009:47). Longworth and Davies (2013:56) state that lifelong learning is the development of human potential which stimulates and empowers individuals to acquire all the knowledge, values, skills and understanding they will require throughout their lifetimes and to apply them with confidence and creativity in all roles, circumstances and environments. Delors (1996:47) argues that lifelong education should enable people to develop an awareness of themselves and their environments, as well as encourage them to play their social role at work and in the community. According to Longworth's and Davies' (2013:56) definition, each individual has a learning potential. Provided that one is given suitable learning opportunities and access to relevant education, this learning potential encourages and motivates learning for life. Longworth and Davies (2013:59) further argue that the learner's learning experience must incorporate both continuity and change, hence the need for lifelong learning to be a continuum of independent elements. It may therefore be argued that since the curriculum develops knowledge, values and skills in students, it is imperative for the science curriculum to incorporate the principles of lifelong learning in order for the content to be relevant to students.

3.2.1 Historical perspective of lifelong learning

One of the earliest known sources that made reference to lifelong learning was from the UNESCO commissioned work entitled *Learning to Be* (Faure, Herrera, Kaddoura, Lopes, Petrovsky, Rahnema and Ward 1972:97). According to the commission, with scientific revolution and the enormous flood of information that people are bombarded with, there is a need for education systems to undergo transformation to provide people with the necessary knowledge and skills to cope with revolutionary changes in the world in which they live (Faure *et al*. 1972:33). The commission also suggested that education systems should identify their weaknesses and strengths in order to determine whether learning activities enhance the effective acquisition of knowledge by students to equip them to occupy a significant role in society (Faure *et al*. 1972:33). In essence, Faure *et al*. (1972:33) emphasised lifelong education and a learning society. An analysis of the recommendations of the commission reveals that before embarking on adulthood, a person needs to be intellectually equipped to cope in a changing society. All that has to be learnt has to be continually re-invented and renewed so that teaching and learning become education and a learning society develops.

According to Torres (2014:34), much focus needs to be placed on notion that lifelong learning includes issues such as a person's way of life and their social circumstances. Faure *et al*. (1972: 33) reached consensus that nations should strive to build lifelong learning systems that offers every individual diverse learning opportunities throughout her or his lifetime. This theme was picked up again, two decades later by UNESCO in its report *Learning – The Treasure Within,* which emphasised that learning throughout life must take advantage of all the opportunities offered by society. According to Delors (1996:38) the concept of learning throughout life provides access to the twenty-first century and that learning throughout life goes beyond the concept of continuing education. The report alludes to the notion that learning throughout life links up with learning society in that lifelong learning is about making use of all the opportunities offered by society in order to allow one an opportunity to fulfil one's potential (Delors 1996:38).

Today, the idea of lifelong learning highlighted in the 1970s by the Faure Commission has gained importance in the context of a learning society where the acquisition and use of knowledge, skills and values have taken on greater importance. It can be argued that because lifelong learning embraces all forms of educational and learning experiences, it should equip individuals to engage in purposeful interactions with their environment through the development of their knowledge, skills and critical thinking abilities.

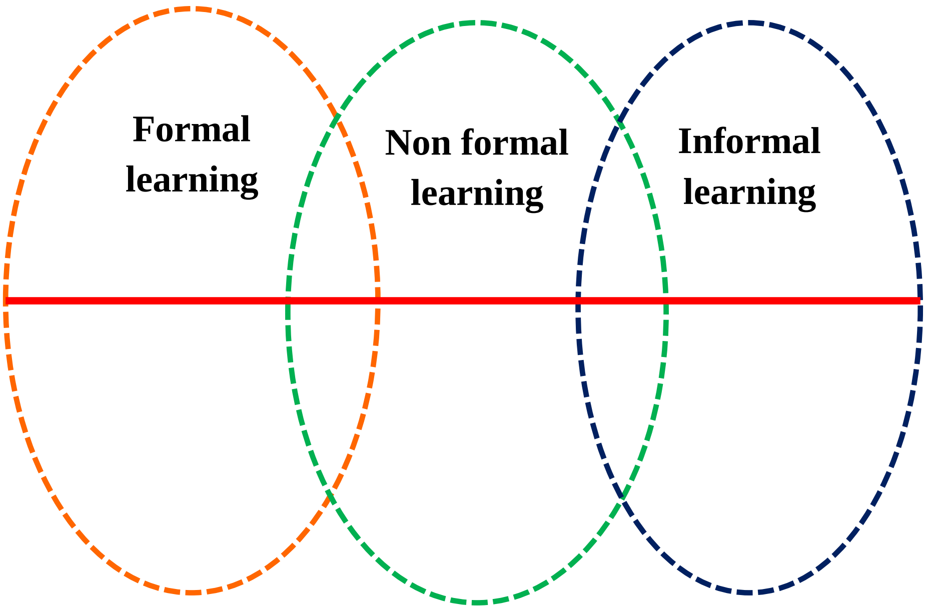
According to Meyer (2011:22), three general lifelong learning practices are commonly distinguished in terms of the context in which they occur, namely formal education or schooling; informal learning and non-formal. The three contexts are discussed below (Meyer 2011:22):

- Formal education is learning that occurs within an organised and structured context such as schools.

- Informal learning refers to all those individual and collective learning activities that go beyond the requirements of any educational institution.
- Non-formal education is all other organised educational activities or programmes offered by any social institution and also encompass a learning element such as accidental learning resulting from daily life situations.

In the context of science education in secondary schools, formal education refers to the actual science curriculum with all its topics that guides teaching and learning at school. Informal learning in science refers to learning that results from daily activities related to family or leisure - for example, making observations about scientific phenomena and trying to find suitable explanations for those observations. Non-formal learning may not be specifically defined learning activities in science, but involves the learning that is acquired through field trips, science competitions and science debates. Figure 3.1 illustrates how these learning contexts overlap and interact as they play out in the science curriculum.

Figure 3.1 Framework for lifelong learning



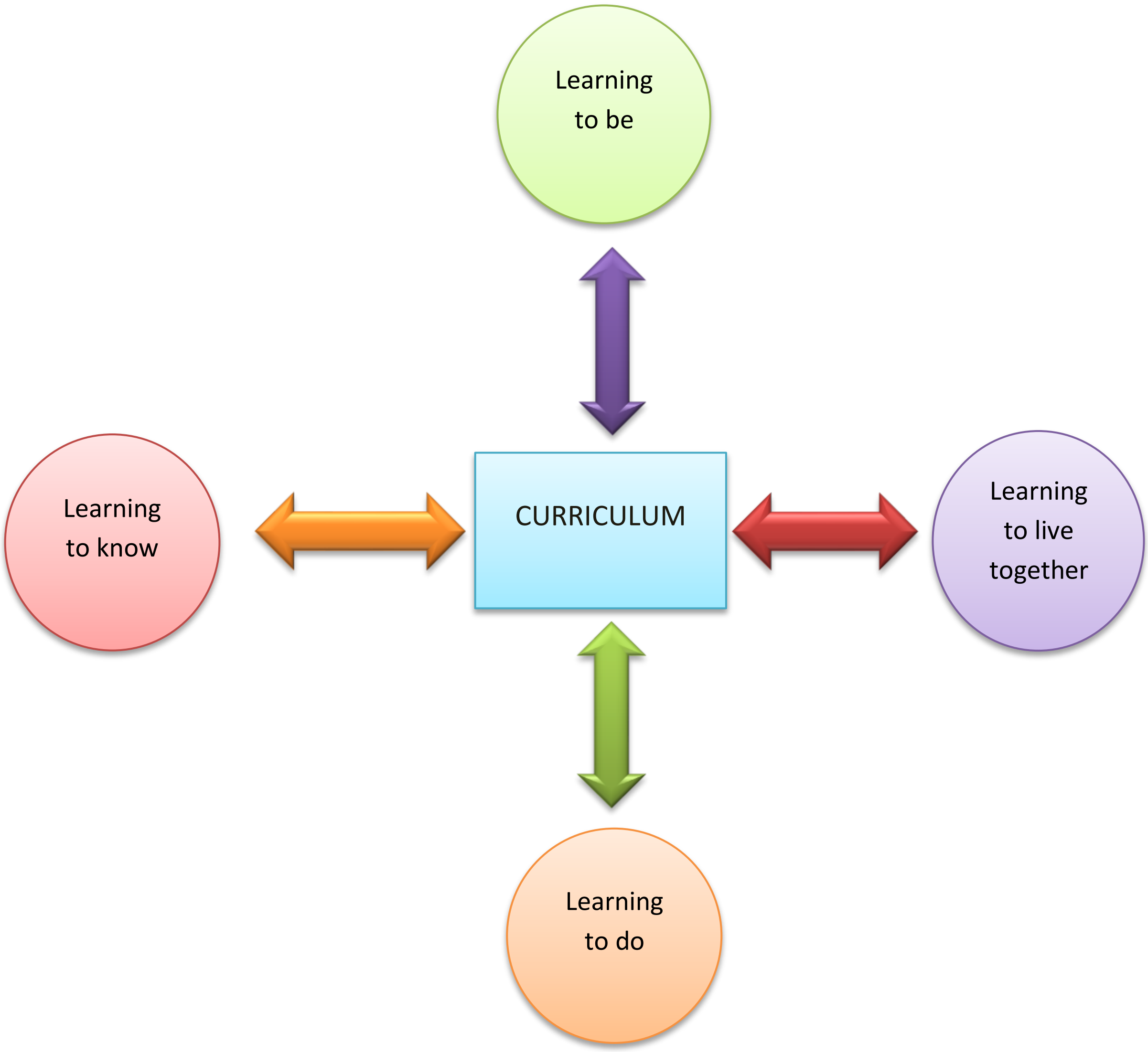
Source: Self-generated by researcher

It is evident from Figure 3.1 that the content of the science curriculum acquired through lessons at school (formal learning) overlaps with the scientific knowledge that is obtained through debates in the media (non-formal learning), which in turn overlaps with the knowledge acquired from one's daily activities (informal learning). In other words, each learning context does not occur in isolation from the other. Learning science in this way helps to provide diverse learning opportunities for every individual. It must be noted from Figure 3.1 that formal learning, non-formal learning and informal learning play a crucial role in the learning continuum. In light of the different definitions suggested, policy makers, researchers and science practitioners should be able to recognise and attach value to the knowledge, skills and values that science students acquire through the three types of learning environments.

3.2.2 Key competencies for lifelong learning

Rychen and Tiana (2012:13) contend that a competency, in an educational setting, is the ability of an individual to engage with tasks or to fulfil the demands of an activity successfully, taking into consideration the persons mental abilities and disposition. Lifelong learning, according to the European Association for the Education of Adults (2006:10), includes "*all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competency within a personal, civic and social and/or employment-related perspective*". The European Reference Framework advocates that the formal education system should recognize skills acquired outside the system (Blom and Sohnesen 2005:12). Furthermore, lifelong learning was recognized as integral to the vision of harnessing the potential of education for a viable future knowledge-based society and which lies at the centre of educational processes in enabling learners to become not only successful learning achievers at school but also responsible citizens, effective workers, caring community members and life-long learners in an increasingly interdependent world (Robinson 2011: 22). Delors who was the chairman of the International Commission for the Twenty-first Century commission argued that curriculum should encompass the four pillars of learning if the aims and objectives of education are to be achieved. These pillars were identified as "*learning to know*; *learning to do; learning to live together;* and *learning to be"* (UNESCO 1994: 39). The four pillars are discussed using the representation in Figure 3.2.

Figure 3.2 Four pillars of learning



Source: Self-generated by researcher

- **Learning to know**

According to the report by Delors (UNESCO 2004:39), "*learning to know*" includes the development of the faculties of memory, imagination, reasoning, problem-solving and the ability to think in a coherent and critical way. It is a process of discovery which involves going more deeply into the information/knowledge delivered through ongoing educational opportunities continuously arising (formally and non-formally) throughout life. In relation to science, the curriculum should be designed to allow students to critique and evaluate scientific statements. In acquiring and applying this skill, science education will thus be using an approach to learning that is flexible, critical and capable of allowing students to master learning tools rather than the acquisition of structured knowledge which is usually rigid.

- **Learning to do**

"Learning to do", as indicated by Delors (UNESCO 2004:39), involves an application of what learners have learned and it is closely linked to vocational-technical education and work skills training. According to Delors (UNESCO 2004: 39), this pillar deals with the ability to communicate effectively with others; an aptitude toward team work; social skills in building meaningful interpersonal relations; adaptability to change in the world of work and in social life; competency in transforming knowledge into innovations; and job-creation. With respect to science education, the curriculum should prepare students by equipping them for the types of work needed now and in the future, including innovation and the adaptation of learning to future work environments. For this to materialise, the knowledge as well as the skills that are acquired in science must be relevant to current trends and advancements in science.

- **Learning to live together**

In the context of increasing globalization, the Delors Commission (UNESCO 2004:39) placed a special emphasis on this pillar of learning. Specifically, it implies the development of such qualities as knowledge and understanding of self and others; appreciation of the diversity of the human race; empathy and co-operative social behaviour; respect for other people and their cultures and value systems; capability of encountering others and resolving conflicts through dialogue; and competency in working towards common objectives. A critique by Carneiro and Draxler (2008:149) states that this pillar of learning seems appropriate but is far from being realised. New conflicts and tensions have arisen in recent years that are mainly within countries, between economic, ethnic and religious groups and even, to some extent, between generations which are characterised by growing inequality, scarcity of resources and increased tensions. They further argue that increasing inequalities seem to exacerbate conflicts between groups, between boys and girls, women and men, and within communities. Thus, the expansion of education opportunity does not reach, or does not adequately reach the poorest segments of society. In relation to science education, there are complexities arising from rapid advances in science, bio-genetics and technology which have the potential to bring progress, social and economic well-being, but could also give rise to new inequalities. The "*learning to live together"* pillar thus inculcates good human relations in citizens with an intention to appreciate and critique such advancements in science objectively.

- **Learning to be**

This type of learning was first conceptualized in the Report "*Learning to be"* to UNESCO in 1972, (Faure *et al.* 1972:134). It was based on the principle that the aim of development is the complete fulfilment of man and his various commitments as an individual; member of a family and of a community; citizen and producer; and inventor of techniques. This pillar, according to Faure *et al.* (1972:135), may therefore be interpreted as learning to be human through the acquisition of knowledge, skills and values conducive to personality development in its intellectual, moral, cultural and physical dimensions. Carneiroi and Draxler (2008:149) argue that the younger generation is convinced that the world needs to change and education seems to be grounded in older models. With respect to science education, the curriculum should be more than just the transmission of scientific facts. It should ignite creativity, interest, enthusiasm and the need to develop scientific views about one's surroundings.

From the preceding discussion, it is important to note that the four pillars of learning relate to all phases and areas of education. They should therefore be applied as basic principles and generic competences for integration across subject areas or learning domains. Figel (2009:16) posits that lifelong learning is about acquiring and updating all kinds of abilities, interests, knowledge and qualifications which promote the development of knowledge and competences that will enable adaptation to society. Consequently, lifelong learning is essential for inventing the future of our societies and has become a necessity for all citizens. We need to develop our skills and competences throughout our lives, not only for our personal fulfilment and our ability to actively engage with the society in which we live, but also for our ability to be successful in the constantly changing world of work. This research speaks to how these competencies should be linked to science education in secondary schools in order to achieve its aims. A discussion of this view follows.

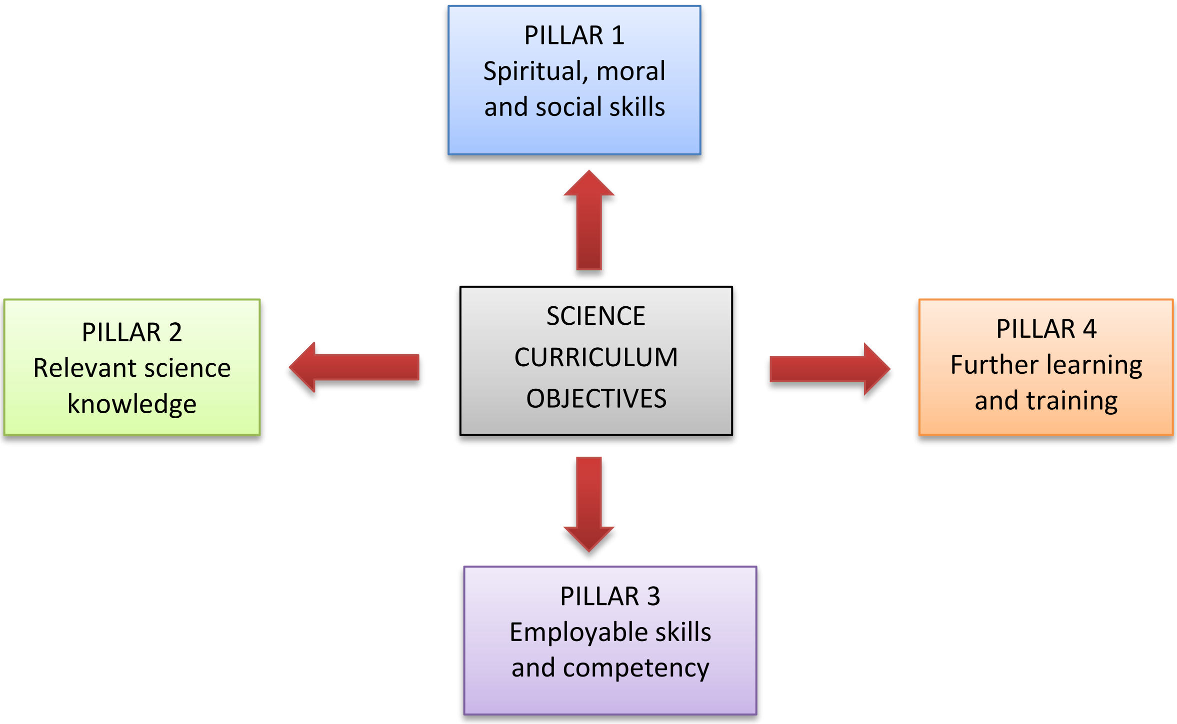
3.2.3. Key competencies for lifelong learning in science

The Organisation for Economic Co-operation and Development (OECD) defined competencies as "*the ability to successfully meet complex demands in a particular context… the mobilization of knowledge, cognitive and practical skills, as well as social and behaviour components such as attitudes, emotions, and values and motivations*" (OECD 2010:29). Generally speaking, the school curriculum seeks to achieve two broad aims, namely to provide equal opportunities for all pupils to learn and to achieve, for best possible progress and at the highest attainment (Zhou 2010:3), as well as to promote learners' spiritual, moral, social and cultural development and prepare all pupils for the world of work and societal responsibilities.

3.2.3.1 Correlation between science objectives and competencies

According to Delors (2010: 86), the four pillars of learning indicate broad goals of education and could thereby re-orient the setting of science competencies as science objectives, because the each pillar focusses on developing specific skills, as represented in Figure 3.3.

Figure 3.3 Science curriculum objectives



Source: Self-generated by researcher

The following represents an elaboration of the argument regarding science objectives and competencies (Delors 2010:86):

- The first pillar of learning reflects a shift from an instrumental view of education as a process to a humanistic view of education. Thus, the science curriculum should be more balanced, taking into account not only the cognitive- intellectual dimension of personality but also its spiritual, moral, social skills and values aspects.
- The second pillar of learning emphasises an important educational goal of contributing to social cohesion, inter -cultural and inter-national understanding. This

goal therefore fosters a new curriculum domain in which relevant science knowledge should be taught to resolve and manage conflicts for peace in the family, at school, in the community and in the world at large.

- The third pillar of learning points to the goal of closer linkage between education and the world of work, which re-iterates that one central function of science education is to prepare young learners to be successful workers and responsible citizens in their adulthood. Thus, the science curriculum can no longer be purely academic and school bound. It has to impart employable skills and positive attitudes toward work, and to develop competency in adapting to change.
- The fourth pillar of learning implies developing a learning society, which in turn implies that school education, is only a phase of the learning continuum and that the science curriculum should therefore not only focus on cramming knowledge but also focus on basic skills and universal values which will prepare pupils for further learning.

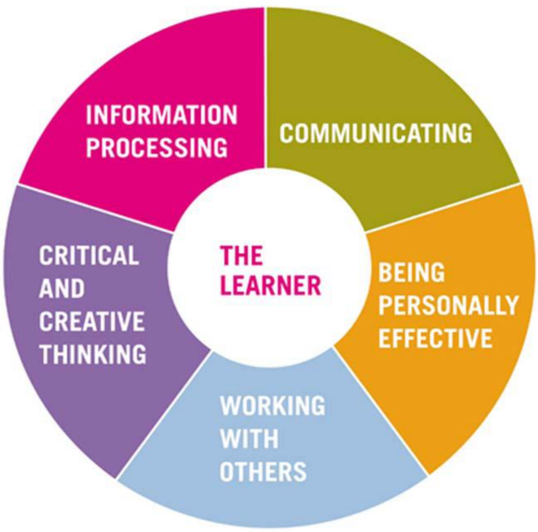
It is crucial for educationists to take cognisance of the fact that the four pillars of learning as outlined, relate to all phases and areas of the education system. These pillars should therefore be applied as basic principles and generic competences for integration across subject areas or learning domains. Figel (2010:12) concurs that lifelong learning is about acquiring and updating all kinds of abilities, interests, knowledge and qualifications which promote the development of knowledge and competences that will enable adaptation to society and as such lifelong learning is essential for inventing the future of our societies and has become a necessity for all citizens. Thus we need to develop our skills and competences throughout our lives, not only for our personal fulfilment and our ability to actively engage with the society in which we live, but for our ability to be successful in a constantly changing world of work. The following aspect of this research speaks to how these competencies should be linked to science education in secondary schools in order to achieve its aims.

3.2.3.2 Skills for developing competency in lifelong learning in science

According to Figel (2009:16), competence in science involves having the ability and willingness to use the body of knowledge and skills to explain the natural world in order to identify questions and to draw evidence-based conclusions. Figel (2009:16) described knowledge to include the basic principles of the natural world, fundamental scientific concepts, principles and methods, technology and technological products and processes, as well as an understanding of the impact of science and technology on the natural world. Figel (2009:16) also stated that skills include the ability to use and handle scientific data to achieve a goal or to reach an evidence-based decision or conclusion.

A report presented by the National Council for Curriculum and Assessment (NCCA) led by David Pepper in Ireland in 2012, developed a set of competencies for lifelong learning in science which included the incorporation of five key skills identified as relevant to the lives of learners as illustrated in Figure 3.4. Figure 3.4 locates *the learner* at the centre, implying learning to learn across the five key skills that are represented. The formulation of these key skills was informed by the European Reference Framework of Key Competences (Mosely, Eilliott, Gregson and Higgins 2013:371).

Figure 3.4 Skills for developing competency in lifelong learning in science



Source: Adapted from Mosley, Eilliott, Gregson and Higgins (2013)

The discussion below represents the main points presented by the researcher after having analysed the report by Mosley *et al.* (2013:371) as illustrated in Figure 3.4:

- Critical and creative thinking is about students thinking imaginatively; actively seeking out new points of view; and being innovative in dealing with problems and/or solutions about scientific phenomena.

- Information processing is the ability to search for, obtain and process scientific information and transform it into knowledge. Different skills are involved, from accessing to selection of the information to its use and transmission through different media to resolving problems efficiently and keeping a critical and reflective attitude when evaluating the available information.
- Communication refers to the ability to understand, initiate, sustain and conclude science conversations and to read, understand and produce science texts appropriate to the needs of individuals. This competency further implies that individuals should also be able to recognise the essential features of scientific inquiry and have the ability to communicate the conclusions and reasoning that led to them.
- Being personally effective implies the acquisition of a scientific-rational thought process which allows the autonomous interpretation of information, personal initiative in decision-making and the use of ethical values when taking personal and social decisions.
- Working with others deals with creativity, innovation, responsibility and a critical approach in the development of group projects.

These competences should enable individuals to better understand the advances, limitations and risks of scientific theories, as well as the applications and technology in societies. The integration of the key competences in science education allows a focus on essential learning in a holistic sense and learning that is directed towards the practical application of the knowledge acquired, thus promoting lifelong learning in science.

3.2.4 Imperatives for lifelong learning

Information overload and a climate of rapid technological change have created new problems and challenges for education and training. What learners need, therefore, is not only instruction but also access to the world, in order to connect the knowledge in their heads with the knowledge in the world, with the chance to play a meaningful part in it. Lifelong learning is thus more than training or continuing education. It must support multiple learning opportunities through various techniques. A few of the key techniques that can be used to support lifelong learning development is highlighted below:

(a) Engaging in meaningful activity

One of the major roles for new media and new technology, as stated by Fischer (2014:12) is not to deliver pre-digested information to individuals but to provide the opportunity and resources for engaging in meaningful activity for social debate and discussion; for creating shared understanding amongst stakeholders; and for framing and solving authentic problems. According to Fischer (2014:13), this global perspective leads to the following requirements for lifelong learning:

- Various stakeholders in education should set most of the goals and not the system;
- The vocabulary, tools, functions and practices supported by the system should come from the working environment, where they are natural and appropriate;
- Tools must appear directly relevant to help with the attainment of skills; and
- The system should aid learners in two kinds of reflection, namely immediate, to deal with the problem and organize a solution and post-mortem, to see if the problem is recurrent and can be avoided by restructuring work processes.

The argument stemming from the above is that lifelong learning offers a holistic perspective on the role of education in a person's life. It affirms that learning plays an essential role in enabling individuals to adapt to and to deal with new challenges and changes in their lives and surrounding environments.

(b) Modes of learning

Interactive learning environments provide support in helping learners detect mistakes and overcome these in respect of their environment (Fischer 2014:15). Ahmed (2009:7) states that implicit in the idea of lifelong learning is the concept of life - wide learning. He purports that while the former emphasises the continuity of learning throughout the human life cycle, the latter recognises that people find it necessary to engage in multiple learning activities simultaneously through different modalities and in varying settings. As an added dimension of lifelong learning, life - wide learning thus relates to the multiple and parallel roles of a person in society (Dreze and Sen 2013:67). It is evident that lifelong learning is intended to enable individuals to become active social agents as people who are able to act, reflect and respond appropriately to the cultural, social and development challenges they face both as individuals and as members of society. Lifelong learning, embracing all forms of educational and learning experiences, helps individuals to engage in purposeful interactions with their environment through the development of their knowledge, skills and critical thinking abilities.

(c) Critiquing

In many lifelong learning situations, human understanding evolves through a process of critiquing existing knowledge and consequently expanding the body of knowledge. Critiquing is a dialogue in which the interjection of a reasoned opinion about an issue or action triggers further reflection on or changes the existing knowledge (Fischer 2014:13). In 1965, Karl Popper theorized that science advances through a cycle of conjectures and refutations (Popper 1965:43). Popper (1965:43) surmised that critiquing involves scientists formulating hypotheses and putting forth these conjectures for scrutiny and refutation by the scientific community. An analysis of the aforementioned literature indicates that besides contributing to the growth of knowledge, this critiquing cycle of conjectures and refutations is essential for creating a shared understanding within the scientific community and providing for individuals to become active social agents.

(d) Working shops — an environment for teachers to engage in lifelong learning

Teachers are the ultimate change agents (Guzdial and Weingarten 2005:12). Creating new paradigms for learning requires teachers who understand and are committed to the improvements envisioned. Teachers, more than other members of society, need to be lifelong learners who learn about new aspects of learning, teaching and the innovative use of technology in the context of their work, specifically exploiting possibilities that they can learn most readily from each other. Working shops involve a regular, continuous meeting of colleagues who, through sharing diverse experiences and ideas, learn together in the process of doing meaningful work. Working shops provide an opportunity for teachers to acquire and apply knowledge. According to Fischer (2014:16), creating an environment to support teachers as lifelong learners requires an examination of how teachers as professional practitioners can make effective use of the rich individual and collective experiences; outside resources; new information; and the environment itself to support and enhance student learning. Rittel (2014:319) posits that teachers need to work in teams in order to work on innovative projects and curricula of common interest, thereby learning how to use new technologies or practices in the context of designing and implementing the projects and curricula. Through their collaborative efforts, teachers simultaneously develop new pedagogical strategies and tools; acquire new skills and knowledge; and enhance their sense of professional value (Guzdial and Weingarten 2005:12). In the light of lifelong learning this will therefore allow teachers to keep abreast of current issues and provide the opportunity and resources for social debate, discussion and collaborative knowledge construction in their classrooms.

3.2.5 Imperatives for lifelong learning in science

In its broadest sense, curriculum encompasses pedagogy and the instructional practices of teachers. A commonly used elaboration of this concept in international studies is the distinction between the intended, the implemented and the realized or attained curriculum (McKnight 2005:530) as highlighted below:

- Intended curriculum: This is the curriculum that schools intend to implement. It can be described in terms of achievement targets and planned educational processes (instructional processes, role of teachers and evaluation procedures). It is often defined at a national level. For this reason, Aikenhead (2006:5), positions this type of curriculum as "*pipeline ideology*". With respect to science and lifelong learning, there is no room for the inclusion of aspects or topics that are relevant to the student at a localised level. The difficulty in learning this type of school science is the curriculum's lack of relevance for everyday life.
- Implemented curriculum: This refers to the educational processes that are actually taking place inside schools. It can be described in terms of learning opportunities offered to students. Aikenhead (2006:5) outlines that classroom materials and teacher orientation determines student learning in science. Thus, if the learning opportunities offered to students are restrictive during science lessons, then lifelong learning is hampered.
- Realised (attained) curriculum: This refers to the student outcomes from the learning experiences acquired at school. Aikenhead (2006:5) argues that most students experience school science as a cross-cultural event. Students experience difficulty in trying to see the relevance between school science and their community culture.

The knowledge, skills, attitudes, understanding and values acquired by learners, as determined by the curriculum, may not be sufficient in providing them with the relevant survival skills needed to cope in a rapidly changing and complex world. According to Conner (2009:13), lifelong learning aims both to equip individuals and communities with the relevant skills, knowledge, attitudes, aptitudes, interests and values that are urgently needed to transform themselves into effective citizens, as well as into learning societies. Some of the imperatives for lifelong learning in science are described as follows:

(a) Science education, equity and equality

From the immediate basic essentials of life such as access to water, food and shelter to important issues that affect every individual like the management of agricultural production; water resources; health; energy resources; biodiversity; conservation; the environment; transport and communication, there has to be a strong science component to which everybody should have access (Savater 2004:7). The importance of this access to science, as highlighted by Savater (2004:7), is that it enables individuals to take part in local, regional, national and transnational decisions in a meaningful way. Sen (2001:15) argues that what distinguishes poor people or countries from rich ones is that not only do they have fewer possessions but that the large majority remain excluded from the creation and the benefits of scientific knowledge. Stemming from the aforementioned, it may be suggested that lifelong learning in the field of scientific development would continue to have a significant influence on topics that have great importance for humanity, quality of life, the sustainable development of the planet and peaceful coexistence amongst people.

(b) Science and culture

All societies have ways to educate their young members in order to ensure that they become full participants in society; are able to contribute and develop it; and become more human (Savater 2004:12). Education introduces students to valued aspects of the culture of society, as well as aspects of culture that are important for the members of that society. Pozo (2008:7) has shown, in a variety of contexts that thinking scientifically helps develop new ways of thinking as it widens and deepens the capacity to think. Therefore, it can be noted that thinking about and with scientific ideas means students have to think in new ways that could lead to a rich network of opportunities throughout life, which would in turn be informed by learners' needs and aspirations. Thus, lifelong learning in science instils empowerment and the ability to make and exercise choices which is fundamental to the promotion of human rights, human dignity and just societies.

(c) Science education and the world of work

Literature widely supports school science to emphasise on working with ideas through scientific investigations of ideas of students on science topics related to current scientific issues rather than transmitting information (Prat 2010:45). When students develop a more realistic understanding about the nature of science and how it operates, they will be able to see science as part of the rich heritage that previous generations have bequeathed to them. They will be encouraged to view it as a living, growing corpus of ideas that are subject to change as new observations and ways to interpret them appear (Fensham 2011:11). Aikenhead (2010:12) argues that such a science is not a dogmatic body of unchanging truth but a science that offers knowledge, understanding and methods of working, that offer powerful ways to look at the world. Thus, through science education, learners must be given the opportunity to gain the knowledge and develop the values, attitudes and skills that will enable them to develop their capacities to work, which in turn could offer them powerful possibilities for the future.

(d) Science and globalization

The most rapid, wide-ranging and widespread influence that science has had on human society is one of the outcomes of globalization. Everyone is part of the global communication society (Baines, Blatchford, Kutnick, Chowne, Ota and Berdondini 2008:14). According to Macedo (2006:9), the exchange of and access to information previously reserved for a few is now available to all. This revolution has also brought about profound change in the world of work and the knowledge society. Baines *et al*. (2008:15) suggest that school will have to help students acquire an active repertoire of generic and specialist competencies. This differs from the priorities that are governing science, where the success of students is measured in terms of their range of knowledge. The science curriculum should include the lifelong aspect of global issues by preparing students to take cognisance of and take an active role in issues such as poverty reduction; sustainability; public and individual health promotion; good livelihoods; and generally meaningful, productive and rewarding lives. Hence, the science curriculum should serve as an empowerment agency for students to develop into key role-players when it comes to adapting global concerns to national contexts.

3.2.6 Challenges facing lifelong learning

In the 21st century, learning can no longer be confined to a place and time to acquire knowledge, like school, and a place and time to apply knowledge, such as the workplace. Keeping in line with this, UNESCO (2013:22) stated that today's citizens are coded with more information than they can handle and tomorrow's workers will need to know far more than they can learn today in school. Torres (2008: 38) makes it explicit that lifelong learning is an essential challenge for inventing the future of societies. It is a necessity rather than a possibility or a luxury to be considered, according to Torres (2008: 38). At a certain point in their development, learners leave school and are required to become socially competent, responsible, self-directed citizens who successfully enrich their personal and working lives and who collaborate with one another to solve local and global problems. Yet little of their previous educational experiences prepare them to do any of this because at school they were mostly consumers of educational material.

The increased pace of globalization, technological change and the changing nature of work are a few factors stressing the need for the continual upgrading of education systems. Walters (2010:430) emphasises that a significant weakness of current educational systems is that they do not deliberately educate for lifelong learning. Stemming from this, lifelong learning is more than training and continuing education. It is about reinventing schools to create new intellectual spaces, new physical spaces, new organisational forms and new structures to make lifelong learning an important part of education (Walters 2010:430).

The policy discourse on lifelong learning was introduced into the international scene in the seventies with the Faure Report issued by UNESCO in 1972 (Shuping 2002:295). Since then, much of the literature on lifelong learning has identified challenges regarding lifelong learning. According to Medel-Anonuevo (2010:15), the following factors pose challenges to lifelong learning:

- **Diversity in or lack of understanding of the vision of lifelong learning**

  For many countries, lifelong learning is understood mostly as a common sense principle operating in people's daily lives as they make meaning and adjust to rapid changes. Lifelong learning had assumed many other names such as recurrent education, permanent education, continuing education and adult education. While the vision and mission of lifelong learning seem to have resonated in many countries in the world, the working definition of lifelong learning has taken on many different forms where only some features of lifelong learning are implemented.

- **Illiteracy levels**

  One of the fundamental challenges facing lifelong learning is the unacceptable gap between those who have access to learning opportunities and those who do not , which coincides with the poverty gap. While there is a need for lifelong learning because of the rapidly changing economic and technological changes, there is a lack of a basic foundation for such learning to take place because of the illiteracy in many countries in the world. If governments are unable to address the large pockets of illiterate populations in their countries, there would be a perpetuation and most likely a widening of the gap as those who have good foundations for learning will continue learning, while those who have no foundations will continue to be marginalized. Ensuring that learning opportunities are available for everybody is thus a key challenge of lifelong learning.

- **Lack of co-operation by stakeholders**

  It is necessary that all actors in the field of lifelong learning are involved in curriculum design to ensure that learning opportunities for all are made available. In some schooling systems, collaboration and coordination of government, community, civil society and the private sector is lacking. This is a serious challenge which needs to be addressed in order to ensure that all stakeholders are mobilized and their suggestions acknowledged.

- **Financial constraints**

  It is critical that the appropriate financial resources are allocated to ensure that the relevant content, methods, human resources and infrastructure are in place. Without the resources for the education of millions of citizens, the aspiration for lifelong education appears to be impractical and impossible to implement.

The challenge facing education is for lifelong learning to build a learning society where all forms of educational exclusion are reduced and at the same time, that relevant and quality educational content and processes are put in place so that individuals can fully participate as active citizens in development processes in their communities and societies.

3.2.7 Challenges facing lifelong learning in science education

Promoting lifelong learning strategies for scientific issues is much more difficult compared to other subject areas as there are students that are not interested in science. According to the OECD (2010: 29), the content of school science has an abstractness that makes it irrelevant and science is more difficult than a number of the other subjects. Effective lifelong learning in science education is fundamental for the ongoing development of our global knowledge society. This implies that schools need to help students acquire lifelong learning competencies in science to meet the challenges of globalisation. The following discussion highlights some of the challenges facing lifelong learning in science education at schools.

- **Policy documents**

  According to Koleva and Anchev (2009:4), in most of the European countries there are policies promoting lifelong learning in general. Policies in science should address socio-economic, gender and cultural inequalities in order to widen access and provide everyone with lifelong learning opportunities (Jensen 2011:5). Policymakers, according to Jensen (2011:5), need to better understand and communicate the transformative connection between science, innovation and society in policy documents. However, for the specific field of scientific disciplines, a well-defined policy is missing. In the absence of such policy documents, teaching science for lifelong learning is therefore neglected.

- **Inadequate and poorly qualified teachers**

  According to Mittnerova, Stepankova and Kinzlova (2009:4), the number of science teachers is not adequate. Their study also found that many teachers do not hold a degree in science and most of them have never attended a specific training course necessary to "learn to teach". To deal with this challenge, it is advised that universities train teachers and follow them throughout their professional lives according to a lifelong learning approach. Teachers in schools need interaction with universities to exchange experience with experts and get access to research in science-specific didactics and methods.

- **Inadequate resources**

  According to Singer (2009:6), in order to develop and promote a better understanding of science as a subject, national governments should organise numerous national and local initiatives like projects funded by the government and form partnerships with centres for scientific expositions like museums and industries so that students have access to the necessary knowledge of and about science to participate actively and responsibly in society.

- **Lack of motivation**

  Students and adults think that science is an abstract subject and do not manage to see its connection with everyday life. Moreover, they do not know the job opportunities that are available. According to Prösel (2009:6), if children are helped to approach science as a part of their everyday lives, they will be able to gradually understand all rules and laws and realise that science needs to use models that may possibly change when better ones are discovered.

- **Quality of the science curriculum**

  Research by Osborne and Dillon (2008:5) suggests that students found school science to consist of too much repetition and too much copying and note taking. They felt that they had been frogmarched across the scientific landscape with no time to discuss any of the ideas or their implications. In addition, his study found that the gap between science as it is taught and science as portrayed in the real world made the relevance of school science to lifelong learning questionable. The ROSE Review (Schreiner and Sjoberg 2010:10) argues that a new school science has to match the context where the students learn. They say such an approach draws on current learning theory which argues for the efficacy of situating learning in the contexts experienced by students.

Any endeavour to develop better school science which is better matched to science in the wider world needs to consider what scientific knowledge and concepts should be included in basic education. This needs to be complemented by scientific ways of working and changes that will impact not only within the classroom but also the wider school contexts, the homes of students and their societies (Schreiner and Sjoberg 2010:15). The lack of relevance of the science curriculum is probably one of the greatest barriers for lifelong learning, as well as for interest in the subject.

School science is not something abstract but something that can be connected to the lives of the students. Learners should be able to acquire knowledge, values, attitudes and skills that would serve them throughout life. The onus lies with school science curriculum designers to incorporate essential dimensions of learning such as self-directed learning and collaborative learning into the science curriculum in order for the science learnt by students to include their environmental concerns which will in turn lead to lifelong learning.

3.3. Quality

Quality has emerged as a necessity for the survival of organisations faced with increasing competition and an ever - rising demand for better and better quality products and services. School and classroom activities are places where educational policies transform life. Yoloye (2000:22) argued that quality must characterise education at every stage if it is going to prepare students to become effective citizens in society. The problem that many governments face is in reconciling access with quality in the provision of education. The onus rests with all those associated with education, including policy makers, managers and teachers, to find ways of improving the quality of educational provision.

3.3.1 The concept of quality in education

Education systems have always had some kind of checks and balances. These are implemented to keep track of quality or standards in education institutions and systems, and to try to improve them. In trying to understand the concept of quality in education, the first step is to look for an appropriate definition. Early literature describes quality as "*the degree of excellence at an acceptable cost, achieving or reaching for the highest standard*" (Broh 1982:3). Aminu (1995:13) refers to quality of education as "*the principal measure of the effectiveness of education*". These definitions of quality in education make reference to achieving high standards in education that lead to effective education. Arikewuyo (2004:13) argues that quality in education must be judged by both its ability to enable students to perform well in standard examinations and the relevance to the needs of the students, community and society as a whole. More recent literature by Barret (2007:14) and Tikly (2010:88) argue that quality in education is illusive and multifaceted. They attribute such illusiveness and the multifaceted nature of quality education to being grounded in the context and culture of particular settings, such as factors which contribute to the uniqueness of a country's education system.

Quality education, as understood by Adams (1993:22) includes the following dimensions of quality:

- Learners who are healthy, well-nourished and ready to participate and learn and supported in learning by their families and communities.
- Environments that are healthy, safe, protective and gender-sensitive and provide adequate resources and facilities.
- Content that is reflected in relevant curricula and materials for the acquisition of basic skills, especially in the areas of literacy, numeracy and skills for life, as well as knowledge in such areas as gender, health, nutrition, HIV/AIDS prevention and peace.
- Processes through which trained teachers use child-centred teaching approaches in well-managed classrooms and schools with skilful assessment to facilitate learning and reduce disparities.
- Outcomes that encompass knowledge, skills and attitudes that are linked to national goals for education and positive participation in society.

This definition allows for an understanding of education as a complex system embedded in a cultural and economic context. In view of the aforementioned dimensions of quality education, definitions of quality should be open to change and evolution based on information, changing contexts and new understanding of the nature of the challenges facing education.

The most widespread definition of quality in the field of education is one proposed by Harvey and Knight (1996:33) who devised a framework which consists of five definitions of quality. These definitions, according to Harvey and Knight (1996:33), are:

- **Quality as exceptional**

The exceptional notion of quality takes it as a given that quality is distinctive, exclusive or about excellence. This is the more traditional concept of quality, usually operationalised as exceptionally high standards of academic achievement. The emphasis is on high quality input. It is associated with the notion of providing a product or service that is distinctive and special and which confers status on the owner or user.

- **Quality as value-for-money**

At the heart of the value-for-money approach in education is the notion of accountability. Based on this definition, a quality education is one that provides performance and conformance at an acceptable price or cost. This definition sees quality in terms of return on investment. If the same outcome can be achieved at a lower cost or a better outcome can be achieved at the same cost, then the customer has a quality product or service.

- **Quality as perfection**

This notion focuses on the process and sets specifications that it aims to meet perfectly. The perfection or consistency approach or the right-every-time approach or the conformance to specifications approach define quality as the absence of errors, where once the design or a specification has been established by the producer, any deviation from it means a reduction in quality. Here, the word "standard" is used to indicate predetermined specifications or expectations. As long as an institution meets the pre-determined standards, it can be considered a quality institution fit for a particular status. This is the approach followed by most regulatory bodies for ensuring that institutions or programmes meet certain threshold levels.

- **Quality as fitness for purpose**

Fitness for purpose judges quality by the extent to which a product or service meets its stated purpose. The purpose may be institution-defined to reflect the institutional mission. To extend its meaning to a wider dimension in particular, it ensures that educational institutions are more externally focused. In education, fitness for purpose is usually based on the ability of an institution to fulfil its mission or a programme of study to fulfil its aim. This encourages diversity and variability in quality.

- **Quality as transformative**

Harvey (1998:244), in explaining transformation as a definition of quality in education, states that transformative education is about adding value to students by enhancing their attributes. It is also about empowering them as critical, reflective, transformative, lifelong learners: *"Education is not a service for a customer – but an ongoing transformation of the participant. ... Education is a participative process. Students are not customers or consumers; they are participants"* (Harvey 2007:6). This leads to the two notions of transformative quality in education: enhancing and empowering the student. In essence, value-added transformation should become the central element of any concept of quality rather than excellence, fitness for purpose or value for money.

In conclusion, according to Harvey (2007:11) the exceptional approach to quality emphasises the maintenance of academic standards through the summative assessment of knowledge. The perfection approach, he added, emphasises consistency in the external quality monitoring of academic competence and service standards, whilst the fitness for purpose approach relates standards to specified purpose-related objectives. This requires a criteria-referenced assessment of students. Harvey (2007:11) further suggests that the value-for-money approach places emphasis on a good deal for the customer and requires the maintenance or improvement of academic standards. While the transformative approach, according to him, uses standards to assess the enhancement of students in terms of academic knowledge and a broader set of transformative skills such as analysis, critique, lateral thinking, innovation and communication. Such quality perceptions may apply, alone or in combination, to any type of product or service in education. However different people may hold different views about the same object. The end result of quality education is not about achieving high grades and mere academic excellence, but also the total development of the student into an intelligent and compassionate citizen of the global village. In that respect, there is an urgent need for a more holistic approach to education and quality in education.

3.3.2 Quality assurance

In reviewing the aforementioned literature related to quality in education, it is imperative that a broader perspective and analysis of quality is interrogated. In this respect, the distinction between quality and quality assurance becomes implicit. According to Ajayi and Adegbesan (2007:5), when quality is viewed as the total of the features of a process, product or service on its performance, then quality assurance is being given some consideration in that context. In essence, quality is linked to quality assurance in that it is not just about a finished product but involves a focus on internal processes and outputs and includes improvement or productivity.

3.3.2.1 General perspective of quality assurance

Quality assurance is a way of evaluating the effectiveness of structures and processes required to achieve outcomes. Taylor and Hill (1993:22) state that quality assurance involves supplying evidence to external agencies about an organisation's potential effectiveness. Gray, Griffin and Nasta (2001:45) propose a similar argument that quality assurance refers to the procedures and measures for checking that quality is being maintained. Doherty's (2008:260) definition differs slightly from the previous authors in that quality assurance is defined as something organisations do - like a methodology of judging the degree to which macro and micro organisational aims, objectives and outcomes have been achieved. While Doherty highlights the achievement of objectives and aims of an organisation, Garbutt (1996:22) views quality assurance as a means of improving practice and developing a quality culture. The literature emphasise that the ultimate purpose of all quality assurance procedures is to establish whether an organisation has achieved its outcomes and also to improve how things are done.

Over the years, different authors of quality assurance introduced slight variations to their definitions. In so doing Parri, (2006:22) defined quality assurance as the mechanism by which institutions met the requirements of external accountability by demonstrating that they have in place both the management philosophy and the procedures needed to ensure that all those engaged in the activity have a responsibility for ensuring that the activity is carried out to the appropriate level of quality. One can agree with this definition as it encompasses accountability as well as the level of commitment displayed by each individual in ensuring high levels of quality of the organisation. One could therefore argue that quality assurance is a management tool which can make an effective contribution to improving performance at the institutional level or of ndividuals within institutions.

3.3.2.2 Quality assurance in the context of education

Education has been described as the bedrock of every society and as a tool for nation building. Quality improvement in education is no longer an option, it is a necessity. In this regard, Parker (2004:385) defined quality assurance as the planned and systematic actions necessary to provide adequate confidence that the education provided will meet the needs of students. Fadokun (2005:42) argued that current educational institutions must *"demonstrate quality assurance in respect of their services in ways that are intelligible to potential students"*. Quality assurance, according to Ajayi and Adegbesan (2007:4), functions in a proactive manner in the sense that it serves as a series of techniques and activities used to fulfil requirements. Similarly, Nicholson (2011:8) argue that quality assurance is related to accountability and maximizing the effectiveness and efficiency of educational systems and services in relation to their contexts, their mission and their stated objectives. Latchem and

Ali (2012:24) have also argued that it is crucial for institutions to deal with quality assurance as education expands and the demand for improved quality and accountability grows.

Quality assurance in education results in schools aspiring to promote national goals and produce students that participate positively in society. Kao (2003:6) also contributed to the understanding of quality assurance by reiterating that quality therefore involves the development of the intellectual, emotional, social, physical, artistic, creative and spiritual potentials of students. Ehindero (2012:15) focused his definition of quality assurance on the following:

- Entry behaviours of learners, characteristics and attributes - including some demographic factors that can inhibit or facilitate their learning;
- The teacher entry qualification, professional preparedness, subject background and philosophical orientation;
- The teaching / learning processes including the structure of the curriculum and learning environment; and
- The outcomes, which are defined for different levels in terms of knowledge, skills and attitudes - including appropriate and relevant instruments to assess these objectives.

In essence, quality assurance comprises all the attitudes, objectives, actions and procedures that, through their existence and use, together ensure that appropriate academic standards are being maintained to enhance the quality of education. These statements imply that quality assurance focuses on the effectiveness of schooling with outcomes that encompass knowledge, skills and attitudes.

3.3.2.3 Strategies for establishing quality assurance in education

The need for quality assurance in schools in order to ensure quality of teaching and learning cannot be overemphasised. Education quality can be enhanced if the educational institution can monitor internal processes and subsequently provide fruitful learning experiences for students. According to Ogunsaju (2009:12), for a school to provide quality education, managers must perform their roles effectively in assuring quality in the school. Adegbesan (2011:149) proposed the following strategies for establishing quality assurance in education:

- **Monitoring**: This refers to the process of collecting data at intervals about ongoing projects or programmes within the school system. The aim is to constantly assess the level of performance with a view to finding out how far a set of objectives are being met (Ehindero 2012:2).

- **Evaluation**: This is a formal process carried out within a school setting. It is based on available data which are used to form conclusions. Evaluation could be formative or summative. The aim of evaluation, is to see how the system can be assisted to improve on the present level of performance (Ijaiya 2012:5).
- **Supervision**: Supervision might involve inspection, but it goes beyond inspection to include attempts at bringing about improvement in the quality of instruction. It is a way of advising, refreshing, encouraging and stimulating staff (Onocha 2012:2).
- **Inspection**: Inspection usually involves an assessment of available facilities and resources in an institution with a view to establishing how far a particular institution has met prescribed standards. It is more of an assessment rather than an improvement induced exercise (West- Burham 2012:4).
- **Quality control**: Quality control is one of the strategies for establishing quality assurance in the education system at all levels. Ogunsaju (2009:15) is of the view that quality control should be of concern to a country. For this to be successfully carried out, there is need to examine the qualification of teachers; the adequacy of the curriculum; availability of equipment; as well as the proper use of the processes involved in the various skills to ensure that the finished products are of a high standard.

Assurance for quality education should be seen as a total holistic process concerned with ensuring the quality of outcomes. Thus, the responsibility for quality assurance rests with all stakeholders in the school system. Quality assurance in educational institutions should be seen as a mechanism to enhance their capacity to operate in a responsive way.

3.3.3 Requirements for quality education

The concern for quality has been at the core of the motivating forces for reforms in education. Ajayi and Adegbesan (2007:5) see quality as the total of the features of a service such as education on its performance, in ‘customers’ or clients’. The customers and clients of the education service (students, parents and the community) deserve the best possible quality of education. There should be a growing commitment amongst educational institutions to implement quality assurance paradigms in their educational operations in order to achieve their outcomes.

According to Cheng (2009:11), quality in education pertains to the relevance of what is taught and learned with how well it fits the present and the future needs of the learners in question, given their particular circumstances and prospects. The quality of the science curriculum plays an integral part in ensuring this moral obligation to the clients of the education service. On the other hand, Cheng (2009:15) observes that despite the fact that stakeholders may be satisfied with educational services; if education does not cater for future needs and challenges then it is still ineffective and "useless" for the new generation. One could therefore conclude that the ability of education to meet the needs of the future, both at an individual and societal level, is one of the critical elements of quality in education. A curriculum must serve communities and, as such, it must meet the political demands to publicly demonstrate high standards. For quality education to be achieved, a science curriculum must be able to demonstrate that it is able to deliver what is required to meet the demands of a society.

Lifelong learning has become important in society. This is supported by Glynn and McGloughlin (2010:12) who highlighted that the growing number of knowledge workers; the need for citizens that can engage in critical thinking; and the development of new forms of employment call for lifelong learning to be efficient and practical. The European Union's programme for lifelong learning recommends improving the quality and accessibility of lifelong learning programmes (Glynn and McGloughlin 2010:12). Therefore efficient and high-quality education systems should play a decisive role in improving employability. According to Arikewuyo (2004:10), improving educational institutions involves developing effective quality assurance systems. Quality in lifelong learning should therefore take into consideration the needs of students in becoming an integral part of society.

3.3.3.1 Quality and science education

Science education (SE) is of paramount importance in determining a country's scientific status and its socio-economic power in today's open economies. Quality SE has been shown to contribute considerably to the economic development of different nations that have considered putting an emphasis on it (Bybee and Fuchs 2006:380). Both UNICEF and UNESCO have recognised five new major goals for quality education in science which, are:

- The acquisition of survival skill;.
- The support of objectives of peace, citizenship and security;

- The development of cognitive, emotional and creative capacities among learners;
- The promotion of equality; and
- Seeking to pass global and local cultural values down to future generations.

Underpinning the view of UNESCO and UNICEF is the economic, socio-cultural, political and technological developments in today's world, which are increasingly described as shaped and directed by science and by quality SE in particular (Osborne and Dillon 2008:11). The implication is that SE needs to redress the way it is viewed and enacted, particularly so that it is relevant and functional for the public (Aikenhead 2006:33).

When viewing science education in a traditional paradigm, Cheng (2009:6) states that the quality assurance of SE is often focused on the following:

- How well science learning and teaching are organised to deliver the necessary knowledge and skills of science to students? ;
- How well the delivery of science knowledge and skills to students can be ensured through the improvement of teaching and learning? ;
- How well teachers' science teaching can be improved in a given time period? ; and
- How well students can arrive at a given standard in science examinations?

A paradigm shift of SE towards being globalised, localised and individualised, according to Cheng (2009:6), induces a new conception of the quality assurance of science education. The new quality assurance can be based on the following major questions:

- How well science learning and teaching is meaningful? (This question aims to ensure that student learning and teacher teaching in science can be well placed in a globalised, localised and individualised context.);
- How well students' science learning opportunities are maximized? (This question intends to ensure the maximizing of opportunities for students' science learning in a changing environment.);
- How well students' self-learning in science is facilitated and sustained as potentially life long? (This question tries to ensure that maximized opportunities for students' self-learning in science are sustainable life long.); and
- How well students' contextualized multiple intelligences and their abilities in science are developed? (This question focuses on ensuring the relevance and outcomes of student science learning in terms of multiple intelligences and abilities.)

In essence, from the aforementioned discussion, the shift towards the provision of a quality science education should become an essential component of education in today's schools because a quality science education system can prepare individual learners to respond appropriately to a variety of social and cultural challenges. Efforts towards quality SE need to be diverted to focus on identifying the vital capacities learners need if they are to become well-functioning members of society.

More recent literature by Bull, Gilbert, Barwick, Hipkins and Baker (2010:12) also supports the argument that SE foci need to change. There is an ever - increasing emphasis on the 'processes' versus the 'products' of science; an emphasis on a better linkage of science with its technological and social implications (as opposed to the current emphasis on inquiry as a predominant feature of school science); an emphasis on context; and a supportive learning environment (as opposed to established approaches to teaching science content) (Bull *et al*. 2010:15). Studies by Holbrook (2010:85) describe the quality of education in science as a process and outcome in which there is patterned and structured thinking that is valuable. This means that quality SE from this perspective requires more than just connecting new science ideas with old ones. It involves restructuring and becoming proficient, helpful and useful to students. According to Hjorland (2010:220), the delivery of quality SE is possible only if the issues of relevance and the usability of the learning process are considered as the essential focus. This means that if the term "quality" is considered in respect of SE, it would refer to what learners have gained from school and the usefulness of what they have learnt.

3.3.3.2 Quality and lifelong learning

Recently, interest in quality management in lifelong learning has developed as a key issue in the delivery of lifelong learning. This renewed interest in quality, according to Mark (2010:34), arises on the one hand from the need to increase competitiveness in a global economy and, on the other, from the need to demonstrate accountability in public services, as well as an ability to achieve results. The relative importance of quality is demonstrated by the place it is given in policy documents.

The European Report on Quality Indicators of Lifelong Learning by the European Commission (2010:5) stated that the quality of education is a central issue in European co-operation and that the quality of education, training and ultimately lifelong learning is one of the main priorities of the European Union action programmes. At the European level, the European Commission's (2010:28) memorandum on lifelong learning recommended the development of indicators to benchmark the quality of provision throughout Europe. There are a total of 15 indicators which are placed into four areas. The European Commission (2012:5) recommended that the role of indicators could be to describe the present situation; to quantify the objectives which have been set; to provide continuous updates on progress towards certain objectives; or to provide insights into which factors might have contributed to achieving results. The broad areas of the indicators are (European Commission 2012:5):

- **Skills, competencies and attitudes:** A lifelong learning context includes formal, non-formal and informal learning. There are five fundamental indicators for the quality of lifelong learning in this area. These include literacy; numeracy; new skills for the learning society; learning-to-learn skills; active citizenship; cultural and social skills; as well as labour market related outcomes. In the context of lifelong learning, it is essential for countries to have a sound knowledge of the literacy and numeracy levels of the adult population and of the younger generation. Those parts of a population that show particular deficits in many skills and competencies can be considered a specific indicator for the quality of lifelong learning.
- **Access and participation**: Access to lifelong learning and participation in lifelong learning are the key indicators of this area. This area describes the interaction between the individual and the system. Access and participation relate to the opportunities and chances, obstacles and barriers that confront individuals along their lifelong learning pathway. While access is concerned mainly with structural and logistical questions, participation encompasses motivational issues, as well as financial and cultural ones which must also be considered when assessing the success of a system or of a process.
- **Resources for lifelong learning:** This area has its focus on system parameters and, to a lesser extent, individual parameters. Investment in lifelong learning; educators and training; and information and communication technologies in learning are the key indicators for quality lifelong learning. These indicators, which do not cover the proposed resource areas in a satisfactory way are sufficiently concrete and meaningful to serve as a starting point for a long-term analysis of the adequacy of resources for a lifelong learning process.
- **Strategies and system development:** The indicators for this area include strategies of lifelong learning; coherence of supply; counselling and guidance; accreditation and

certification; and quality assurance. This final section is concerned with the areas of lifelong learning where political decisions (strategies) seek ways to turn the components of lifelong learning into an integrated and coherent system (coherence of supply). Within this framework, it should be possible to assess the outcomes (quality assurance) while the individual draws maximum benefit from his/her learning - which would be accredited and certified and receives appropriate counselling and guidance.

Although the aforementioned indicators are merely a guide that can be used to determine the quality of lifelong learning in different countries, a careful analysis of the indicators in different education settings is important. Countries that do not have any, or only very few, indicators should reflect on national efforts to improve the quality of lifelong learning for their students.

Quality in lifelong learning can be viewed in many different ways. Quality in lifelong learning can be considered at policy level, as well as the institutional and learning process level as follows (Schwandt 2010:553):

- Policy level: Policy development is a crucial element in educational planning. Policy analysis should consider a number of aspects of the social context, including political, economic, demographic, cultural and social issues which are likely to affect the quality of lifelong learning at educational institutions. For quality lifelong learning, educational policies must respond to a dynamic situation (ever-changing and evolving contexts).
- Institutional or learning process level: Lifelong learning serves a large and varied group of students of all ages and different educational levels. Adapting study programs to ensure that they are designed to widen student participation improves the quality of lifelong learning. Quality lifelong learning implies developing systems to assess and recognise all forms of prior learning in the context of lifelong learning since knowledge is acquired through formal, informal and non-formal settings.

A subsequent report entitled "*Quality Indicators of Lifelong Learning*" (European Commission 2012:5), which represents the work of representatives from thirty-five European countries and UNESCO, reflects the breadth and complexity of the lifelong learning process as "*the need to set up mechanisms for quality assurance, evaluation and monitoring in order* *to ensure constant progression towards quality improvement with a view to striving for excellence on an ongoing basis."* (E.C. 2012:5). Against the background of an increasingly demanding lifelong learning environment, it is crucial for schools to have quality assurance mechanisms in place to strive for quality outcomes at acceptable standards. The quality of lifelong learning skills acquired by students in schools involves preparing them for the tasks of making complex judgements and decisions in the uncertain and unpredictable circumstances in which they will find themselves in the future. The recent emphasis on the quality debate has led to the development of many different approaches to its assessment. The aims and purpose of any quality assessment may well determine what is examined and what is not. This study maps out the theory behind total quality management as a method for determining quality in education.

3.3.4 Total quality management

Total quality management (TQM) has become a globally implemented management technique aimed at continuously improving the performance of products, processes, and service to achieve and surpass customer expectation. The concept of quality is no longer used solely for the manufactured product. TQM has become an indispensable element of each and every field of life (Simsek and Celik 2009:198) as it intends to meet customer requests and expectations at the maximum level in all institutions or sectors. Thus, TQM can be a powerful tool in the educational setting even though it was developed with manufacturing processes in mind. This study is underpinned by the TQM theory.

3.3.4.1 Origin of total quality management

TQM was originally developed by Edward Deming after World War II in order to improve the quality of products. It was first introduced to Japanese industrial leaders (Svensson and Klefsjo 2006:305). TQM has many definitions. Gurus of the total quality management discipline like Deming, Juran, Crosby, Ishikawa and Feigenbaum defined the concept in different ways. However the essence and spirit of TQM remained the same.

In his book *"Total Quality Control*" (TQC), Feigenbaum (1960:45) stated that TQM is an effective system for integrating the various initiatives in the field of quality to enable production and services to be carried out as cheaply as possible, consistent with customer satisfaction. According to Svensson and Klefsjo (2006:15), this definition contains the very root of the problem. They stated that the reason why TQM was not a success in Western forms is especially due to the fact that Western management was misled by Feigenbaum's reference to an effective system and thought that TQM could be left to a central quality department (2006:15). As a result, the management of industries failed to realize that an essential ingredient of TQM is management's commitment to quality improvements.

Ishikawa (1984:12) also emphasized the importance of total quality control to improve organizational performance. According to him, quality does not only mean the quality of the product, but also of after - sales service, quality of management, the company itself and the human life.

Deming (2000:5) proposed that a never-ending cycle of progress in the system of production should change into gaining better performance and quality standards for the product. According to Deming (2000:7), quality is a continuous quality improvement process towards a predictable degree of uniformity and dependability. Deming (2000:7) posited that, in a typical business meeting, exceeding the customers' requirements is the task of everyone within an organization. Thereafter, Deming (2000:7) broadened the definition of 'customer' to include both internal and external customers. Each person or step in a production line or business process was to be treated as a 'customer' and to be supplied with exactly what was needed, at the exact time needed.

Dr. Joseph Juran (1989:22) in his explanation of TQM emphasised the customer's point of view of products and fitness for use or purpose. According to him, a product could easily meet all the specifications and still may not be fit for use or purpose. Later, Juran (1989:41) defined quality as "*fitness for use*." According to him, every person in the organization must be involved in the effort to make products or services that are fit for use. Juran, (1989:41) stated, "*The most decisive factor in the competition for quality leadership is the rate of quality improvement".*

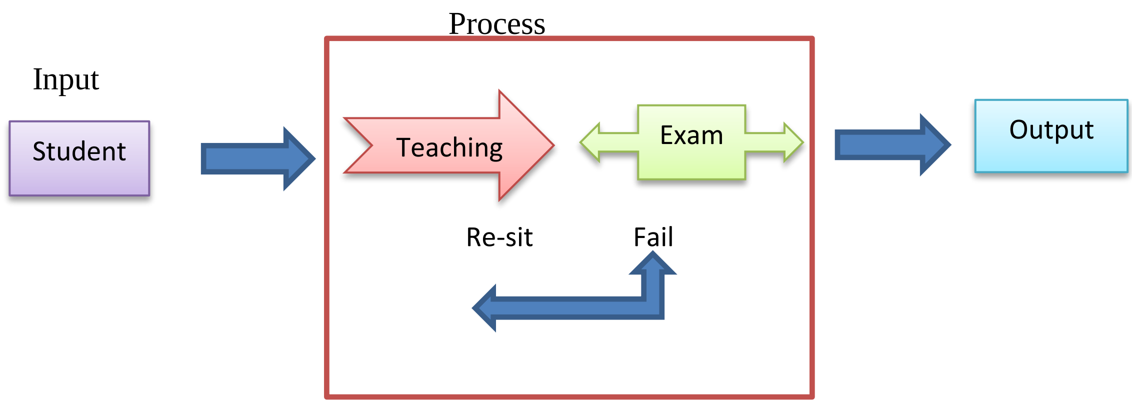
Crosby (1982:11) on the other hand was not keen to accept quality which is related to statistical methods. According to him, quality is conformance to requirements and can only be measured by the cost of non-conformance. He argues that the real cost of quality is the cost of doing things wrong. In contrast, the cost of doing things right is not a cost at all, but an investment (Crosby 1982:11). Thus, the ultimate aim of quality is to eliminate waste and to not do things wrong at any stage in a process. Consequently it is crucial that every stage of a process is done absolutely correctly; that it conforms to requirements; is not incurring costs and is accruing value.

However Deming (2000:5) turns down the concept of “zero defects” as insufficient. In other words, while Crosby tries to make sure that failure in products of the next year will occur less often than that in the previous year, Deming (2000:5) insists that it must be a better product altogether. Deming (2000:8) claimed that the focus of TQM is twofold. Firstly, TQM is about meeting customer needs. Secondly, continuous improvement is always connected with quality. From the aforementioned literature, it is evident that all the major proponents of TQM emphasise that management, while comprising formal arrangements, is a phenomenon that exists throughout the organisation and at all levels. The key role of leaders, both formal and informal is to develop strategies that facilitate the realisation of a collective vision in the pursuit of quality.

3.3.4.2 Education and total quality management

Currently, the schooling process in most schools involves students entering a grade at the beginning of the year and being taught their lessons, after which they write an examination at the end of the year that determines their lot the following year. Figure 3.5 shows the schooling process in which students enter school as an input and go through a teaching process performed by teachers (Stigler and Hiebert 2009:4).

Figure 3.5 The schooling process



Source: Adapted from Stigler and Hiebert (2009)

Students have to sit for an examination before they enter the next level. However, those students who cannot pass the examination may either join the workforce as unskilled workers without any academic credentials or re-sit the subjects they have failed (Ware and Vika 2009:239). One of the shortcomings of this world-wide examination system, according to Crosby (1982:22), is that it emphasises the results of the examination rather than the quality of teaching. According to Crosby (1982:23), an effective schooling system should implement TQM for the following reasons:

- It emphasises the quality of the teaching and learning system rather than the results of the examinations;
- As the name "total" implies, it pays attention to all the constituents of the system; and
- It looks for the factors affecting exam failures and tries to eliminate them at the source.

Following these strategies in schooling systems, schools can produce more students that pass the exam, with less failing (Crosby 1982:23). In this way, education systems will sustain a high level of knowledgeable and quality students. TQM in education is about using scientific methods and tools and problem-solving through teamwork.

In Deming's (1986:6) view, schools do not need to depend on examinations to guarantee quality. According to Deming (1986:9), if the quality of the teaching system is sufficiently taken into consideration, it will not be necessary to examine every student on every single item they have studied. Therefore, examinations will turn into a diagnostic tool to assure the quality of the system rather than the quality of every single student. An analysis of the above model shows that students who have failed and join the workforce would be incompetent and would not suit the fit. Those students who repeat the year of schooling would merely have to be re - taught the same knowledge and rewrite an examination at the end of the year.

Given the crucial role of education in an increasingly competitive global environment, administrators and educators are constantly looking for ways to make educational instruction more effective and meaningful. The notion of TQM is now attracting growing attention amongst educational practitioners and theorists. Without regular progress in the curriculum itself, the educational needs of students cannot be fulfilled. According to Masoumeh, Ramli, Shaffe and Soaib (2011:72), the modifications to a science curriculum should not be restricted to boosting the content but there should also be a dramatic move towards creative thinking and skills, as well as independent learning. To be useful in SE, it would be crucial for curriculum leaders of science to work with stakeholders to understand clearly the role of TQM for quality improvement in SE and customise the science curriculum to suit their particular contexts.

3.3.4.3 Role-players of total quality management in schools

TQM is based on the participation of all members of an organization in improving processes, products, services and the culture in which they work. For TQM to become reality in schools, the school culture must be transformed into one which focuses attention on those holistic functions and processes that transform leaders, teachers, students and other role players into effective and collaborative quality providers of services (Holmes and McElwee 2003:143). In particular, TQM comprises the transformation of the traditional hierarchical (pyramid) school structure into a new organisational structure that is founded along horizontal, rather than vertical lines of cooperation (Mukhopadhyay 2005:12). In other words, TQM endorses current shifts towards distributed or shared leadership models. This process of change requires a deliberate, integrated and dynamic effort by school leaders and embraces all role players, including staff members, students, parents and the community at large, with student learning and satisfaction as the ultimate result (Mukhopadhyay 2005:16; Sallis 2002:45).

TQM enhances the quality of teaching and learning as it addresses the needs and expectations of the customer and is based on the notion of continuous improvement. The first step in implementing TQM would be to identify the "customers" or stakeholders (Bay and Daniel 2001:3). Furthermore, Griffith (2001:170) proposed that if the student is identified as one of the customers, every effort must be made to satisfy that customer. It becomes increasingly essential for customers to make informed decisions in deciding what they want included in the science curriculum. In applying TQM in SE, the principle factor in the implementation of TQM will be the result of the relative weight assigned to the role of each of the customers at the different levels of education (Epstein 2010:15). Subsequently, all relevant participants will be included in the educational process.

In summary, the implementation of TQM in schools could lead to tremendous improvement regarding team-building and stakeholder focus because of the involvement of role players, such as parents, students and teachers participating in developing the curriculum and services to suit the needs of students, thereby reducing the wastage of school resources and increasing productivity. The argument arising from this is that various stakeholders of education should be consulted in applying TQM in the development of the science curriculum so that they could make the necessary inputs about the relevance to the community that the science curriculum would serve. The customers of schools are primarily the learners and their parents. Parents are also suppliers who entrust their money and children to the care of the school. Educators and principals develop personalised relationships with their customers and suppliers who facilitate the school's continuous improvement processes. This implies that at schools partnerships should be created with all the customers and suppliers both external and internal, in developing a quality science curriculum that will prepare students for lifelong learning.

3.3.4.4 Total quality management for curriculum development

Although TQM was first designed for industry and was not appropriate for education, many educationists maintain that TQM could also be applied to education, especially for bringing about educational reforms (Dheeraj 2011:5). According to Winn and Green (1998:9), without regular progress in the curriculum itself, the educational needs of students cannot be fulfilled. The process of developing the curriculum should be underpinned by the continuous improvement of processes in order to meet the expectations of its recipients (Meyer 2008:32). Deciding what are the critical characteristics of any new product, charting these at each stage of design and production and establishing customer requirements should be the priority of curriculum developers.

From a customer perspective, it is important to identify the needs of students as primary customers and strive to meet their needs (Hwarng and Teo 2001:223). This is supported by Lagrosen (2004:9) who suggested that TQM in this area should be valuable by taking into account the view of its customers. This idea could be extended further to imply that TQM may be used to ascertain whether the quality of the science curriculum caters for lifelong learning amongst students. In the same vein, Rowley (1997:900) states that the perspectives of all stakeholders as proposed in TQM should be taken into account when attempting to measure the quality in SE. Nagel and Kvernbekk (1997:104) pointed out that all stakeholders of education are generally concerned about the quality of SE and societies at large do have vested interests in science education. It can therefore be emphasised that the development of a quality science curriculum is a collaborative process involving district leaders, school administrators, teachers, students and parents if it is going to contribute to lifelong learning for students.

Most of the applications of TQM have been in the administrative side of institutions but some schools in the United States have applied TQM to curriculum development (Winn and Green 1998:10). According to De Jager and Nieuwenhuis (2005:254), the key principles of Deming (2000:17) stated that the modifications to the curriculum should not be restricted to boosting the technical content and that there should be a dramatic move towards creative thinking and skills, as well as independent learning. Crawford and Shutler (1999:70) posit that by applying TQM to curriculum development, a more efficient curriculum can be obtained - one that could take the student to a context where they are actively engaged with problem-solving exercises; inquiry projects; group and co-operative work; and equal relationships with their teachers. As a result, they become creative and critical thinkers who are sufficiently ready to meet the challenges of a fast-changing technological world.

Dale (2013:7) argues that too often curriculum developers provide only what they think their customer groups need. The improvement of the curriculum using TQM (Crawford and Shutler 2009:11) could lead to an improvement in student interest and performance. Engaging with science curriculum improvement in a detailed and systematic manner will ensure that the voice of the customer is heard long before a new product comes to the market. Chowdhury (2014:4) defined the necessity of TQM in the science curriculum based on the consideration of the current declining trend of SE. This encourages students to distinguish science knowledge as beneficial, interesting and appropriate.

Continuous improvement through TQM should be an integral part of the whole education system and its processes. Improvement may take forms such as enhancing value to customers, reducing errors, improving productivity and improving responsiveness. Educational systems can include a means by which customer research can be conducted to evaluate and improve supply. In the context of this study, lifelong learning in SE is about acquiring knowledge and skills such as creative thinking, critical thinking and problem solving. If a science curriculum does not cater for quality knowledge and skills development, then the lifelong element is missing and, as such, the student who is the customer might not have the necessary knowledge to function in society. TQM can thus be applied to assess the effectiveness of the science curriculum and develop strategies for improvement to redesign the curriculum and improve its content with regards to lifelong learning.

3.3.4.5 Total quality management and quality assurance

According to Deming (1986:22), quality assurance is about designing quality into a process in an attempt to ensure that the product is produced to a predetermined specification. Sallis (2002:11) contends that quality assurance is about consistently meeting product specifications or getting things right first time, every time. Total quality management incorporates quality assurance and extends and develops it. In a generic context, TQM is about creating a quality culture where the aim of every member of staff is to delight their customers and where the structure of their organisations allows them to do so.

The following definitions expounded by Sallis (2002:11) guide the TQM-oriented quality assurance of teaching in a school setting:

- TQM in an education setting is a philosophy and a set of guiding principles and practices that the instructor applies to the teaching that represent the foundation for continuous learning and improvement on the part of students and the instructor. It is the application of procedures related to instruction that improve the quality of the education provided to students and the degree to which the needs of students and their employers are met, now and in the future.
- Quality assurance of a school setting is a process that involves adopting a total quality approach to teaching (i.e. attempting to improve the quality of instruction and, in the process, students' meaningful learning in every possible way) so that the needs of students are best served.

It may thus be stated that for an education system to serve the needs of the customers and provide quality SE, quality assurance should begin with knowing the needs and interests of students.

As previously stated, in TQM the customer is sovereign. TQM is about providing the customer with what they want, when they want it and how they want it. It involves moving with changing customer expectations to design a science curriculum that meets and exceeds their expectations (Deming 2000:13). A science curriculum has to therefore constantly undergo change to meet the changing needs and expectations of the customers. Only by satisfying customers will they return and tell their friends about it. In this way the number of students opting to do certain subjects will not dwindle. Since the perceptions and expectations of customers are recognised as being short term, science curriculum developers should find ways of keeping close to their customers to be able to respond to their changing tastes, needs and wants.

Curriculum developers are responsible for finding out their stakeholders' requirements in an endeavour to satisfy them and then to determine the degree to which they have been satisfied. This means that applying TQM to measure stakeholder satisfaction is central to quality assurance and is what distinguishes TQM from other management theories and improvement efforts (Kerzner 2008:8). There is a commensurate obligation on stakeholders to clearly express clearly their needs and to participate in providing feedback for monitoring and review. These tools provide a means to enable facts and data to be collected in order to inform decision-making about continuous improvement (Jenkins 2010:47; Kerzner 2008:5; Okes 2002:27). Some of the existing methods used for gathering data and information in schools are suggestion cards, shadowing, interviews, surveys and team meetings but the emphasis from a quality perspective should be on the extent to which TQM tools can be effective (West-Burnham 1997:52). The tools of TQM, as suggested by West-Burham (2012:52), are as follows:

- **Quality Improvement Teams:** These are small groups of employees who work on solving specific problems related to quality and productivity, often with stated targets for improvement. Quality improvement teams are proving to be highly successful at tracking down the causes of poor quality, as well as taking remedial action.
- **Benchmarking:** This is the process of identifying best practices and approaches by comparing productivity in specific areas within one's own company to other organisations.
- **Statistical process control:** This is a statistical technique that uses periodic random samples taken during actual production to determine whether acceptable quality levels are being met or whether production should be stopped in order to take remedial action. Because most processes produce some variation, statistical process control uses statistical tests to determine when variations fall outside the acceptable quality level.

In order for TQM to be a success, each member in an organisation must be committed to the change process.

TQM and quality assurance are responsible for identifying and eliminating potential gaps in processes. The only way to accurately do this is to track the process with statistics and data that can then be used to find what works and what does not. Any variation in the process must be tracked and the origin of any potential problems has to be found and resolved. With the ultimate goal of TQM and quality assurance being to produce a high-quality product at the end of the process, in reference to quality SE that hinges on lifelong learning, a student/customer who will have the necessary knowledge and skills to contribute positively to society is envisaged.

3.4 Education as a service

In addressing quality in education, the idea of the learner as the product misses the complexities of the learning process and the uniqueness of each individual learner. For the purposes of analysing quality, it is more appropriate to view education as a service industry than as a production process since its services include tuition to students, their parents and society. Therefore, the customers, the stakeholders of the service are a very diverse group and need identifying. Figure 3.6 below distinguishes between the various stakeholders.

Figure 3.6 The customers of education

Education (value added to learners)	=	The service
The learner	=	Primary external customer or client
Parents/ governors/ employers	=	Secondary external customer
Labour market/ government/ society	=	Tertiary external customer
Teachers/ support staff	=	Internal customers

Source: Adapted from Sallis (2002)

According to Figure 3.6, the "customers" in education are:

- Primary customers—the learner who directly receives the service.
- Secondary customers—such as parents.
- Tertiary customers—who have a less direct but nonetheless crucial stakeholding in education, such as future employers, government and society as a whole.
- Internal customers—who are the employees of the institution and who have a critical stakeholding in the organization's success.

If quality is about meeting and exceeding customer needs and wants, it is important to be clear about whose needs and wants should be satisfied. Quality in education is determined by the extent to which the needs and expectations of students are satisfied. Course content or curriculum is a teaching component that has been considered as one of the important determinants of enhancing the overall quality of education in meeting the relevance for student and societal needs (Athiyaman 2007:540; Sohail and Shaikh 2004:59). O'Donoghue (2010:58) explains that a curriculum refers to the suitability of the academic programme and course content. The extent to which the objectives of academic programmes maximise the potential of students is one of the important determinants of a high-quality curriculum.

According to Oduran (2011: 1433), quality is a relative term as it could be used, for example, in relation to 'processes' or outcomes. He adds that in most of the literature, quality is used as an exception, perfection, fitness for purpose, value for money or as transformation. This should be considered when a science curriculum is developed. The conceptualisation of quality in this context refers mainly to service quality. Service quality is the result of what consumers receive and how they perceive it (Gronroos 1990:82). Berry and Parasuraman (1991:22) and Yeo (2008:267) concur that clients assess service quality by comparing what they expect with their perceptions of what they actually receive.

3.5 Service quality and perceived quality

Cateora (2007:7) states that the focus on quality globally is driven by increasing competition and choices which ultimately places power in the hands of consumers rather than producers. Service quality is defined by customers and relates to the organisation's ability to satisfy the needs of customers (Palmer 2005:5). Service quality is defined as "*the difference between customers' expectations for service performance prior to the service encounter and their* *perceptions of the service perceived"* (Asubonteng, McCleary and Swan 1996:64). Service quality dimensions include reliability, responsiveness, empathy, assurance and tangibles (Mullins and Walker 2010:18). According to Mullins and Walker (2010:18), the results of a number of surveys suggest that customers perceive all five dimensions of service quality to be very important, regardless of the kind of service. The perceived service quality fully explains the quality dimension in the services industry (Reeves and Bednar 2004:430). This statement is supported by Kang and James (2010:270) who assert that perceived service quality is the core issue of service quality in the literature on services marketing.

Perceived service quality is defined as "*a global judgment, or attitude, relating to the superiority of the service*" (Parasuraman, Berry and Zeithaml 1988:16). According to Bateson (2005:843), customer expectations are the standards or reference points for performance against which service experiences are compared and are often developed in terms of what the customer believes should happen. Othman and Owen (2002:185) define quality as the degree of difference between customer perceptions and expectations. Zeithaml and Bitner (2003: 135) state that the right parameter for the success of a service or a product is achieved once the perception meets expectations in terms of value and that perceived quality is determined by the gap between expected quality and experienced quality.

3.5.1 The Servqual Model as a generic model

Amongst the various service quality models, the Technical and Functional Quality Model (Gronroos 1990:8) and the Service Quality Gap Model, also known as SERVQUAL model (Parasuraman *et al*. 1988:17) are the two most commonly quoted service quality models. According to Zeithaml and Bitner (2003:7), a sound measure of service quality is necessary for identifying the aspects of service needing performance improvement; assessing how much improvement is needed on each aspect; and evaluating the impact of improvement efforts.

One of the first measures to be developed specifically to measure service quality was the SERVQUAL survey (Zeithaml and Bitner 2003:9). Palmer (2005:9) states that the SERVQUAL technique can be used by companies to understand the expectations and perceptions of their customers better. It is applicable across a broad range of service industries and can be easily modified to take account of the specific requirements of a company. In effect, it provides a skeleton for an investigatory instrument that can be adapted or added to as needed. There are five key dimensions of the SERVQUAL model which could be used by consumers to evaluate the perception of the perceived service quality. These dimensions include reliability, assurance, tangibles, responsiveness and empathy (Parasuraman *et al*. 1988:19). These dimensions are briefly described below (Bateson 2005:829; Lovelock and Wirtz 2007:12):

- *Reliability:* Is the company reliable in providing the service? Does it provide as promised? Reliability reflects a company's consistency and certainty in terms of performance. Reliability is the most important dimension for the consumer of services;
- *Tangibility:* How are the service provider's physical installations, equipment, people and communication material? Since there is no physical element to be assessed in services, clients often trust the tangible evidence that surrounds it when making their assessment;
- *Responsibility:* Are company employees helpful and capable of providing fast service? It is responsible for measuring company and employee receptiveness towards clients;
- *Security:* Are employees well-informed, educated, competent and trustworthy? This dimension encompasses the company's competence, courtesy and precision; and
- *Empathy:* This is the capacity a person has to experience another's feelings. Does the service company provide careful and personalized attention?

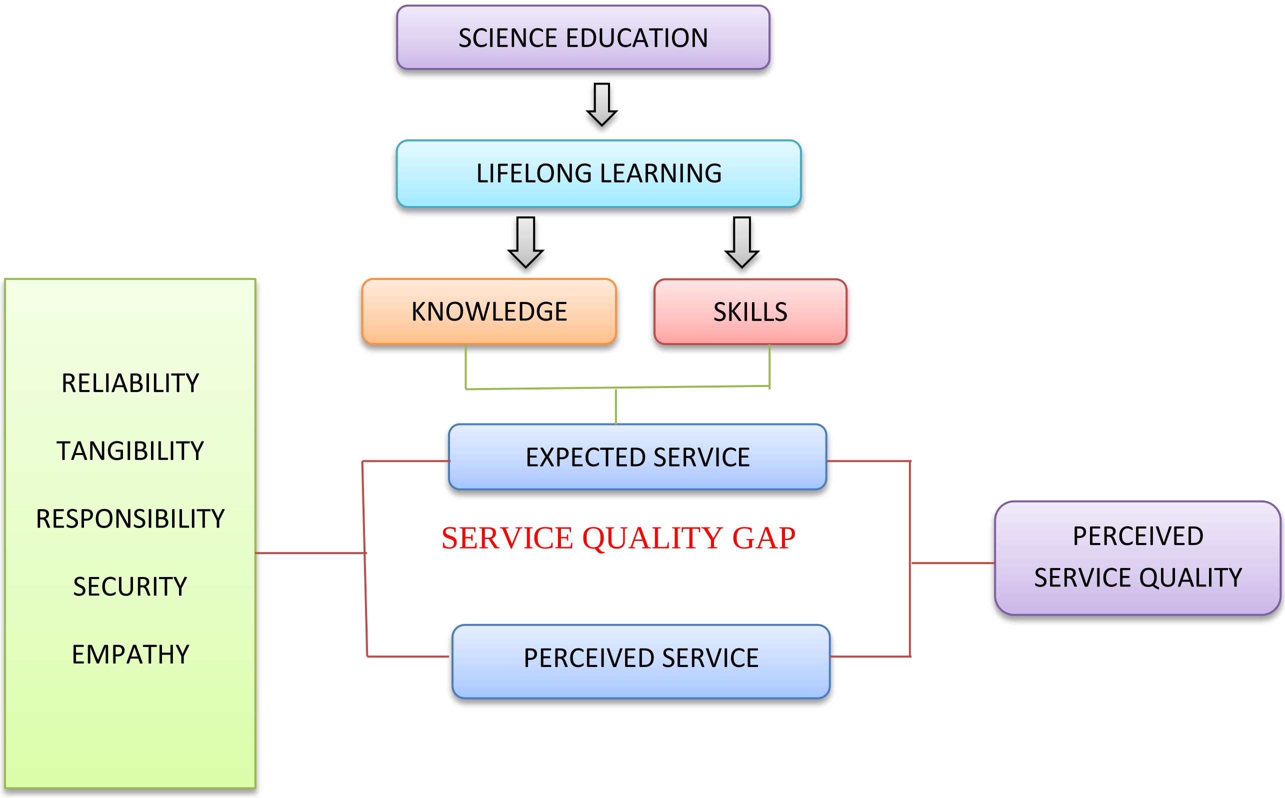
The literature review indicates that the majority of service quality models support the notion that service quality is measured by comparing the customer's service quality expectations with service quality perceptions or experiences. Despite the criticisms and weaknesses, the literature indicates that SERVQUAL is still the most widely applied instrument in service quality research. According to this model, service quality is based on a comparison of the expectations of customers with perceptions of the service actually received and that the five dimensions are a concise representation of the core criteria that customers employ in evaluating service quality, which could also be applied to the education sector.

3.5.2 The Servqual Model as applied to education

Brown and Bitner (2007:16) suggest that the educational system as a service provider has to improve societies in economic, social, cultural and educational developments. In any country, the educational system has an important task in growing human resources and providing them for various sectors. For this purpose, the educational system must be accountable to the external environment. There is no surprise that practitioners and academics are accurately measuring service quality in order to better understand its essential antecedents and consequences and ultimately establish methods for improving quality to achieve competitive advantage and build customer loyalty (Hassan and Iliaz 2008:165). The SERVQUAL model is frequently used and adopted to evaluate the perceived service quality of students in the education industry (Russell 2005:71). The SERVQUAL model that was developed by Parasuraman *et al*. (1988:17) is adapted in this research to measure the gap between the expected level of service of customers and their perceptions of the actual service received. According to Staiou (2008:127), managing gaps in service will help the company improve its quality. Sosis (2006:82) suggests that the confirmation of expectations is observed through the gap, i.e. the deviation which appears between the expectations and delivered service of students in an educational setting. If their expectations meet the perception that means they are satisfied, while in the event that the expectations are higher than the perception, it is assumed that they are dissatisfied with the service.

As mentioned earlier, there has been a considerable decrease in the number of students studying science at schools and the trend is continuing. Students expect to complete their studies within the expected timeframes and enhance their science knowledge and skills in order to increase their chances of getting a “good” job (Peterson, Briggs, Dreasher, Horner and Nelson 1999:77). Considering the many expectations that students have and problems they face when studying science at schools, it is important for curriculum developers to be aware of the needs and expectations of students and take steps to identify, measure, meet and exceed those expectations that are under their control. As proposed by Tofler (2012:1), lifelong learning is about acquiring and updating all kinds of abilities, interests, knowledge and qualifications which promote the development of knowledge and competences that will enable the adaptation of students to the knowledge-based society. Figure 3.7 provides a representation of how the various dimensions of the SERVQUAL model could be used to assess whether the knowledge and skills (lifelong learning) acquired by students in SE meets their expected service and perceived service.

Figure 3.7 Determinants of perceived service quality of lifelong learning in science education



Source: Adapted from Cullen (2000)

The science curriculum implemented at school should be subjected to rigorous service quality tests as represented in Figure 3.7 in order to meet this demand for more frequent changes in the nature of skills and knowledge. It is crucial for curriculum developers to keep in perspective the needs and interests of groups such as student; employers and parents when developing a Life Sciences curriculum. The increased pace of globalisation and technological change, the changing nature of work and the labour market are amongst the forces emphasising the need for a continuing upgrading of knowledge and life skills throughout life. The main theme of this work was to determine the level of service quality provided by the Life Sciences curriculum to its customers in the context of lifelong learning.

3.6 Conclusion

The principles of total quality management; examining the input, process and outputs of the education system; and also restructuring the education system are important in the evaluation of the educational process. Adapting the curriculum is the important issue in terms of creating customer-oriented service. Too often in education, low attainment is not sufficiently researched and analysed and the causes of failure are not the subject of managerial action. It is often stated in the TQM literature that successful quality improvement requires the commitment of all stakeholders. That commitment should not just support the efforts of others. In practical terms, it means recognising that when things go wrong the responsibility for finding a solution always lies with management.

TQM is a practical but strategic approach to running an organization that focuses on the needs of its customers and clients. It rejects any outcome other than excellence. TQM is not just a set of slogans but a deliberate and systematic approach to achieving appropriate levels of quality in a consistent manner that meet or exceed the needs and wants of customers. It can be thought of as a philosophy of continual improvement only achievable by and through people. As an approach, TQM represents a permanent shift in an institution’s focus away from short-term expediency to long-term quality improvement (Dale 2013:6). Constant innovation, improvement and change in the curriculum are emphasised. Curriculum developers should analyse what they are doing and plan to include all stakeholders to improve the curriculum. Curriculum development should be restructured and transformed from a hierarchical activity to a team-based, problem- solving and self-directed learning activity.

CHAPTER 4

QUALITY AND LIFELONG LEARNING IN BASIC EDUCATION IN SOUTH AFRICA

4.1 Introduction

Governments in many countries, including South Africa are concerned about the declining interest of students in science. Students have a tendency to display apathy towards a school science that has very little relevance to their own lives. In keeping with this claim, Onwu and Kyle's (2011:12) study found that dwindling interest, low motivation to learn and poor performance of learners in science could all be attributed to the lack of a recognisable relevance of the science curriculum. Sjoberg and Schreiner's (2005:17) study revealed that the lack of relevance of the science curriculum is probably one of the greatest barriers for sound learning as well as for interest in the subject. Therefore, one could surmise that a better fit between the interests of students and curricula could lead to higher affective and cognitive outcomes in the sciences.

Information literacy developed through outcomes-based learning provides learners with the competencies they need to become lifelong learners (Krapp 2010:400). International studies show that formal school education has to position itself more effectively to lay firm foundations for lifelong, life-wide and life-deep learning (Claxton and Lucas 2009:10). Studies of the Life Sciences curriculum by de Villiers (2011:537) revealed that more emphasis needs to be placed on what learners are interested in and on having this incorporated into Life Sciences curricula.

South Africa needs to make a concerted national effort to promote science as a means of improving living standards. There is a need for a new generation of young minds, skilled in and passionate about science, working to put South Africa on the global technological map. South Africa more than ever needs qualified individuals who will use their skills and entrepreneurial spirit to compete internationally with the best. The most effective way of taking the country forward is to engender an enthusiasm for science education in its young people.

This chapter explores the basic education system in South Africa, highlighting how it evolved from the apartheid era through the post-apartheid era to its present system. In tracing the transformation process, the study outlines the various policies and legislation that have impacted on the quality of basic education in South Africa, with special reference to the quality of the Life Sciences curriculum in grade 12 regarding lifelong learning.

4.2 Apartheid education in South Africa

4.2.1 Foundations of apartheid education

Apartheid education in South Africa has mainly been underpinned by racism and repression. The provision of education in racially segregated schools was guided by the Education for Indians Act of 1969; the Education for Coloured People's Act of 1965; the Christian National Education Act of 1962 for "white" South Africans; and Bantu Education Act of 1953 (later to become the Education and Training Act of 1978) for Africans. During apartheid there were four racial classifications for South Africans. These were White, Asian, Coloured and Black. In each instance, the location of such racially defined schools was in a racially defined group area and for a racially defined population group. This means that "white" schools were in "white" areas, catering for "white" South Africans; "Indian" schools in "Indian" areas and catering for "Indian" South Africans; and so forth.

Apartheid education was defined by the racial segregation of schools; inequalities in educational provisions; and practices of discrimination in schools to the misrecognition and non-recognition of "black" views and experiences in the construction of knowledge (Troup 1977: 5; Kallaway 2002:12; Nkomo 1990:22). This education system thus provided access to education for "black" children on the basis of inequality, segregation and white supremacy. It could be argued that apartheid schooling was designed and motivated to ensure that "white" South Africans were schooled in order to take on managerial positions in society and to be dominant in economic, political and social arenas of South African society, whilst "black" South Africans were being schooled explicitly to take on menial, un/semi-skilled and inferior positions, particularly in the economy.

4.2.2 Schooling in the apartheid era

Until the early 20th century, African children attended mission schools and were taught by clergy, while the indentured Indians set up and provided funding for their own schools. This was in contrast to whites who received schooling directly provided for or subsidised by local governments. By 1923, it was compulsory for all children of ‘European descent’ to undergo a minimum of seven years of schooling, while it remained optional and often exceptionally challenging for non-whites to pursue an education (Malherbe 1925:401). The Bantu Education Act of 1953 was aimed at providing the labour market with unskilled workers. According to Malherbe (1925:401), the Bantu Education system robbed the largest section of the population of basic skills such as critical thinking and problem-solving and instead equipped them with a sub-standard education. Apartheid education in South Africa promoted race, class, gender and ethnic divisions and emphasised separateness, rather than common citizenship and nationhood.

Apartheid schools also spatially segregated people along gender lines. According to Truscott (1994:22), the patriarchal dominance in apartheid schools was reflected in the treatment of females in classrooms; subject choices given to females; sexual harassment of female pupils; and drop-out rates of females at secondary school levels. The performances of female students were equal to, if not better than, males at primary school level and decreased significantly by the time they reached high school (Christie 1991:57). Females were channelled into subject areas away from the sciences, which were dominated by male preferences.

According to Wolpe (1994:10), the fiscal allocation in terms of race, where “white” education enjoyed more funding, resulted in wide-scale disparities with regard to all aspects of education. This included the quality of teacher training; level of teacher training; resources at schools; location of schools; support materials; and almost every aspect of educational service delivery. Conditions of and for schooling in the racially cast schools were different and this affected educational performances. Most black schools did not have libraries, laboratories, running water or functional toilets, textbooks and had under and/or unqualified teachers. Therefore, schooling under apartheid was based on racial inequality.

In South Africa, successive governments since 1953 essentially institutionalised the underdevelopment of black people through the education system (Christie 1991:17). In effect, what followed was a 40- year period of developing a system of education that exercised social control over the political and economic aspirations of black people. Apartheid schooling was authoritarian; teacher dominated and promoted rote learning tendencies

(Kallaway 2002:12; Christie 1991:24). According to Christie (1991:44), the apartheid education system was characterised by a curriculum policy that was both discriminatory and centralised. This education system exacerbated the negative perceptions and political tensions that culminated in political strikes throughout South Africa.

The 1976 uprisings sparked off protests against the imposition of Afrikaans as a medium of instruction in primarily African schools. This indicated that the knowledge taught in apartheid classrooms attempted to legitimise the views of Afrikanerdom and white supremacy. The inferior education received by black people was one of the factors that led to the political resistance that, ultimately, resulted in the democratic general elections of 1994.

4.2.3 Science education during the apartheid era in the realm of quality and lifelong learning

Hendrik Verwoerd claimed that the aim of the Bantu Education Act No.47 of 1953 was to solve South Africa's "ethnic problems" by creating complementary economic and political units for different ethnic groups (Horrel 1968:58). Education played a pivotal position in separating South Africans. As part of his ambitious plan to overhaul black education, Verwoerd insisted that black education had to be rooted in the native community. According to Horrel (1968:58), Verwoerd stated that it was in the interest of the Bantu that he be educated in his own circle and not become a black Englishman in order to be used against the Afrikaner. Verwoerd stated that "*there is no place for the Bantu in the European community above the level of certain forms of labour. What is the use of teaching the Bantu child mathematics and science when it cannot use them in practice?"* Taking its cue from these words, mathematics and science were no longer taught as core subjects in black schools. Emanating from the aforementioned quotation, Verwoerd implied that it made little sense to teach mathematics and science to a black child if he or she could not use it in a career. It could further be concluded that public education for blacks was aimed at providing them with literacy and numeracy skills that did not allow them to progress further than semi-skilled jobs in industry.

During the apartheid era, a small number of blacks matriculated with a school-leaving certificate in mathematics and science. From 1958 to 1965, a total of only 431 black matriculants passed mathematics and science (Horrel 1968:58). Bantu Education forced blacks to pay for their education, whilst also receiving a very watered down science education, making them only useful as gardeners, maids and simple workers. Kahn (2001:12) claimed that the lack of science equipment and laboratories prevented teachers in black schools from teaching science practically. In cases where a few laboratories were found in township schools, most teachers lacked the knowledge to use chemicals and apparatus effectively. Thus, science equipment was not being used as it should be in these schools. The underutilisation of science equipment seemed to lead to deficiencies in practical skills and the understanding of science. Thus, scientific knowledge and skills were lacking in learners from black schools. The science curricula of Bantu education therefore lacked the concept of lifelong learning, which made it impossible for students to go beyond matric or to qualify for admission to any higher education institution. This impacted on black workers securing skilled jobs.

According to Bird (1991:7), the science curriculum that black learners were exposed to was narrow and unable to be upgraded, while the science curriculum of white learners included opportunities for multiskilling, competency-based learning, life-long and flexible learning which provided them access to skilled jobs and upward mobility. Mr Senzo Mchunu, MEC for Education in Kwazulu-Natal, according to a report published in the local Xpress newspaper (2012:3), blamed the poor academic results of black pupils in 2011 on Dr Verwoerd when he stated that *"one of the points that we found was a problem was maths and science. In these two subjects we are aiming to pull everyone out of the mind-set that they are difficult subjects, it was Verwoerd who made these subjects difficult, because he thought that blacks would be a threat to him."* From the aforementioned quotation, it can be contended that the state of science education in black schools did not appear to improve significantly over the years because of a lack of qualified teachers in key subjects, particularly the natural sciences and mathematics, as well as the lack of laboratory facilities due to insufficient funding during the apartheid era.

4.3. Transformation in education in South Africa

Prior to 1994, the National Assembly Training and Education Department (NATED) 550 was the curriculum that was used in schools. According to Le Grange (2008:94), this curriculum was conceptually demanding and had a narrow conception of scientific literacy that depicted science as a static body of knowledge. Lederman (2007:833) affirmed that the NATED 550 curriculum was not aligned with basic tenets of the nature of science. For an emerging economy such as South Africa to grow, higher-order intellectual skills needed to be strongly emphasised. Each worker is expected to think critically, solve abstract problems and generate new ideas for improvement (Castells 2005:65). Amongst others, this was one of the main reasons that led to the education system of South Africa being re-structured.

By 1994, the education structure in South Africa had undergone a major redesigning process to dismantle apartheid education. Eighteen racially-divided departments had to be restructured into nine provincial departments with an over-arching national department called the Department of Basic Education to provide coherence of policy and philosophy (Chisholm 2000:92; Harley and Wedekind 2004:33; Jansen 2001a:722). The vision statement of the Department of Basic Education declares that "*our vision is of a South Africa in which all our people will have access to lifelong learning, as well as education and training, which will in turn contribute towards improving the quality of life and building a peaceful, prosperous and democratic South Africa*" (Department of Basic Education 2011:15). It was thus deemed necessary that policy should be in place for transforming the national system of education.

All policies introduced by the Ministry of Education since 1994 have been aimed at transforming the national system of education and training. Soon after the change from apartheid to democratic rule, the post - 1994 Government of National Unity embarked on a transformation agenda in the school system to redress past inequalities which were based on discriminatory principles. The educational transformation in post-apartheid South Africa was meant to instil new values in the school system by replacing oppressive policies with democratic values which would unite the various social groups in society through equity and redress (Chisholm 2000:22). Thus, after 1994, the education system of South Africa needed urgent transformation in order to redress past inequalities. It was for this reason that the government initiated a number of policy instruments during the 1990's to reform the school system in ways that would ensure that both historically advantaged and disadvantaged groups would not be deprived of their right to quality education. A number of policies and legislation emerged from the Constitution regarding education, as follows:

4.3.1 The National Education Policy Act

As part of the transformation of the education system, the National Education Policy Act (NEPA) No. 27 of 1996 (Department of Education 1998b:9) emerged from the Constitution and operates alongside the South African Schools Act (SASA). Through NEPA, a new and a single system of education was introduced in South Africa. The following aims and objectives of NEPA have been used to structure the education system of South Africa (Department of Education 1998b:9):

- **To advance and protect the fundamental rights of all**

  In South Africa, education became a fundamental right for all. To protect this right, parents are now compelled by law to take their children to school, at least in the school-going age which is between age six and sixteen.

- **To achieve equitable education opportunities and redress the past**

  In South Africa, the vision of the Department of Education is to equip learners with the skills, knowledge, values and qualifications needed by them and the country. The aim is that learners would be prepared for the best opportunities in adult life.

- **To provide opportunities for and to encourage lifelong learning**

  Providing opportunities and encouraging lifelong learning is another important aim of NEPA. The aim of NEPA for lifelong learning was that the content and assessment standards in the various subject policies would be designed in such a way that learning would not only be limited to within the walls of the classroom.

- **To achieve an integrated approach to education and training**

  The curriculum is effective in equipping learners for both a career path and higher education. Teachers are, therefore, expected to be well trained and skilled to prepare lessons and assessment plans. Formal and informal activities must be included to help learners gain skills, knowledge, values and qualification as expected by society.

- **To encourage independent and critical thought**

  Learners must be actively involved in their learning. One of the aims of NEPA is to help learners participate in a learning environment that makes them ask questions and not simply be receptive to what their teachers present to them. Teachers are required to use content and relevant assessment activities to encourage independent and critical thinking.

- **To promote a culture of respect for teaching and learning in education**
  Learners are expected to be committed to their education and to not be disruptive to the teaching and learning environment. Infrastructure and learning facilities must also be well looked after. Thus, access to education is a basic right of all learners and it is a right which is laid down in the Bill of Rights. The perspective of the education system is to provide opportunities that will lead to the development of all learners.

It was against this backdrop that curriculum change in post-apartheid South Africa started. Immediately after the elections in 1994, the National Education and Training Forum began a process of syllabus revision and subject rationalisation. From the initial process of introducing the first Outcomes - Based Education (OBE) in South Africa up to the recent strengthening of the Curriculum and Assessment Policy Statement (CAPS) by the Minister of Basic Education (Department of Basic Education 2011: 22), the department hoped that there would be a positive impact made by the curriculum changes from Nated 550 to the current CAPS.

4.3.2 Legislation guiding the transformation of education in South Africa

The Constitution of the Republic of South Africa, Act No. 108 of 1996 aimed at transforming the curriculum and the education system along perspectives and paradigms that would make South African citizens able to participate globally. The Act states that the transformation of education in South Africa must include and instil values such as human dignity; the achievement of equality; advancements of human rights; non-racism; and non-sexism. The Act further clarifies that the democratisation of education encompasses the idea that all stakeholders (which include parents, educators, learners and members of the community) must participate and be included in the activities of schools. In South Africa, the Bill of Rights was introduced as part of the Constitution of the Republic of South Africa. These rights called for a curriculum that protects and enshrines the rights of all South Africans to human dignity, equality and freedom.

4.3.2.1 The South African Schools Act (SASA)

The main objective of the South African Schools Act (SASA) of 1994 (Department of Education 1994:44) is to promote access to a quality schooling system. It ensures that all learners have the right of access to quality education without discrimination and makes schooling compulsory for children aged 7 to 14. It provides for two types of schools – independent schools and public schools. The school funding norms outlined in SASA prioritise redress and target poverty in funding allocations to the public schooling system. One of the principles of SASA is to provide a uniform system for the organisation, governance and funding of schools and to establish a disciplined and purposeful school environment that is dedicated to the maintenance and improvement of quality learning (Department of Education 1994:10). According to SASA (Department of Education 1994:10), this principle would be achieved through several aims. The first aim is infusing the principles of democracy into education by curriculum designers; while the second aim is for policies of the education system to ensure that it is possible for all learners to learn and realise the learning outcomes by attaining the required skills, knowledge, values and qualifications (Department of Basic Education 2011:21). The focus of the third aim is that curriculum changes will take place until all the aims of transforming education in South Africa are met (Department of Education 1994:22). This aim also suggests that parents, communities and other stakeholders in society should be involved in the transformation of the curriculum and the education system.

On the contrary, Jansen (1999:237) observed that curriculum development and formulation was carried out by politicians instead of experts in the education system who have a better understanding of what is applicable and practical pedagogy. He noted that the politician's choice of curriculum received a mixed response because most educators had no idea of how to implement the new curriculum in the classroom as it was merely imposed on the school system. This, according to Harley and Wedekind (2004:45), resulted in a lack of cohesion between policy and practice by undermining policy which is the very instrument of political vision.

4.4 Curriculum change in post-apartheid South Africa

The demise of apartheid in 1994 was heralded by opportunities and responsibilities to reconstruct a fragmented and deeply discriminatory education system while establishing a unified national system underpinned by democracy, equity, redress, transparency and participation. The political thinking in 1994 was to abolish an education system that had been systemically linked with apartheid and to introduce new policies in education (Du Plessis 2009:12). As a result, a number of reforms were introduced at the various levels of the education system. However, instead of making small, fundamental changes, starting with early childhood development and working incrementally through the system, the Minister of Education opted for experimental changes affecting the entire education system.

According to Malada (2010:22), many previous systems had been excellent even though they might have had flaws and room for improvement. However, instead of assessing what was good and building on that, the new approach was to discard tried and tested basic principles of education. According to Jansen (2001b:47), the government carried out curriculum reform in three phases. In the first phase, it merged the different educational departments under one department to unify a previously fragmented system of education management under the Department of Education. In the second phase of the reforms, the government initiated curriculum revision in which racial and sexist, offensive and out-dated content was removed from the syllabi. The final phase of the reforms saw a shift from content - based education to outcomes - based education, with the introduction of continuous assessment in the school system. The result was Outcomes-Based Education (OBE), an approach that had already failed dismally in some First World countries (Jansen 2001b:45).

The two political tensions that shaped curriculum policy reform under the new government was firstly the pressure to remove outdated and offensive content from the syllabi; while the second was the pressure to implement the new educational policies within a short period of time.

4.4.1 The need for curriculum change in a new democratic dispensation

Curriculum during the apartheid era was not dynamic enough to adapt to a changing environment, as the learning material and the lessons did not change. The change from an authoritarian regime to a democratic dispensation required urgent transformation in order to remove historical discrepancies and to promote democratic values in society. The new administration saw the need to use the school system and the curriculum, in particular, to create new social values in society based on equality and respect for different cultures (Harley and Wedekind 2004:35). The aim of a new curriculum in the new democratic dispensation was to create a new South African state that could function in and find a place in the larger world.

The curriculum during the apartheid era was formulated in such a way that it prevented learners, especially Blacks, from acquiring the necessary skills for them to have professional careers. In other words, the curriculum was structured to provide a minimal education for Blacks which could only be used to work in subordinated positions in the workplace. According to Chisholm (2005:84), the ministry of education in the new dispensation wanted to formulate a curriculum which would provide equal access to education, promote skills development and be relevant to the needs of individuals. The curriculum was used to promote the values of a society striving towards social justice, equity and development through the development of creative, critical and problem-solving individuals. According to Spady (2007:68), anti-apartheid activists who advocated for changes in the national curriculum argued that change would bring about human resource development which would have a positive impact on the South African economy.

The process of implementation of the new curriculum in South Africa began in 1997 with OBE in grade one. The introduction of Curriculum 2005 (C2005) in 1997 saw the new curriculum representing a shift to social reconstruction. According to Green and Naidoo (2006:79), C2005 was founded on the principle of Outcomes-Based Education (OBE) by specifying outcomes. Then followed the Revised National Curriculum Statement (RNCS) in grades one to nine and the infusion of the National Curriculum Statement (NCS) in grades ten to twelve and more recently, the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education 2011:12).

4.4.2 Outcomes-based education

The Minister of Education launched C2005 in Cape Town on 24 March 1997 (Department of Education 1997b:12), with implementation in Grade one scheduled for 1998; and Grade seven in 1999. This curriculum was to be thus phased in progressively so that it would cover all sectors of schooling by 2005 (Harley and Wedekind 2004:35).When the new democratic government transformed the school curriculum, it aimed to equip learners with the knowledge, competence and orientations needed for success after they left school or completed their training (Jansen 2001b:41). This led to the introduction of Curriculum 2005 which sought to introduce Outcomes-Based Education (OBE) in all schools in 1997 (Department of Education 1997b:12). The objective of OBE was to "*enable all learners to achieve their maximum ability by encouraging a learner-centred and activity-based approach* *to education*” (Department of Education 2002:24). Educational transformation was a given and the OBE approach was adopted. OBE’s three premises were:

- All students can learn and succeed, but not on the same day in the same way;
- Successful learning promotes even more successful learning; and
- Schools control the conditions that directly affect successful school learning (Department of Education 1994:9)

The curriculum was built on 8 critical outcomes. These were the main set of outcomes that each teacher needed to plan around and were designed by the South African Qualifications Authority (SAQA) (Department of Basic Education 1994:9). These outcomes state that learners should be able to successfully demonstrate their ability to (Department of Education 1994:9):

- Communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation;
- Identify and solve problems by using creative and critical thinking;
- Organize and manage themselves and their activities responsibly and effectively;
- Work effectively with others in a team, group, organization and community;
- Collect, analyze, organize and critically evaluate information;
- Use science and technology effectively and critically, showing responsibility towards the environment and the health of others;
- Understand that the world is a set of related systems, meaning that problem-solving contexts do not exist in isolation; and
- Show awareness of the importance of effective learning strategies, responsible citizenship, cultural sensitivity, education and career opportunities and entrepreneurial abilities.

The aforementioned outcomes are essential to learning and include skills and values such as being able to think; to solve problems; to collect information; to organize information; to analyse information; to work in a group as well as independently; to communicate effectively; and to make responsible decisions. These critical outcomes applied across all learning areas.

4.4.2.1 Biology education under outcomes-based education

The first revision in the Biology curriculum in South Africa occurred immediately after the advent of democracy. This curriculum, known as the Interim Core Syllabus (ICS), was implemented in 1996. Divided into Higher and Standard grades, the (ICS) was a slight modification of the apartheid-era House of Assembly [white] education department biology curriculum (Jansen 1999:8). This biology curriculum followed a highly academic approach and was underpinned by the conservative ideology of Christian National Education and excluded any mention of evolution.

The perceived goals of science education by Rosenthal and Bybee (1987:130) and Fensham (2000:150) can generally be assigned to the following five broad categories: knowledge; skills; applications; attitudes and values; and science as a human enterprise. In light of this view, the Biology curriculum context in OBE positioned itself along the nature of science (NoS) and other themes such as Indigenous Knowledge Systems (IKS). According to Jegede (1994:129), South African curriculum reform efforts have aimed to simultaneously incorporate indigenous knowledge, cultures and norms through the inclusion of IKS, whilst also promoting the evidence-based reasoning that underlies science as a rational epistemic enterprise through NoS frameworks. IKS "*has an implication for sustainable development, capacity building and intellectual development in Africa in the 21st century*" (Emeagwali 2005:1). According to Onwu and Kyle (2011:14), as envisaged through ICS, a relevant science education - particularly one that recognises the wide diversity of knowledge systems through IKS - allows people to make sense of and attach meaning to the world in which they live. Knowledge acquired thus enhances the emancipatory interests of students in a way that enables them to play a responsible role in society.

With the radical restructuring of education according to the outcomes-based principles of Curriculum 2005 (Department of Education 1997b:5), the ICS was replaced by the National Curriculum Statement (NCS) (Department of Education 2003:5) in 2006.

4.4.2.2 Shortcomings of outcomes-based education

There were major shortcomings during the implementation process of OBE because the day-to-day contextual reality of teaching and learning in South Africa varies greatly from school to school due to varying facilities in schools. There was widespread ignorance as the new curriculum moved away from crucial basics like reading to a learner-centred approach, with the result that most learners at university level have now been found to encounter difficulties with reading and understanding of content at a level that would reasonably be expected of a university scholar (Malada 2010:22). While some educationists saw the introduction of the different education systems as progressive, Jansen (1998:323) and Chisholm (2000:16) consistently argued that the curriculum of the department was confusing and unlikely to succeed in South African schools.

Even in America where OBE originated, it was not successful. Jansen (1999: 237) identified major reasons why OBE had a negative impact upon South African schools as follows:

- **The language was too complex, confusing and at times contradictory**

  A teacher attempting to make sense of OBE will not only have to come to terms with many different concepts and labels but also keep track of the changes in meaning and priorities afforded to these different labels over time. For example, to understand the concept of "outcomes" required an understanding of terms like competencies, unit standards, articulation, bands, levels, phases and curriculum frameworks.

- **OBE was based on flawed assumptions**

  The claims that transformational OBE is a collaborative, flexible, transdisciplinary, outcomes-based, open-system, empowerment-oriented approach to learning suggests that highly qualified teachers exist to make sense of such a challenge. The education system was based on flawed assumptions about what happens inside schools, how classrooms are organised and what kinds of teachers exist within the system. Large class sizes made group work, as prescribed by OBE, impossible in many township schools and many teachers lacked the capacity to use a collaborative teaching style.

- **The management of OBE increased the administrative burdens placed on teachers**

  Teachers had less time to teach since the focus was on assessing as the number of tasks multiplied significantly. To manage this, teachers were required to reorganise the curriculum; increase the amount of time allocated to monitoring individual student progress against outcomes; administer appropriate forms of assessment; and maintain comprehensive records.

- **OBE trivialised curriculum content**

  Curriculum content is a critical vehicle for giving meaning to a particular set of outcomes. A fixation with outcomes in OBE could easily lead to serious losses with respect to building a multicultural curriculum. The proponents of OBE further assumed that knowledge acquisition proceeds in a linear way such that one outcome is linked in a stepwise direction to another. This was one of the most common criticisms made of OBE and was ignored in the move towards implementation (Holland 1994:4).

- **Re-engineering of the education system was required**

  For OBE to succeed, it required trained and retrained teachers; new forms of assessment (such as performance assessment or competency-based assessment); classroom organisation which facilitates monitoring and assessment; constant monitoring and evaluation of the implementation process; retrained education managers or principals to secure implementation as required; parental support and involvement; as well as new forms of learning resources (textbooks and other aides). However, there was neither the fiscal base nor the will by proponents of OBE to intervene in the education system at that level.

What failed to capture the newly-elected government's attention was the fact that the countries in which outcomes-based education programmes operated were First World countries with very broad tax bases; very favourable teacher-learner ratios; a high degree of professional education of teachers; well-resourced classrooms; and critical-thinking teachers (MacDonald 1999:232). Although education during the pre-1994 dispensation had its own problems, educators perceived the OBE approach as being so much more problematic that it had to be revised. In 2002 the National Curriculum Statement (NCS) was implemented at the lower grades (Grades R–9). The intention was to introduce this curriculum for Grade 10 learners in 2003, for Grade 11 learners in 2004 and for Grade 12 learners in 2005 but, according to Velupillai, Harding and Engelbrecht (2008:65), the curricula for these grades were not developed in time for implementation.

4.4.3 National Curriculum Statement

In 2006, the National Curriculum Statement (NCS) was implemented at the Grade 10–12 levels, which is the Further Education and Training (FET) phase (Department of Education 2003:22). The NCS was still seen as an outcomes-based system based on a learner-centred pedagogy. The National Curriculum Statement Grades 10 – 12 aimed to develop a high level of knowledge and skills in learners The National Curriculum Statement specifies the minimum standards of knowledge and skills to be achieved at each grade and sets objectives in all subjects (Department of Education 2003:32). The NCS for Life Sciences focused on the development of skills, construction of knowledge and the relationship between science, society and the environment (Department of Education 2003:5).

The aim of NCS was that teachers would be trained and developed to ensure that they would be able to make an impact in terms of the implementation of the principles of the NCS in order to teach learners to become critical thinkers. The problem, as emphasised by Van Deventer (2009:127), was the fact that schools did not have qualified teachers to teach. Rogan and Grayson (2003:1173), as well as Rogan (2004:168), identified the problem that too often the energies and attention of politicians and policy-makers are focused on the "what" of desired educational change, neglecting the "how". The NCS Grades 10-12 curriculum was developed with the aim of giving expression to the values of democracy, human rights, social justice, equity, non-racism, non-sexism and ubuntu. According to the Department of Education Policy Framework (Department of Education 2003:2), the NCS was based on the following principles:

- Social transformation;
- Outcomes-based education;
- Integration and applied competence;
- Progression;
- Articulation and portability;
- Human rights, inclusivity, environmental and social justice;
- Valuing indigenous knowledge systems; and
- Credibility, equality and efficiency.

The NCS built its Learning Outcomes for Grades 10-12 on the Critical and Developmental Outcomes that were guided by the Constitution (Department of Education 2003:3). The Critical Outcomes required learners to be able to do the following as outlined by the Department of Education (2003:3):

- identify and solve problems and make decisions using critical and creative thinking;

- work effectively with others as members of a team, group, organization and community;
- organize and manage themselves and their activities responsibly and effectively;
- collect, analyze, organize and critically evaluate information;
- communicate effectively using visual, symbolic and or language skills in various modes;
- use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation.

The Developmental Outcomes required learners to be able to:

- reflect on and explore a variety of strategies to learn more effectively;
- participate as responsible citizens in the life of local, national and global communities;
- be culturally and aesthetically sensitive across a range of social contexts;
- explore education and career opportunities; and
- develop entrepreneurial opportunities. (Department of Education 2003:3)

In addition to the above, learners emerging from the FET band must have access to, and succeed in, lifelong education and training of good quality; demonstrate an ability to think logically and analytically, as well as holistically and laterally; and be able to transfer skills from familiar to unfamiliar situations.

4.4.3.1 Life Sciences education under the National Curriculum Statement

In 2006, when the National Curriculum Statement (NCS) for Grades 10–12 was implemented the name changed from Biology to Life Sciences (Department of Education 2003:22). The Biology syllabus, according to Le Grange (2008:94), required students to "*learn chunks of biological facts that they had to regurgitate in tests and examinations*". Furthermore, Le Grange (2008:94) maintained that the school subject Biology focused mainly on the study of plant and animal life, with the artificial separation of fact and value. The content knowledge areas included:

- Tissues, cells and molecular studies;
- Structures and control of processes in basic life systems;

- Environmental studies; and
- Diversity, change and continuity.

Several Botany, Zoology and/or human Biology related themes or topics were grouped under each content area (Department of Education 2003:15). The findings of Johnson, Dempster and Hugo (2011:41) provided evidence that there had been an improvement in the re-contextualisation of Life Sciences as a hierarchical knowledge structure in the Life Sciences curricula implemented since 1995. Basic Education Minister Pandor (Department of Basic Education 2009:2), described the newly implemented Life Sciences curricula as "*modern and up to date and it starts our children on the road to understanding new scientific knowledge*". The goal of many of the changes in Life Sciences education in South Africa is to present a curriculum that will help prepare learners for lifelong learning and provide equal opportunities for all learners.

4.4.3.2 Shortcomings of the National Curriculum Statement

With the new NCS curriculum there was a shift from an emphasis on learning content to specific outcomes and from the memorisation (rote learning) of facts to the demonstration of outcomes (Spady and Marshall 1991:68). A number of problems presented themselves namely:

- **Teachers were not well trained**

  According to Johnson, Dempster and Hugo (2011:42), "*the majority of teachers do not seem to have received training and support thoroughly*". Without the appropriate training of teachers, the NCS could not make the required positive impact in terms of the construction of skills, knowledge and values in line with the implementation of the principles of the NCS. Without proper teacher training, teachers are likely to be caught up in the excessive use of integration in the lessons, which could cause confusion and undermine the attainment of learner outcomes (Brophy and Alleman 1991:156). Thus, without adequate training, teachers were not able to perform mediation in the classroom.
- **Shortage of resources as well as lack of support from government**

  Schools needed financial support from government in order to implement the new curriculum effectively. The implementation of the NCS without adequate resources posed a serious challenge (Green 2001:129). The diversity of schools in South Africa is vast. There are some schools that have excellent infrastructure and educational programmes. In contrast, there are those schools that occupy dilapidated buildings lacking doors and windows, electricity and sanitation. According to Davidoff and Lazarus (1997:4), the cognitive and social construction of knowledge is made even more difficult because many schools are still overcrowded and operate without the required equipment and sporting facilities, as the majority of schools in South Africa are either still under-resourced or dilapidated or both.

- **Managers were not well trained to manage the transition to the new curriculum**

  The principal is expected to have instructional leadership skills for the effective management and implementation of the NCS. According to Hoy and Miskel (2008:40), this transformation was not properly managed in many schools. Therefore, educators faced challenges in implementing the NCS. As pointed out by Briggs and Sommefeldt (2002:106), many leaders failed to embrace the change and handle it properly which affected educators negatively. The proper implementation of the NCS by educators required effective monitoring by principals to determine successes and also to determine deficiencies and challenges which educators encountered. However, from the observation of the researcher as an educator, this was lacking in many schools.

- **Educators were expected to select appropriate learning content and develop a curriculum**

  It can be contended that the NCS focused too much on the outcomes and neglected issues of content, which was left to individual teachers to construct. The teacher decided on the appropriate content to use to develop concepts specific to NoS and IKS. However, given the poor training of teachers and the lack of resources coupled with the impact of apartheid on the education system, the majority of teachers found it difficult to know what to teach. This posed a serious challenge in that there was great disparity in the knowledge acquired in Life Sciences by learners in different schools. The reality that some teachers did not have the skills, the resources or the time to develop learning content was ignored. Curriculum development is a specialised activity and there is a need to inform educators about what they should be teaching in each learning programme in each grade. De Clercq (1997:140) argues that for instruction to be effective, the teacher must know more than the learner; must have adequate content knowledge; and must know the conceptual destination of the learning. The cognitive aspect of schooling had been lost through too much emphasis on outcomes in the NCS.

The new curriculum was chosen to improve the quality of South African Education. It was hoped that doors might be opened for learners whose academic or career paths had previously been blocked by providing a curriculum more relevant to learner's needs. The process of change which was introduced by policy makers created an enormous burden for teacher implementers, who discovered that their skills and knowledge no longer matched the new demands of the changed curriculum (Chisholm 2000:4). The NCS represented a paradigm shift from content-based teaching and learning to an outcomes-based one for which they were not adequately prepared. The reality was that there were some major problems with the implementation process of the NCS in South Africa, of which the inadequate training of teachers and the lack of financial resources to train teachers efficiently and effectively were the most important.

4.4.4 Shortcomings of the Life Sciences curriculum under Outcomes-Based Education and the National Curriculum Statement

Some schools in South Africa do not have well-trained science educators, nor do they have resources or laboratories. Also, educator to learner ratios in a class is often so high that the educator only conducts practical demonstrations, where possible, in science. This argument is further supported by Onwu and Kyle (2011:16) in that most schools have many teachers who often have little experience, meagre training and are operating in under-resourced, large classes. In 2001, the mathematics and science audit revealed that more than 50% of mathematics and 68% of science teachers have had no formal subject training. In 2005, it was reported that only 50% of maths educators had specialised in mathematics and 42% of them were qualified in science (Mji and Mbinda 2005:240). Despite these constraints, teachers were expected to implement a very complicated curriculum.

Dissatisfaction with the under-specification of the content to be taught in Life Sciences in the NCS led to its rewriting in 2009 as the New Content Framework (NCF). The NCF, which was due for implementation in 2010, provided more detail of the content to be covered (Johnson, Dempster and Hugo 2011:235). It was extremely daunting for the educator of Life Sciences as during this period there were two different curricula, namely Version 1 and

Version 2 within the FET band. The second version retained the knowledge areas and Learning Outcomes but substantially altered the structure and focus of the content material and provided more detail of the content (Johnson, Dempster and Hugo 2011:235). An educator who taught Life Sciences in Grades 10, 11 and 12 in 2010 had to implement Version 2 in Grade 10 while Version 1 had to be implemented in Grades 11 and 12. This posed challenges for educators in that they did not have sufficient resources and were not adequately trained (Bantwini 2009:169). It could therefore be contended that educators felt frustrated and many of them would have resorted to teaching the concepts that they felt were correct. Version 2 was then incrementally introduced to Grades 11 and 12 over the years 2011 and 2012. However in 2012, while implementing Version 2 of the NCS Life Sciences curriculum in Grade 12, the Life Sciences curriculum changed again in Grade 10. This continual change of the curriculum within this period resulted in a great deal of uncertainty amongst Life Sciences educators.

Policy research shows that it does not work to rush the implementation of curriculum reform and the reason offered was that the "*politics*" of education reform wins over the "*pedagogy*" of reform (Bertram 2011:426). Each curriculum change meant changes in the content to be taught, methods of teaching and assessment practices. However, problems persisted and Minister Angie Motshekga announced a new curriculum improvement process on 6 July 2010. Once again, radical changes were planned for the period 2012-2014 (Maluleka 2011:134). This revision was intended to strengthen the National Curriculum Statement in order to improve the quality of teaching and learning in schools. In 2011, a new document, the Curriculum and Assessment Policy Statement (CAPS), was produced for implementation in 2012 (Department of Basic Education 2011:2).

4.4.5 Curriculum Assessment Policy Statement

According to the Department of Basic Education (2011:2), the Curriculum and Assessment Policy Statement is not a new curriculum but an amendment to the National Curriculum Statement (NCS). It therefore still follows the same process and procedure as the NCS Grades R–12 (2002) (Department of Basic Education 2011:2). The amendments were made to address four main concerns about the NCS as identified by a task team and reported to the Minister of Education in October 2009 (Department of Basic Education 2009:5). According to Johnson, Dempster and Hugo (2011:32), the four concerns were: complaints about the implementation of the NCS; teachers were overburdened with administration; different interpretations of the curriculum requirements; and the underperformance of learners.

According to CAPS (Department of Basic Education 2011:12), the development of a new curriculum for school was necessary due to global changes and the demands of the 21st Century where learners need to be exposed to different levels of skills and knowledge because South Africa has new values and principles that need to be reflected in the curricula of schools. According to the CAPS document (Department of Basic Education 2011:11), one of the purposes of the curriculum is equipping learners- irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment and meaningful participation in society as citizens of a free country.

4.4.5.1 Life Sciences education under the Curriculum Assessment Policy Statement

Knowledge production in science is an on-going endeavour and, as with all knowledge, scientific knowledge changes over time as scientists improve their knowledge and understanding and as people change their views of the world around them. The expectation is that by studying and learning Life Sciences, learners will be able to develop (Department of Basic Education 2011:8):

- their knowledge of key biological concepts, processes, systems and theories;
- an ability to critically evaluate and debate scientific issues and processes;
- greater awareness of the ways in which biotechnology and knowledge of Life Sciences have benefited humankind;
- an understanding of the ways in which humans have impacted negatively on the environment and organisms living in it;
- a deep appreciation of the unique diversity of past and present biomes in Southern Africa and the importance of conservation;
- an awareness of what it means to be a responsible citizen in terms of the environment and life-style choices that they make;
- an awareness of South African scientists' contributions;
- scientific skills and ways of thinking scientifically that enable them to see the flaws in pseudo-science in popular media; and

- a level of academic and scientific literacy that enables them to read, talk about, write and think about biological processes, concepts and investigations. .

The Life Sciences content framework is organised according to four knowledge areas called strands (Department of Basic Education 2011:9). Knowledge strands are expected to be developed progressively over the three years of the Further Education and Training band. These knowledge strands are:

- Knowledge Strand 1: Life at the Molecular, Cellular and Tissue Level;
- Knowledge Strand 2: Life Processes in Plants and Animals;
- Knowledge Strand 3: Environmental Studies; and
- Knowledge Strand 4: Diversity, Change and Continuity.

The purpose of studying Life Sciences under CAPS is to develop scientific knowledge and understanding, science process skills and understanding of science's roles in society (Department of Basic Education 2011:9). There are three broad subject-specific aims in Life Sciences which relate to the purposes of learning science. These are (Department of Basic Education 2011:9):

- Specific Aim 1: relates to knowing the subject content (theory);
- Specific Aim 2: relates to doing science or practical work and investigations; and
- Specific Aim 3: relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science.

The third aim of Life Sciences, according to the CAPS document (Department of Basic Education 2011:11), is to enable learners to understand that school science can be relevant to their lives outside of the school and that it enriches their lives. This could therefore be considered to be the intended curriculum. However, the implemented curriculum in Life Sciences is examination oriented as the learners' passing an examination depends to a very large extent on their knowledge of the content. Black and Atkin (1996:15) have commented that education goals for Science are changing and the result is a conception that draws attention to the actual and everyday connections between scientific knowledge on the one hand and human needs on the other. The implication of the ideals of CAPS is that teachers would be trained and developed to ensure that they would be able to make an impact in terms of the implementation of principles of the CAPS in order to teach learners to become critical thinkers. While the basic philosophy and content of the curriculum remained unchanged, the fundamental principles of outcomes-based teaching and assessment were eliminated. Since CAPS intends to have a positive impact on the education of the learners by promoting learner participation, it therefore became more content-based and inclined towards traditional school science.

The CAPS document (Department of Basic Education 2011:13) provides a rating scale (represented in Figure 4.1) which measures individual learners' attainment of knowledge (content, concepts and skills).

Figure 4.1 Codes and percentages for reporting in Grades R-12

RATING CODE	COMPETENCEY	PERCENTAGE
7	Outstanding achievement	80-100
6	Meritorious achievement	70-79
5	Substantial achievement	60-69
4	Adequate achievement	50-59
3	Moderate achievement	40-49
2	Elementary achievement	30-39
1	Not achieved	0-29

Source: Department of Education (2011)

The many criticisms levelled that students are qualifying for university entrance but the schooling system was not preparing them at the right level has reference. A number of academics have raised concerns about the pass mark requirements set for the National Senior Certificate (NSC) qualification. According to Essack, Wedekind and Naidoo (2012:475), Jonathan Jansen and Mamphele Ramphela are among the many who suggested that the 30% pass requirement in most subjects was too low and that this entrenched mediocrity in the system. Jansen, speaking at the Umalusi Conference in 2012, went on to propose that the pass mark be raised to 50% (Essack, Wedekind and Naidoo 2012:475). This call has been repeatedly echoed and often justified on the basis that this is the level required at university.

In South Africa, the National Senior Certificate (NSC) is a qualification that is the main exit point from the schooling system, which serves multiple audiences and multiple purposes. A small proportion of school leavers enter into degree-level programmes. The majority of school leavers either enter into vocationally-oriented certificate and diploma programmes at public and private colleges, or universities of technology, or they enter directly into the labour market. Thus, as denoted in Figure 4.1, the certificate indicates the competencies of the recipients to a range of higher education providers as well as to employers and the general public. There is a perception that the pass mark of 30% is too low, either because it indicates that learners have only mastered 30% of the material or that low minimum pass marks set low expectations.

4.4.5.2 Shortcomings of the Curriculum Assessment Policy Statement

If CAPS were to make the required positive impact in terms of the construction of skills, knowledge and values in line with the implementation of its principles, appropriate training of teachers and school management teams is crucial. According to Johnson, Dempster and Hugo (2015:110) the majority of teachers have not received thorough training and support. Without proper teacher training, teachers are likely to be caught up in the excessive use of integration of NCS and CAPS in the lessons, which could cause confusion and undermine the attainment of learner outcomes. Notwithstanding the apparent problem, the integration and implementation of the principles of CAPS at schools remains critical. For the successful implementation of CAPS and its principles, all relevant stakeholders in education must be cooperating partners both in the social and cognitive construction and development of the curriculum. One could allude that teachers are not able to assimilate innovation and change in the education system if they do not share in the meaning of such innovation and change.

Lovemore (2012:1) stated that the Department of Basic Education started the roll-out of a new South African schools' curriculum in January 2012, even though quality assurance on the curriculum was not completed by Umalusi - the statutory body tasked with monitoring standards for education. It was also revealed that the Department of Basic Education had ignored Umalusi's request to delay the roll-out of the new Curriculum and Assessment Policy Statements (CAPS) until quality assurance had been completed, stating that forcing a new curriculum on children without the appropriate quality assurance is irresponsible (Lovemore 2012:1). One could therefore infer that a curriculum borne out of much controversy is deemed to fail. Educators of grade 12 Life Sciences do not have the time to analyse and question the curriculum, since the grade 12 year is exam driven. The ultimate aim of the educator is to cover the vast content of the Life Sciences curriculum on time to enable learners to sit for their exit examination. It is through research studies like this and others that the quality of the curriculum could be interrogated in order to identify various flaws in the system. Despite the fact that this study might not result in any significant change in the Life Sciences curriculum, it may contribute to a body of knowledge which would be available for perusal by any official of the DOE.

4.5 Comparative analysis of the Life Sciences curricula under OBE, NCS and CAPS

The development of new curricula is a common event in countries across the globe. In many cases, these curricula are well-designed and the aims they are intended to achieve are laudable. However, all too often the attention and energies of policymakers and politicians are focused on the 'what' of desired educational change, thereby neglecting the 'how'. Porter (1980:75), speaking about the role of the national government in educational change in the USA and Australia, stated that "*the people concerned with creating policy and enacting the relevant legislation seldom look down the track to the implementation stage"*. As a result, a great deal of time, money and effort may be wasted, as good ideas are never translated into classroom reality.

In the same vein, Jansen (1998:323) maintained that the language of innovation associated with outcomes-based education was too complex, confusing and at times contradictory. On the contrary, the language in the NCS had been simplified and its design features reduced so that educators could understand it better and give it meaning through their classroom practice. Jansen (1998:328) was of the opinion that outcomes-based education trivialized curriculum content. In addition, Kraak (1998:49) criticised OBE for its disregard of the centrality of the curriculum and the need for professionally trained and motivated teachers. Thus, in the NCS, curriculum content was regarded as a critical vehicle for giving meaning to a particular set of outcomes.

The adoption of OBE shifted the emphasis of learning and teaching away from rote learning to concrete educational results called outcomes (Jacob, Vakalisa and Gawe 2004:2). Furthermore, the roles of teachers as transmitters of knowledge changed to facilitators, to help learners achieve the desired goals, and classroom activities mainly focused on learner-centred approach (Chisholm, 2005:91). During the adoption of OBE in South Africa, science teaching and learning approaches were changed and the adoption of a constructivist's point of view was encouraged. This highlighted the impact of learners' preconceptions on the process of developing new knowledge and the need for an instructional strategy that encouraged active conceptual change rather than the passive transmission of knowledge (Yip 2001:755). According to Le Grange (2008:92) this curriculum in Life Sciences was little more than a slight modification of the apartheid-era House of Assembly (white) education department biology curriculum, which followed a highly academic approach underpinned by the conservative ideology of Christian National Education excluding any mention of evolution.

Many NCS topics in grades 10, 11 and 12 lend themselves to adaptation in different teaching and learning contexts. Other topics (e.g. evolution and reproduction) need to be taught with great sensitivity on the part of teachers. Studies done locally indicate that some of the learners and teachers who have deeply entrenched religious beliefs find it hard to accept evolution (Chinsamy and Plaganyi 2007:249; Sanders 2010:45). The distribution of difficult (and less interesting) topics across Grades 10, 11 and 12 was uneven. In NCS, in terms of difficulty, the Grade 10 curriculum themes were the most difficult, followed by the Grade 12 and then the Grade 11 curricula. However, Umalusi (2009:12) reported that the volume of content decreased across Grades 10, 11 and 12 in the NCS Life Sciences curricula.

In South Africa, under the NCS, teachers were only guided by learning objectives in addressing IKS. The challenge was in teacher ability to find and adapt materials and resources to address the outcomes for IKS. Where educators failed to obtain suitable resources, this aspect was neglected. This is one of the arguments against a curriculum that specifies outcomes and leaves it up to the teacher to decide on how to use the specified content to develop those skills in learners. Considering the socio-political history of IKS in South Africa, there was a likelihood of particular issues being sensitive for discussion and teachers might have needed support in coordinating the tensions and conflicting goals embedded in IKS (Ogunniyi 2011:965). For instance, on the one hand, IKS will have at its core the goal of promoting inclusive education by capitalising on the cultural African practices and norms that have been side-lined historically in South Africa (Ntuli 2002:55). On the other hand, some of these practices and norms (e.g. explanations for particular natural phenomena like thunderstorms and disease) might be directly at odds with the scientific worldview.

A reading of the CAPS for Life Sciences curriculum has revealed that, while much of the NCS was retained, some key topics have been eliminated, thus compromising the overall integrity of the document. The NCS was constructed with vertical development of topics as a core. However, this has been somewhat diluted in the CAPS, especially in the section on evolution. For example, Grade 10 exposes learners to the fossil record and biogeography; Grade 11 has a gap in establishing the evidence on which evolution is based; and Grade 12 presents evolution by natural selection (Department of Basic Education 2011:5). Even though the skills included in the curriculum are achievable, many activities in the "*Investigations"* column of CAPS do not state who (i.e. teacher or learner) should do the activity (Department of Basic Education 2011:15). The non-availability of equipment at most South African schools severely limits the types of investigations that can be undertaken. CAPS has reduced content, compared with the NCS but has added more practical investigations, with a practical examination as a requirement in Grades 10 and 11.

With respect to lifelong learning, integration with learners' everyday life and world of work is mentioned in a few places in both curricula but to a lesser extent in the CAPS. Examples are provided in Figure 4.2.

Figure 4.2 Integration between Life Sciences and everyday knowledge in grade 10

	NCS	CAPS
Example 1	Link nutrient cycle and forestry to current environmental issues	Integration with world of work: - -Ecotourism - Fossil tourism
Example 2	Link environmental lobbying and the importance of evidence is discussed using the case study of St Lucia	
Example 3	Integration with world of work: • Fossil tourism as a source of income and employment • Careers in biotechnology • Ecotourism	

Source: Adapted from Umalusi (2014)

There are no explicit connections that are made to everyday knowledge and experience (Department of Basic Education 2011:26). As observed in Figure 4.2, there was greater integration between everyday knowledge in the NCS, whereas CAPS contains very few examples of integration as represented in Figure 4.2. Indigenous knowledge is identified in both curricula as important to acknowledge and incorporate into the subject, but the content provides very few opportunities to do so. In keeping with this view, Mnguni's (2013:4) findings led him to conclude that CAPS for Life Sciences would serve to advance the discipline but not empower students in relation to current social challenges.

Both the NCS Version2 and CAPS were written and published in a relatively short timeframe, with the result that errors, omissions and lack of clarity were still present when the documents were published. The rapid succession of curriculum change since 2006 has had a detrimental effect on Life Sciences teachers, who were confused about which curriculum was current in each Grade. Both curricula provide very little guidance with regard to pedagogy. Although both the NCS Version2 and CAPS allow for teachers to deviate from the prescribed sequencing and pacing, the centralisation of assessment inhibits teachers from exercising this freedom.

4.6 Quality assurers in South Africa

Education systems have always had some kinds of checks and balances put in place to keep track of quality or standards in education institutions and systems, and to try to improve them. The emergence of quality as a key issue in education has led to the development of legitimised policies that are handed down from politicians, policy-makers, administrators and heads of institutions to teachers, learning support staff and learners. In a short space of time, a quality industry had become more prevalent in the South African education system, creating an ever increasing bureaucratic load on those responsible for the actual delivery of education and training. There are two quality assurance organisations which operate directly under the Minister of Education. The first is Umalusi, which monitors quality in general and the second, the Department of Basic Education.

4.6.1 Umalusi

Umalusi a statutory organisation is the Council for Quality Assurance in General and Further Education and Training. It uses both traditional methods of monitoring quality in education and more modern quality assurance methods. It is responsible to the Minister of Education. Umalusi was created to monitor and improve the quality of general and further education and training in South Africa. According to Allais, King, Bowie and Marock (2007:5), this is done in three main ways:

- It monitors and moderates the achievements of students, primarily through external examinations. On the basis of this it issues certificates to students;
- It evaluates whether providers of education and training have the capacity to deliver and assess qualifications and learning programmes. This is done through an accreditation system, whereby educational institutions have to meet criteria stipulated by Umalusi. Umalusi also accredits assessment bodies, which then set the external examinations that are used to evaluate students; and
- It evaluates the quality of qualifications. This means looking at the curricula which belong to different qualifications, as well as the rules for how many subjects must be passed and at what level in order to obtain a qualification.

Umalusi mainly focuses on the end point of formal schooling – the National Senior Certificate examination, which learners write at the end of Grade 12. According to Allais, King, Bowie and Marock (2007:5), Umalusi is not directly involved in setting exams. Instead, it checks the quality of exams that assessment bodies are responsible for. It works with two main assessment bodies – the Department of Education and the Independent Examinations Board. Umalusi arranges for subject experts to look at the exam question papers and check that they are of the right standard. Umalusi (2011:24) also monitors that exams are administered appropriately; that marking is organised properly and is of the right standard; and that the marks which students obtain are of a similar standard to those in previous years. It looks at a small sample of assessments that have been done at schools (or colleges and adult education centres), and checks that these were of an appropriate standard.

Umalusi undertook a project in 2013 to establish the quality of the Curriculum and Assessment Policy Statement (CAPS). This research was conducted to develop an understanding of the strengths and weaknesses of the subject curricula. With regards to Life Sciences, it was found that fewer than 5% of South African schools have equipped functional laboratories. It raised the concern that CAPS is unlikely to be able to be fully implemented in the vast majority of South African schools, given the specialised nature of the equipment required for the prescribed classroom activities in CAPS (Dempster, Khoboli, Kunene, Lindegger, Matumba and Whyte 2013:10). In respect of lifelong learning, Umalusi noted that the level of integration between Life Sciences and the everyday (general) knowledge of learners at their stage of development and in their contexts was very limited. It was further affirmed in the report that where the sentence in the NCS Life Sciences was elaborated as *"the history of some scientific discoveries, the nature of science, how indigenous knowledge relates to living systems"* and also mentions applications of life sciences in industry, careers, and in everyday life, in CAPS it reads that *"one of the differences between modern science...and traditional, indigenous knowledge systems is that they have their origins in different world views"* (Dempster, Khoboli, Kunene, Lindegger, Matumba and Whyte 2013:24). This emphasises that while IKS is still incorporated in CAPS Life Sciences, the focus on it has been greatly reduced. Thus, it was found by Umalusi that lifelong learning appears to have very little significance in the Life Sciences policy document.

4.6.2 Department of Basic Education

Responsibility for monitoring the quality of schools rests with the Department of Basic Education. The core role function of the Department of Education is to deliver quality education in all institutions. To realise this objective, proper planning, implementation, monitoring, evaluation and reporting are key to the DOE. The DOE has implemented the aforementioned activities so that quality teaching and learning takes place and all students ultimately become productive members in society (Department of Basic Education 2011:2).

The system currently being implemented is called the Integrated Quality Management System (IQMS). It attempts to incorporate the evaluation of schools, the monitoring of teacher performance and a system for supporting teachers in their work. However, according to Baijnath, Maimela and Singh (2001:33), the Department of Education had publicly announced that it is considering returning to an independent inspectorate system instead. The Department of Education also organises systemic evaluations (tests of samples of students) at the lower levels of the school system, to establish the number of children in primary schools that were learning. These tests looked at numeracy and literacy levels. To ensure standardisation at school exit level, the DOE sets the final examination which all students attending public schools in South Africa write. However, there is no other known mechanism that the DOE uses to determine the quality of the curricula. It can therefore be noted that if a curriculum is lacking in certain important aspects, the DOE might not be aware of these shortcomings.

4.6.2.1 Challenges facing the Department of Basic Education in the realm of quality assurance

It is crucial for the DOE to improve the quality of education in all schools. This is a daunting task as many schools are deprived of resources, facilities and qualified teachers. The current challenge is to prepare young people for the world of work more effectively. According to Cassim (2006:7), the first priority in the development of skills should be the education of Mathematics and Science (MS) in schools.

Fleisch (2008:1) describes the South African education system as essentially two "systems". The well-functioning system which is well resourced serves middle class children of all race groups and performs at a level similar to that of middle class children around the world. The vast majority of university entrants are produced by this well-functioning system. The much larger second system includes poorer children who are further disadvantaged through attending schools with dysfunctional management and classroom practices. Children in this system have low functioning in reading and writing and can perform only simple numerical operations (Fleisch, 2008: 2). According to a report (Department of Basic Education 2009:28) this dualistic pattern in one sense is a failure of the education system to meet the country's development needs.

The majority of South Africa's poor, who need the school system to provide a pathway out of poverty, typically receive a low quality education. This ensures that existing patterns of poverty and inequality are reproduced in subsequent generations. The dualistic school system also presents a challenge to policy makers. For example, a more basic curriculum may be appropriate in schools where children lack a strong foundation in literacy, but this will be at odds with the aspirations held by those developing the curriculum and the general public. In this vein, Banerjee and Duflo (2011:22) argue that unrealistic expectations are contained in developing country curriculums. With regards to the Life Sciences curriculum in South Africa, a similar challenge exists between the desire to follow a curriculum that is relevant to local cultures, languages and systems of knowledge but which, at the same time, also prepares the population for the labour market and for the global economy. However, it is imperative for curriculum developers of Life Sciences to include these elements in the curriculum if the curriculum is to prepare learners for lifelong learning.

4.7 Lifelong learning

The new South Africa has formally embraced the concept of lifelong learning in its education and training policies. Many of the mission statements of South African educational institutions refer to the importance of developing lifelong learners. Constant changes in all spheres of life deem it necessary for everyone to become lifelong learners in order to be competitive globally. Lifelong learning offers a holistic perspective on the role of education in a person’s life cycle. Lifelong learning, embracing all forms of educational and learning experiences, helps individuals to engage in purposeful interactions with their environment through the development of their knowledge, skills and critical thinking abilities.The vision of lifelong learning in the context of Life Sciences is that the curriculum and learning programmes should empower learners to become competent citizens who reflect knowledge, skills, attitudes and values, which are necessary to set in motion and sustain a culture of lifelong learning. Thus, lifelong learning should be at the core of the Life Sciences curriculum.

4.7.1 The need for the development of lifelong learning in a South African context

In South Africa, the concept of lifelong learning had been developed as one of the components of a reconstructed education system capable of meeting both equity and development needs. Globalisation and migration of people from one place to another has resulted in the demand for new sets of skills and competencies. This is because the skills acquired a decade ago may be unsuitable to meet the work challenges of the present age. According to Faulds (2001:20), the South African education policy has implemented a process of recognition of prior learning as a tool to bridge the gap between formal and informal education. Belanger (1994:354) argued that lifelong learning is not a norm to prescribe but an empirical reality to analyse and reconstruct. Thus, lifelong learning inevitably exists in all societies in different forms as people move through the different stages of life. Hence, taking into consideration the prior knowledge of learners and not ignoring the societal knowledge that exists contributes to and fosters lifelong learning in a curriculum.

In 1999, a report commissioned by the National Department of Education adopted a rigorous attitude to lifelong learning. According to Walters and Watters (1999:7), the very nature of lifelong learning was broad and cross-sectoral – it included formal education, non-formal education, community education and workplace based learning. However the report revealed two main conceptions. The one was a broad conceptual framework that had a comprehensive understanding of educational priorities. The other conception was of lifelong learning as mainly about ensuring equity of access and provision. Walters and Watters (1999:224) argued that "as *with many countries, we in South Africa are at an early stage in the development of a comprehensive approach to lifelong learning. We have made a start through the production and adoption of various policy documents and the construction of various, necessary component parts of a lifelong learning system."* However, a more vigorous critical dialogue and pedagogical debate is needed in this regard. Above all, more intervention is urgently needed to empower the more disadvantaged education communities in developing lifelong learning skills. Indeed, policies are crucial in setting up a new terrain to enhance a more equitable and effective education system that incorporates lifelong learning.

The argument for a lifelong learning system in South Africa, which is reflected in the education legislation, is made in terms of the following imperatives: firstly, to redress the apartheid past; secondly, to strive for social equity; and thirdly, to achieve economic competitiveness (Walters and Watters 1999:7). Walters and Watters (1999:7) further proclaim that for lifelong learning to deepen for more than a small group of well-educated, mainly urban people, the learning environments of all the people will have to be improved. Thus, preparing people for lifelong learning is a way to ensure that they will be able to cope with whatever changes they will experience. The position of government on lifelong learning is quite clear. Government legislation and policy like the White Paper, Curriculum 2005: Name the Lifelong Learning for the 21st Century, Education White Paper: Special needs education: building an inclusive education and training system agree that lifelong learning is the route to follow in order to improve the economy and life style of South African citizens.

4.7.2 Governance and the legal framework of lifelong learning

Lifelong learning was rapidly adopted in government documents and was most visible in a number of education white papers and policy documents. These papers were important in that they laid down the policy foundations for a supposed massive shift away from the past apartheid education system as well as towards the global environment into which South Africa was to be readmitted. Clearly, for lifelong learning to have any substantive impact on the new educational dispensation, it was heralded and detailed in the documents discussed below.

4.7.2.1 The National Education Policy Investigation Reports

The National Education Policy Investigation (NEPI) reports had a very different perspective on the meaning of lifelong learning. In the NEPI report (Department of Education 1994:3), mention is made of Australia having a national standards framework and a competency-based approach to education and training. The report noted that in order to expand the notion of competency beyond its original restricted use, the following aspects should be included (Department of Education 1994:5):

- the identification of generic skills and competencies which are transferable to other contexts
- promoting the concept of life-long learning and blurring the distinction between education and training.

The National Education Policy Investigation's report (Department of Education 1994:5) adopted a simple categorisation of four main concepts of adult education, namely adult education, non-formal education, continuing education, and lifelong education. In its brief definition and description of lifelong education the report stated (Department of Education 1994:10) "*although seemingly similar to continuing education, lifelong education is a more comprehensive and visionary concept which includes formal, non-formal and informal learning extended throughout the lifespan of an individual to attain the fullest possible development in personal, social and professional life*".

It is interesting that the only reference to lifelong learning in the final NEPI general report is the above quote in the summary. Thus the first major education policy documents of the new South Africa gave little attention to lifelong learning.

4.7.2.2 The policy framework for education and training

This document was presented in 1994 and provided a clear vision for a new education and training system that advocated lifelong learning (Department of Education 1994:3). The document places lifelong learning at the core of the vision for a new education and training system when it stated that "a*ll individuals should have access to lifelong education and training irrespective of race, class, gender, creed or age".* The new national learning system had as one of its basic principles *"the right of the individual to access lifelong learning and training*" (Department of Education 1994:17) and an explanation of lifelong learning appears towards the latter part of that document which reads as follows (Department of Education 1994:77): *"The reconstruction and development of the education and training system in line with the goal of lifelong learning requires that we radically transform the way in which the delivery of education and training is organised. The conventional educational system, its assumptions, structures and practices, in particular, its focus on the teacher and the school as the central delivery agents, is not capable of, and indeed it is a barrier to, the achievement of lifelong learning for all. To meet the challenge of lifelong learning successfully, we need to reorganise the delivery of education and training within an open learning framework. Open learning is an approach to education and training which seeks to remove all unnecessary barriers to learning, thus increasing access to, and allowing people to take advantage of, learning opportunities throughout their lives".*

An analysis of the aforementioned quotation indicates that there is strong emphasis being placed on the structural changes required and the role of lifelong learning in helping to bring about these changes. However, very little detail is provided on how basic education could accomplish this objective. Since there appears to be very little or no detail on how lifelong learning could be accomplished through day to day teaching, it is thus inevitable for educators to ignore totally or place very little emphasis on this aspect in their teaching.

4.7.2.3 White papers on education and training

In 1994, South Africa elected a new democratic government and education activists hoped that education (and particularly basic education) would gain some degree of prioritisation and that there would be greater emphasis on lifelong learning (Aitchison 2003a:52; Castle 1999:10; Groener 2000:164). According to Aitchison (2003b:164), "*lifelong learning*" was rapidly adopted in government communications as a rhetorical shorthand term for all that was desirable in a system of education. This term is most visible in a number of education and training white papers published from 1994 to 2001. These papers are important in that they lay down the policy foundations for transformation from the past apartheid education systems to the current democratic education system.

- **White Paper 1: Education and Training**

  This White Paper appeared in 1995 and outlined a broad vision of what the Ministry of Education hoped to achieve in education and training and enunciated policy principles about how it was going to achieve that vision within the ambit of the National Reconstruction and Development Programme. A key policy principle was that education and training were to be seen as an integrated whole (Department of Education 1995:10). The actual words, lifelong learning appears only a few times in the White Paper, for example *"the system must increasingly open access to education and training opportunity of good quality, to all children, youth and adults, and provide the means for learners to move easily from one learning context to another, so that the possibilities for lifelong learning are enhanced"*.

- **White Paper 2:The organisation, governance and funding of schools**

  This White Paper appeared in 1996 and stated that *"the new structure of school organisation, governance and funding must aim to enable a disciplined and purposeful school environment to be established, dedicated to a visible and measurable improvement in the quality of the learning process and lifelong learning outcomes throughout the system"*. It further stated that the Constitution guarantees equal access to basic education for all and that education must provide an increasing range of learning possibilities, offering learners greater flexibility in choosing what, where, when, how and at what pace they learn (Department of Education 1996:15).

- **White Paper 3: A programme for the transformation of Higher Education**. This White Paper, which was published in 1997, envisioned education for lifelong self-fulfilment as enlightened, responsible and constructively critical citizens (Department of Education 1997a:10) with a strong emphasis on human resource development; high-level skills training; and the production, acquisition and application of new knowledge to aid national growth and competitiveness.

- **White Paper 4: A programme for the transformation of Further Education and Training**

  The White Paper was published in 1998. This White Paper envisioned "*a successful FET system will provide diversified programmed offering knowledge, skills, attitudes* *and values South Africans require as individuals and citizens, as lifelong learners and as economically productive members of society"***.** It envisioned that further education and training be integrated and must enhance learner mobility and progression, with the purpose and mission to respond to the human resource needs of South Africa for personal, social and economic development (Department of Education 1998a:14). Positive changes envisaged are that it should cater for a wider range of learners, including out-of-school youth and young and old adults.

- **White Paper 5: Early childhood education**

  This White Paper, which was issued in 2001, refers to a statement that young children need to be provided with "*a solid foundation for lifelong learning and development*" (Department of Education 2001b:4), a phrase repeated in Education White Paper 6: Special Needs Education Building an inclusive education and training system - published in the same year. This document reads that "*the long-term goal is to build an open, lifelong and high-quality education and training system for the 21st century*" (Department of Education 2001c:45).

- **White Paper 7: e-Education -transforming learning and teaching through information and communication technologies (ICTs)**

  This White Paper of 2004 emphasised that the Department of Education will ensure that every school has access to a wide choice of diverse, high-quality communication services which will benefit all learners and local communities in that *"the services provided by the initiative will enhance lifelong learning and provide unlimited opportunities for personal growth and development to all*" (Department of Education 2004:6). The only other reference made to lifelong learning in White Paper 7 is "*The challenge facing our education and training system is to create a learning culture that keeps pace with these changes, and equips people with the knowledge, skills, ideas and values needed for lifelong learning*" (Department of Education 2004:15).

To sum up, lifelong learning, though present as a key founding concept in the White Papers on South Africa's new education system, lacks much prominence or substance. However, it could be assumed that the concept of lifelong learning in the various documents may simply be used to add a rhetorical flourish to the expressed desire for a better education system. Of great concern, though, remains the issue of the quality of the Life Sciences curriculum and whether it is aligned to the White Papers with regards to lifelong learning so that the knowledge and skills acquired by students could be applicable and useful in the context of South Africa in particular and in society in general. The analysis chapter of this study will shed more light on this concern.

4.7.3 Lifelong learning and Life Sciences education in the context of South Africa

In the context of Life Sciences, lifelong learning embodies the concept of knowledge and skills wherein the factors of relevance, responsiveness, access, equality, equity and globalisation are inherent. In this regard, Aikenhead (2006:2) juxtaposes pipeline science education with humanistic science education; an alternative everyday-life approach that animates self-identities of students'; their future contributions to society as citizens; and their interest in making personal utilitarian meaning of scientific and technological knowledge. Aikenhead (2006:2) also argues that traditional science education is dominated by a pipeline ideology that governs school science's purpose to provide students with adequate preparation (acquisition of skills and knowledge) to progress to the next level of science courses and, ultimately, to direct the most capable students into science and engineering careers.

With regard to lifelong learning in Life Sciences in South Africa, there are distinctively cultural philosophical worldviews that are associated with concepts of connectedness, communalism, interdependency and inter-subjectivity (Bell 2010:42). In particular, Letsaka (2000:183) argues that the concept of *ubuntu* in Southern Africa (roughly translated as humanness) is fundamental to Black socio-ethical thought. Its focus is on human relationships predicated on notions of respect and concern for others. This emphasis is built upon the belief that we are all connected through the spiritual world and that we have a mutual obligation to respect the living. Mbigi (2005:5) links indigenous South African value systems and traditions to the Delors (1996:33) Report's pillars for lifelong learning. He emphasises, for instance, concepts such as *ubuntu* and interdependence as aspects of the pillar 'learning to live together'. According to Siegel (2008:815), lifelong learning in the context of Life Sciences therefore has to somehow capture a more hybrid view of development that also builds on different value systems. Hoppers (2006:6) is concerned that the existing flood of scientific information in the globalised world must be made relevant to South Africa. In other words, South Africa should find a way of inserting its own scientific knowledge into world systems.

In the modern, knowledge-driven economy, the Organisation for Economic Co-operation and Development (OECD) (2010:45) argues that people must upgrade their skills in science in order to remain competitive and to prepare for frequent changes in jobs. Therefore, lifelong education, in response to the constantly changing conditions of modern life, must lead to the systematic acquisition, renewal, upgrading and completion of knowledge, skills and attitudes, in science as are required by these changes.

Lifelong learning has become an important strategic force, especially for a country that has to depend on the knowledge and skills of its people in order to compete in the global economy. For South Africa to keep abreast of changes in methods of production, scientific and technological advancement and the challenges of the information and knowledge age, it has to adopt a high quality lifelong learning science education.

4.8 Conclusion

Education has to prepare young people to play a dynamic role and constructive part in the development of a society in which all members share fairly in the good or bad fortune of the group, and in which progress is measured in terms of human well-being, which must therefore indicate a sense of commitment to the whole community. To corroborate the idea of learning as cutting across all levels of people and throughout one's lifespan, Oduran (2011:1434) argues that it will be culturally, socially, economically, politically and psychologically illogical, unfair and wasteful to confine learning to any one segment of life, society, location or any one (space) and time. He goes further to advise that every resource in society that is capable of widening access to lifelong learning in science must be profitably utilised to promote the goal of learning to live and living to learn, particularly for the betterment of humankind in the 21st century.

CHAPTER 5

RESEARCH METHODOLOGY

5.1 Introduction

Research may be conceived as the process of arriving at dependable solutions to problems through the planned and systematic collection, analysis, and interpretation of data. Furthermore research is a crucial tool for advancing knowledge; for promoting progress; and for enabling man to relate more effectively to his environment, accomplish his purposes, and resolve his conflicts (Mouly 2006:45). Cole (2001:121) posits that research has influenced ideas and thoughts about education, as well as the practices and processes that were used to achieve goals and objectives in education. For example, some research involved educators who were constantly trying to discover and understand different and new pedagogical styles in order to embrace the quality of teaching and learning, thus enabling them to make professional decisions that had immediate and long-term effects on learners, educators, parents and ultimately on a community at large. The aim of this chapter is to explain the research process that led to the collection of the data used to provide answers to the main research questions. This chapter presents a description of the research context; research design; rationale behind the research methodologies and data collection instruments; the data collection process; ethical considerations; sampling strategies; and the techniques that were used in the analysis and interpretation of the data.

The literature reviewed in the previous chapter revealed the historical background of curriculum development and implementation in South Africa and how the quality of the curriculum impacted teaching and learning in schools. The researcher also outlined from the reviewed literature, the comparative impact of the Life Sciences curriculum by comparing South Africa with other countries. The aforementioned impact of the curriculum lent impetus for the researcher to investigate how the quality of the curriculum affects the teaching and learning of Life Science in many schools in South Africa. This research might close the gaps that have been revealed in the reviewed literature. It might also help curriculum developers to understand how the Life Sciences curriculum impacts upon the lifelong learning of students in grade 12.

5.2 Research design

How the world is viewed from an academic point of view is generally referred to as a paradigm. Anaf and Shepard (2007:185) describe a paradigm as representing a patterned set of assumptions concerning reality (ontology), knowledge of that reality (epistemology) and the particular ways for knowing that reality (methodology). Research methodologies, as suggested by Cohen, Manion and Morrison (2011:74), refer to the range of approaches used in educational research to gather data which are to be used as a basis for interpretation, explanation, prediction and drawing inferences. According to Morgan (2007:50), methodology refers to a design which the researcher devises for data collection, as well as the analysis procedures used to investigate the research problem. He adds that the research methodology in a research study is determined by both the nature of the data collected and the problem under investigation. This data can be either verbal or numerical. Morgan (2007:50) explains that when verbal data is collated, the methodology tends to be qualitative and when it is numerical data, the methodology leans towards a quantitative approach. In the context of research design, this study falls within the realm of a mixed methods study. The mixed methods approach employs both quantitative and qualitative techniques.

The benefits of mixing qualitative and quantitative research designs are generally enhanced triangulation, a more robust development of theory and the potential to more comprehensively understand the research situation (Anaf and Shepard 2007:185). Creswell, Shope, Plano Clark and Green (2006:2) suggest that mono-method studies are often limited in transferability while mixed methods studies are best able to capture the nuances of a phenomenon or an educational or social issue. For this research, a mixed method design was particularly suitable as there were multiple facets of the research questions that needed exploring. A further advantage of using the mixed methods approach was that qualitative or quantitative components can predominate or both can have equal status to obtain rich data (Cohen, Manion and Morrison 2011:74). In the context of this study, using a mixed methods approach can capture the different perspectives of learners and educators, thereby enhancing the ability of this study to represent complexity and multiple levels. Combining different data sets in mixed methods strategies enhances transferability, generalisability and practical significance (Onwuegbuzie and Collins 2007:283). The rationale for using a mixed methods approach in this study is that quantitative data alone would not provide answers to the question of how curricula should be constructed by stakeholders. Qualitative information was also needed on how curriculum decisions should be made regarding the lifelong learning of grade 12 Life Sciences learners.

5.2.1 Quantitative research

Quantitative research is influenced by the empiricist paradigm which is concerned with the cause and effect of social phenomena and uses data based on empirical observation and critical interpretation (Creswell 2009:15). Quantitative research, including surveys and questionnaires, can help to improve products and services by enabling informed decisions to be made. The basic building blocks of quantitative research are variables with an emphasis on the relationships, either correlational or causal, that exist between these variables. According to Sekaran and Bougie (2010:18), quantitative research is about explaining phenomena by collecting numerical data that are analysed using mathematically-based methods. In quantitative research design, the researcher will count, classify and build statistical models to explain what is observed. Quantitative research is about asking people for their opinions in a structured way so that one can produce facts and statistics. To get reliable statistical results, it is important to survey people in fairly large numbers and to make sure they are a representative sample of the target market. Quantitative data collection methods use a limited range of pre-determined responses in which the expectations and perceptions of the participants can be measured (Creswell 2009:17). Cohen *et al.* (2011:76), contend that the greatest strength of quantitative research is that it produces quantifiable, reliable data that are usually generalizable to some larger population.

Quantitative analysis also allows researchers to test specific hypotheses. In contrast, qualitative research is more exploratory. According to Cohen *et al.* (2011:76), the greatest weakness of the quantitative approach is that it decontextualizes human behavior in a way that removes the event from its real world setting and ignores the effects of variables that have not been included in the model. It also lacks the depth and richness of data that is present with qualitative research. In this study, the researcher did not want to influence the participants in any way and therefore decided to ask specific questions; collect numeric (numbered) data from participants; analyse these numbers using statistics; and conduct the inquiry in an unbiased manner using a quantitative method. According to Creswell (2009:17), if the problem calls for the identification of factors that influence an outcome, then a quantitative approach is best. As this study sought to establish such relationships between the quality of the Life Sciences content and lifelong learning, the use of the quantitative method of data collection was appropriate. The researcher also wanted to establish if there were correlations between the views of the Life Sciences educators and the learners about the Life Sciences curriculum content. Hence, a quantitative approach assists in establishing whether or not such correlations exist.

5.2.2 Qualitative research

According to Denzin and Lincoln (2011:19), qualitative methods used in research provide an in-depth description of a specific programme, practice or setting. Cohen, Manion and Morrison (2011:85) explain that "qualitative" implies a direct concern with experience as it is lived, felt or undergone. In this study, the researcher attempted to provide an in-depth description of the attitudes of teachers towards the quality of the Life Sciences curriculum in respect of lifelong learning. However, based on the above literature it may be argued that the experiences of individuals are quite different from each other and, as such, the qualitative researcher will argue that experiences cannot be boxed into categories. According to Cohen *et al.* (2011:15), qualitative research methods:

- are concerned with opinions, feelings and experiences;
- describe social phenomena as they occur naturally. No attempt is made to manipulate the situation, just to understand and describe it;
- seek understanding by taking a holistic perspective / approach, rather than looking at a set of variables; and
- use qualitative research data to help to develop concepts and theories that help one to understand the social world, which is an inductive approach to the development of theory, rather than the deductive approach that quantitative research takes - i.e. testing theories that have already been proposed.

A qualitative approach focuses on investigating social behaviour in natural settings. This study, being school-based research, included close attention be paid to what ordinarily and routinely happens in schools and classrooms. Creswell (2009:18) states that the qualitative approach is used in more natural and less controlled research settings. According to Cohen *et al.* (2011:85), qualitative research data collection methods are time consuming. Therefore, data is usually collected from a smaller sample. Creswell (2009:19) suggests that data collection approaches for qualitative research usually involve direct interaction with individuals on a one-to-one basis or direct interaction with individuals in a group setting. The qualitative research of this study allowed educators to elaborate on the views of each other and in so doing; the researcher obtained a better sense of the opinions of educators regarding the prevalence of the lifelong learning aspect in the Life Sciences curriculum. In this study, it was imperative that the researcher used a qualitative approach because in the educator interview and learner interview, the respondents felt comfortable to provide in-depth discussion on their perceptions and expectations of the Life Sciences curriculum. The qualitative method of data collection was crucial for the researcher to observe patterns and identify distinct themes.

5.3 Research population

All research questions address issues that are of great relevance to important groups of individuals known as a research population (Cohen *et al.* 2011:95). Creswell (2009:28) argued that a research population is generally a large collection of individuals or objects that is the main focus of a scientific query. Thus, all individuals within a certain population usually have a common, binding characteristic or trait. The province of Kwa-Zulu Natal consists of 12 education districts, with each comprising many circuits.

5.3.1 Target Population

Denzin and Lincoln (2011:20) define the target population as the group or individuals to whom the survey applies. In other words, according to Creswell (2009:21), the researcher seeks those groups or individuals who are in a position to answer the questions and to whom the results of the survey apply. A target population could therefore refer to the group of individuals or objects to which researchers are interested in generalising their conclusions. However, due to the large size of target populations, researchers often cannot test every individual because it is too expensive and time-consuming. The district of Pinetown was identified as the target population by the researcher because, in 2013, this district produced the best results in Kwa-Zulu Natal in the National Senior Certificate Life Sciences examination. During the 2014 period, there were 8500 grade 12 Life Sciences learners and 195 Life Sciences educators in the Pinetown district which formed the target population. Table 5.1 details the 12 education districts with their circuits.

Table 5.1 Districts and circuits of the Kwa-Zulu Natal Basic Education Department

DISTRICT	CIRCUIT
Amajuba	Dannhouser Newcastle
Ilembe	Lower Tugela Maphumulo Ndwedwe
Pinetown	Mafukuzela – Gandhi Durban North West Umhlathuzana
Sisonke	Ixopo Pholela Umzimkhulu
Ugu	Sayidi Scottburgh Emzumbe
Umgungundlovu	Msunduzi Umngeni Ubumbano
Umkhanyakude	Hlabisa Ubombo Ingwavuma
Umlazi	Durban Central Phumelela Umbumbulu
Umzinyathi	Msinga Bambanani Senzokuhle
Uthukela	Bergville Estcourt Mnambithi
Uthungulu	Lower Umfolozi Mthonjaneni Nkandla Umlalazi Umhlathuze
Zululand	Bhekuzulu Mahlabathini Nongoma Pongola Paulpietersburg

Source: Adapted from the Department of Basic Education (2011:3)

5.4 Sampling

According to Creswell (2009:21), when conducting research it is almost always impossible to study the entire population that one is interested in. As a result, Cohen *et al.* (2011:88) suggest that researchers use samples as a way to gather data. They define a sample as a subset of the population being studied, representing the larger population and is used to draw inferences about that population. In other words, sampling is a research technique widely used as a way to gather information about a population without having to measure the entire population and is the process by which an inference is made to the whole by examining a part. This alludes to the fact that researchers need to sample the population if the area under study has a large population. Denzin and Lincoln (2011:19) propose sampling for the following reasons:

- Lower and more appropriate administrative costs. Research should usually be cost effective and economical to the researcher; and
- The ability to administer controlled follow-up procedures. The researchers can follow-up on non-respondents, both to encourage them to complete the survey and also to try to understand the reason for the non-response. If a researcher has a population of several thousands, sends questionnaires to all of them and achieves a response rate of 20%, it is difficult to systematically follow-up all non-responses.

5.4.1 Probability sampling

Probability sampling is a sampling technique wherein the samples are gathered in a process that gives all the individuals in the population equal chances of being selected. In this sampling technique, the researcher must guarantee that every individual has an equal opportunity for selection and this can be achieved if the researcher utilizes randomisation (Sekaran and Bougie 2010:19). Creswell (2009:22) stated that if random selection was properly conducted, the sample would be representative of the entire population. Sampling bias is also eliminated since the subjects are randomly chosen. Two types of probability sampling often utilised by researchers are:

5.4.1.1 Simple Random Sampling

According to Denzin and Lincoln (2011:21), simple random sampling is the easiest form of probability sampling in which the researcher needs to ensure that all the members of the population were included in the list and then randomly select the desired number of subjects. Cohen *et al.* (2011:90) state that there are many methods that can be used to do this. It can be as mechanical as picking strips of paper with names written on it from a hat while the researcher is blindfolded or using computer software to do the random selection.

5.4.1.2 Stratified random sampling

According to Denzin and Lincoln (2011:23) stratified random sampling is also known as proportional random sampling. It is a probability sampling technique wherein the subjects are initially grouped into different classifications such as age, socioeconomic status or gender. The researcher randomly then selects the final list of subjects from the different strata. Creswell (2009:23) argued that researchers usually use stratified random sampling if they want to study a particular sub-group within the population and that it was preferred over simple random sampling because it warrants more precise statistical outcomes.

5.4.2 Non-probability sampling

Cohen *et al.* (2011:90) stated that non-probability sampling is a sampling technique where the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected. In contrast with probability sampling, a non-probability sample is not a product of a randomised selection process. Sekaran and Bougie (2010:19) stated that subjects in a non-probability sample are usually selected on the basis of their accessibility or by the purposive personal judgment of the researcher. The downside of the non-probability sampling method is that an unknown proportion of the entire population was not sampled and the sample may or may not represent the entire population accurately. Therefore, the results of the research cannot be used in generalisations pertaining to the entire population.

5.4.2.1 Convenience or purposive sampling

According to Cohen *et al.* (2011:90), with convenience or purposive sampling, subjects are chosen to be part of the sample with a specific purpose in mind. In purposive sampling, the researcher believes that some subjects are more fit for the research compared to other individuals and the samples are selected because they are accessible to the researcher (Biggam 2011:286). This technique is therefore considered to be the easiest, cheapest and least time consuming.

5.5 Sample size

The main function of the sample is to allow researchers to conduct the study amongst individuals from the population so that the results of the study can be used to derive conclusions that will apply to the entire population. The researcher will discuss the sampling method for the two data collection instruments separately as the method of recruitment of the samples differed with each instrument.

5.5.1 Surveys

Questionnaires were administered to both grade 12 Life Sciences learners as well as grade 12 educators of Life Sciences. In arriving at the learner and educator samples for this part of the study, Table 5.2 below has reference.

Table 5.2 Circuits and number of public secondary schools in the district of Pinetown

Name of district	Names of circuits	Number of public secondary schools
Pinetown	Mafukuzela – Gandhi	40
	Durban North West	54
	Umhlathuzana	52

Source: Adapted from the Department of Basic Education (2011:131)

Table 5.2 illustrates that the district of Pinetown comprises 3 circuits, namely Mafukuzela-Gandhi circuit; Durban North West circuit; and Umhlathuzana circuit with each having 40, 54 and 52 public secondary schools respectively.

5.5.1.1 Learner sample

In arriving at the learner sample, the researcher consulted the sampling frame as indicated in Table 5.3. To obtain the learner and educator sample, the following steps were taken. The researcher used the sampling frame in Table 5.3 to obtain the learner sample size. Since there were 8500 Life Sciences learners in the Pinetown district, the sample should consist of 368 learners (as per Table 5.3). Although 368 learners formed the minimum number of participants in the research study, the researcher increased the learner sample to 400.

Table 5.3 Table to determine sample size

N	S	N	S	N	S
10	10	1 000	278	20 000	377
20	19	8 000	367	40 000	380
100	70	9 000	368	50 000	381
200	83	10 000	370	500 000	382
500	217	15 000	375	1 000 000	384

Note N is population size. S is sample size

Source: Adapted from Krejice and Morgan (1970: 608)

As represented in Table 5.2 the names of the three circuits in the Pinetown District were placed in a hat and the Mafukuzela Gandhi circuit was drawn. The researcher then obtained the names of all the public schools that offer Life Sciences in the Mafukuzela-Gandhi circuit from the circuit office. The researcher wanted to include as many schools in the study as possible and therefore decided that twenty Life Sciences learners each from twenty schools would be selected randomly. The researcher used simple random sampling to obtain the sample of schools that would form part of the study. From the forty schools in the Mafukuzela-Gandhi circuit (see Table 5.2), the names of twenty public secondary schools were drawn out of a hat. When consent was requested from the principals of the schools, 4 principals were not willing to allow their learners to be part of the study. The researcher did not draw another 4 schools to replace those that did not want to form part of the study because a month had passed since the researcher had requested consent from the principals and it was drawing close to the Trial examination for the grade 12 learners. The researcher did not want to inundate the educators and the learners during the examination. Thus, the researcher increased the sample of learners in each of the 16 participating schools from 20 to 25.

This study used simple random sampling to obtain the learner participants. In simple random sampling, Johnson and Christensen (2011:131) state that each member of the target population has an equal chance of being selected and the probability of a member of the population being selected is unaffected by the selection of other members of the population. Thus, the grade 12 learners from the sixteen schools were randomly selected. This was done by obtaining name lists of all the grade 12 Life Sciences learners from the schools under study. The names of the learners for each school were ordered numerically. The researcher conducted the study in sixteen schools and 25 learners from each school were randomly selected. The researcher placed numbers into a hat and drew 25. The numbers were then used to identify the learner participants from the first school. This technique was employed another fifteen times with the remaining schools until the researcher obtained the required number of participants, which were 400 learners.

5.5.1.2 Educator sample

In arriving at the educator sample, the purposive sampling technique was used. However, the educators were not coerced into completing the questionnaire. In 2014, the district of Pinetown held a workshop for Life Sciences educators from the three circuits. The educators who were present were then invited to complete the questionnaire on a purely voluntary basis. Of the 80 educators that were present, 75 of them were willing to complete the questionnaire. The researcher justified this method on the basis of literature by Creswell (2009:24) which stated that in purposive sampling, the researcher believes that some subjects are suitable for the research compared to other individuals and the samples are selected because they are accessible to the researcher.

5.5.2 Interviews

According to Cohen *et al*. (2011:89), the use of interviews is sometimes used when it is better to obtain information from a group rather than all individuals. In view of this the researcher decided to interview learners from one school only. The aim of the interview is to make use of participants' feelings, perceptions and opinions. Johnson and Christensen (2011:131) stated that the interview is effective if the researcher took into consideration the following characteristics:

- Recommended size of the interview sample is 6 - 10 people as smaller groups may limit the potential on the amount of information collected, and more may make it difficult for all participants to participate and interact and for the interviewer to be able to make sense of the information given

- Members of the interview should have something in common which is important to the investigation

5.5.2.1 Learner sample

For the qualitative part of the research one school from the 16 participating schools was drawn out of a hat. The names of the 18 learners that completed Section D on the questionnaire from the randomly chosen school were placed in a hat. In keeping with the recommendation by Creswell (2009:22) that the size of the interview sample should be between 6 - 10 people, six names were drawn to participate in the learner interview.

5.5.2.2 Educator sample

It was not possible to randomly select educators as educators are generally under tremendous stress at school and are not willing to participate or do not have the time after school. Therefore, the researcher used purposive sampling. The researcher is an educator in the Mafukuzela –Gandhi circuit which consists of 4 cluster groups. Life Sciences educators from the cluster group of which the researcher is a member were invited to participate in the interview. Table 5.4 has reference in this regard.

Table 5.4 Cluster groups of the Mafukuzela-Gandhi circuit

DISTRICT	CIRCUIT	CLUSTER
Pinetown	Mafukuzela-Gandhi	Tongaat Verulam Phoenix Central Phoenix North

Source: Self-generated by researcher

The educators were under no compulsion to participate. They were invited to avail themselves for 30 minutes after school. Of a total of 13 Life Sciences educators in the cluster, six of them indicated their availability and formed the educator sample for the interview. Thus the researcher obtained the educator sample for the interview by using purposive sampling.

5.6 Data Collection

After much deliberation on the merits of the various data collection instruments, it was decided that it would be necessary to use more than one source for the purposes of the collection of data that would further the aims of the study. This study used questionnaires and semi-structured interviews as data collection techniques. O'Leary (2004:150) remarks that collecting credible data is a tough task and there is no technique that is better than the other. As a result, the technique used depends upon the research goals and the advantages and disadvantages of each method.

The nature of this study compelled the researcher to choose two of the aforementioned data collection techniques with the aim of obtaining deeper perspectives from the participants on the quality of the Life Sciences curriculum in the context of lifelong learning. According to O'Leary (2004:162) the researcher has to know and select the right method for addressing the needs of the research question. Therefore, the researcher has to make a decision and choose the correct method for that study. However, each data collection technique has its own complexities and demands.

The questionnaires and the two semi-structured interviews which were conducted, one with the grade 12 Life Sciences learners and the other with the Life Sciences educators, allowed the researcher to collect more detailed and descriptive data about the views of the educators and learners about the Life Sciences curriculum.

5.6.1 Questionnaires

According to Sekaran and Bougie (2010:23), researchers usually use questionnaires or surveys in order that they can make generalisations. Denzin and Lincoln (2011:45) posits that questionnaires consist of questions dealing with some topic or related group of topics given to a selected group of individuals for the purpose of gathering data on a problem under consideration. A well designed questionnaire can boost the reliability and validity of the data (Schumacher and McMillan 2006:55). Therefore, surveys are usually based on carefully selected samples. In other words, questionnaires or social surveys are a method used to collect standardised data from large numbers of people. To achieve this, Cohen *et al*. (2011:90) state that questionnaires should consist of the same set of questions that are asked in the same order and in the same way in order that the same information can be gathered. Questionnaires are used to collect data in a statistical form.

Questionnaires allow for data to be collected in a quantitative way. Anaf and Shepard (2007:185) postulate the following advantages of questionnaires:

- Large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost effective way;
- Surveys can be carried out by the researcher or by any number of people with limited affect to its validity and reliability;
- The results of the questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package; and
- Questionnaires can be analysed more scientifically and objectively than other forms of research.

Against the above background, the researcher constructed the questionnaire. It was necessary to pay careful attention to question format; question order; types of questions; formulation of questions; and the validity and reliability of questions. The rationale for using the questionnaire was to collect data from a larger group of participants, which deepened the researcher's understanding of the study. The use of the questionnaire allowed the researcher to reach a large group of geographically dispersed respondents and obtain their views on the quality of the Life Sciences curriculum.

5.6.1.1 Learner questionnaire

The researcher wanted to ascertain the quality of the curriculum in the context of lifelong learning and, as such, considered the SERVQUAL instrument to be effective in obtaining data that would address this objective. In the current socioeconomic context, the service sector has become increasingly important, revealing the need to know and study the particularities of its operations and to institute specific management methodologies that fit its context and specificity. According to Zeithaml, Parasuraman and Berry (1990:43), SERVQUAL is the method that assesses client satisfaction as a result of the difference between expectation and the performance obtained; is universal; and can be applied to any service organisation to assess the quality of services provided.

Educational institutions are also in search of improvements in teaching service quality to satisfy the expectations of their students. According to Kilbourne (2004:525), education is classified as a service and institutions must work to obtain a standard of quality that exceeds student expectations and needs. The popular SERVQUAL questionnaire is a pre-eminent instrument for measuring the quality of services as perceived by the customer (Parasuraman, Berry and Zeithaml 1988:12). The SERVQUAL scale (questionnaire) has two sections: one to map client expectations in relation to a service segment and the other to map perception in relation to a certain service. Quality is judged according to perceived satisfaction (Kilbourne 2004:527). Badri, Abdulla and Al- Madani (2005:825) posit that perceived quality is determined "*by the gap between expected quality and experienced quality"* which is the difference between client perceptions and expectations.

Since this research sought to ascertain the expectations and perceptions of grade 12 learners of the Life Sciences curriculum, the instrument that the researcher used was adapted from the Quality of Instructor Service to Students (QISS) questionnaire (Emanuel and Adams 2006:12) modified from the SERVQUAL instrument which was developed by Parasuraman, Berry and Zeithaml (1988:12). The SERVQUAL model measures service quality as five dimensions namely: reliability; responsiveness, assurance, empathy and tangibles. These dimensions are defined as follows by Parasuraman, Berry and Zeithaml (1988:12):

1. Reliability: Ability to perform the promised service dependably and accurately;
2. Responsiveness: Willingness to help students and provide prompt service;
3. Assurance: Knowledge and courtesy of employees and their ability to inspire and trust;
4. Empathy: Caring individual attention the school provides to its students; and
5. Tangibles: Physical facilities, equipment and appearance of personnel.

The aforementioned variables were measured by the use of the survey questionnaire, as indicated in appendix 4 on page 239, which was administered to the grade 12 Life Sciences learners from the selected schools in the Mafukuzela-Gandhi Circuit. In this study, this instrument was used as the primary step in building a model of student perceptions of the value of the Life Sciences curriculum with the students need for that service.

Maree (2007:157) explained that a researcher must ensure that adequate time is budgeted in the construction and preliminary testing of the questionnaire. An important aim in the construction of the questionnaire for this investigation was to present the questions as simply and straight forwardly as possible in order to avoid ambiguity, vagueness, bias, prejudice and technical language in the questions.

Cooper and Shindler (2008:35) define an open-ended question as a survey question in which no answer categories are provided and participants are given spaces to fill their answers. This type of question has several advantages - , according to Cooper and Shindler (2008:37) namely the researcher can get new ideas and information which is not included in the alternatives; the participant can answer in detail and can clarify and qualify their responses; and finally, respondents can express their feelings fully and are not constrained by the options given. Johnson and Christensen (2011:131) state, however, that open-ended questions are not without disadvantages in that the researcher may collect irrelevant information.

Johnson and Christensen (2011:131) define closed questions as requiring respondents to choose from a limited number of responses predetermined by the researcher and that this type of question forces the respondents to select one of the response categories provided. In a closed questionnaire, minimum numbers of irrelevant answer are received as alternative answers are provided. This type of questionnaire has the disadvantage that respondents may misinterpret questions, resulting in the respondent giving wrong information. Therefore, the focus group interviews could be a means of clarifying such concerns.

The questionnaire for the learners consisted of 4 sections which contained closed-ended questions. The first section of the questionnaire collected the demographic information of the learners participating in the data collection process. This part was kept to a minimum to ensure that the questionnaire did not become too long and time consuming to complete. However, the data collected allowed for analysis and inferences to be made. The design of the second section of the questionnaire was based on the SERVQUAL methodology, utilised by Parasuraman *et al*. (1988:12) in their multi item scale for measuring consumer perceptions of quality.

Questions were asked on each of the five dimensions, namely:

Reliability: Questions 1 to 4

Assurance: Questions 5 to 7

Tangibles: Questions 8 to 10

Empathy: Questions 11 to 12

Responsiveness: Questions 13 to 15

The third section dealt with learners' expectations and their perceptions of the Life Sciences curriculum in the context of lifelong learning. The fourth section, which was optional, allowed the participants to decide, whether they wanted to engage in a semi-structured interview or not.

5.6.1.2 Educator questionnaire

The educator questionnaire was not adapted from the SERVQUAL instrument. The data obtained from the educator questionnaire assisted the researcher to determine grade 12 educators' perceptions of the quality of the Life Sciences curriculum content in the context of lifelong learning. The data was used to draw inferences about topics that educators would consider to inculcate lifelong learning in grade 12 learners. The educator questionnaire comprised 6 questions (see appendix 5 on page 244). The first 3 questions of the questionnaire collected the demographic information of the educators participating in the data collection process. In question four, educators were required to indicate their perceptions on the relevance of the grade 12 Life Sciences curriculum. Question 5 required educators to provide a list of the topics that had very little or no relevance to lifelong learning for grade 12 Life Sciences learners, while in question 6 educators were required to provide a list of possible topics that should be included in the grade 12 Life Sciences curriculum which they consider to have relevance to lifelong learning. Questions 5 and 6 were thus open-ended questions and elicited a wide variety of responses. These responses were further clarified during the educator focus group interview.

5.6.1.3 Administration of Questionnaires

Permission to conduct the research was obtained from the Department of Basic Education, Ward managers, and Principals of each of the selected schools. Before commencing with data collection, written consent to participate in this study was obtained from the: parents or guardians of the learners as the learners are minors; grade 12 Life Sciences learners; and grade 12 Life Sciences educators who participated in this study. Learner questionnaires were disseminated via the Life Sciences educator at each school. The educators were asked to administer the questionnaires to the selected learners in each of their classes. The learners were given one week to complete the questionnaire. On completion, they dropped off their questionnaires in a sealed box which the researcher provided to the Head of the Life Sciences Department. This ensured anonymity of the learners as the educators did not collect them personally from the learners. The sealed boxes were collected by the researcher. In total, 400 learner questionnaires were despatched and 398 were returned which gave a 99.5% response rate.

The educator questionnaires were hand-delivered to each of the participants. Of the 80 educators that were present, at a workshop mentioned earlier, 75 of them were willing to complete the questionnaire. The workshop was held over three days and the researcher requested that completed surveys be handed in by the third day. The completed educator questionnaires were collected in a sealed envelope (which the researcher provided), thus ensuring anonymity. In total, 75 educator questionnaires were despatched and 71 were returned, which gave a 94.7% response rate.

5.6.2 Interviews

Biggam (2011:281) described an interview as the purposive interaction between two or more persons, with one trying to obtain information from the other. The researcher in this study avoided the use of structured interviews because the research is of a qualitative nature and there is a need to probe deep information which might not be the case with a structured interview. According to Bryman (2007:15), probing can be a problem area for a structured interview. Respondents may not understand the question and unable to answer it or the respondents may not have received sufficient information to answer the question. According to Murray and Beglar (2009:6), semi-structured interviews serve to provide rich data which the questionnaire would fail to do, thus enhancing the quantitative data. With the interviews there was also room for the researcher, by probing, to find out more information if the respondents have not provided sufficient detail.

The purpose of choosing to conduct semi-structured interviews with learners and educators in this study was to obtain in-depth views from both the educators and learners about the quality of the Life Sciences curriculum. It was imperative that the researcher conduct interviews since the learner questionnaire contained closed questions implying that the learners would not have had an opportunity to describe their feelings about the curriculum. The learners, through the interview, were therefore afforded an avenue to converse openly about the curriculum. The educator questionnaire also would not have been able to elicit rich data as many of the questions were closed while there were two open-ended questions only. Thus it was the intention of the researcher to collect much more detailed and descriptive qualitative data. To achieve this, the interviews were fairly informal and interviewees were made to feel that they were participating in a conversation or discussion rather than in a formal question and answer situation.

Creswell (2009:22) contends that semi-structured interviews, also called “focused interviews” contain a series of open-ended questions based on the topic areas the researcher wants to cover, as well as a series of broad questions which may have some prompts to help the interviewee. Denzin and Lincoln (2011:19) suggest that focus group interviews contribute to rich, insightful results of qualitative research due to the following:

- Synergy amongst respondents, as they build on each other’s comments and ideas;
- The dynamic nature of the interview engages respondents more actively than is possible in a more structured survey;
- The opportunity to probe ("Help me understand why you feel that way") enables the researcher to reach beyond initial responses and rationales;
- The opportunity to observe, record and interpret non-verbal communication (i.e. body language, voice intonation) as part of a respondent’s feedback is valuable during interviews;
- The open-ended nature of the question defines the topic under investigation but provides opportunities for both interviewer and interviewee to discuss some topics in more detail; and
- Semi-structured interviews allow the researcher to prompt or encourage the interviewee if they are looking for more information or if they find what the respondents are saying interesting.

Reference can be made to Cohen *et al.* (2011:90) when they allude to participants’ interactions with each other rather than with the interviewer and, as such, the views of the participants emerge.

The learner interview was conducted at the resource centre in their school. In this way the learners felt comfortable because they were in their own environment. This familiar atmosphere did not inhibit them in any way and they were able to talk freely. The researcher created a warm and relaxed ambiance in order to obtain rich data from the learners. The educator interview was conducted at a coffee shop where educators felt relaxed. The researcher did not want to set up the interview at a school because educators do not want to remain at school after hours. They would have rushed through the interview and the researcher would have failed to obtain rich data from them. Hence, the semi-structured interviews provided the researcher with the opportunity to obtain in-depth answers on the learners' and educators' views of their interaction with the Life Sciences curriculum content in respect of lifelong learning. The data in the form of verbal responses were audio recorded.

5.7 Data analysis

The process of data analysis commenced immediately the questionnaires were returned by the respondents. According to Chamaz (2006:33), the first step in the analysis involved counting the questionnaires and reading through all the responses. Data was analysed using the statistical software package called SPSS version 23.0. This statistical programme is used to analyse data collected from surveys, tests and observations. It can perform a variety of data analyses and presentation functions, including statistical analysis and graphical presentation of data. Stevens and Larry (2015:30) contend that SPSS helps the user understand how to interpret the output for research questions. Data from the questionnaires were analysed along the following categories: descriptive statistics, describing the main features of a collection of data through cross tabulation; frequencies; and descriptive ratio statistics.

The recordings of the interviews were transcribed verbatim. According to Biggam (2011:165), dealing with qualitative data was described as working with data, organising it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned. The qualitative research design of this study was for enhanced triangulation; a more robust development of theory; and the potential to more comprehensively understand the research situation. The responses obtained from the interviews also provided greater clarification of responses that were obtained from the questionnaires. The analysis process for each of the research instruments is extensively described in chapter 6.

5.8 Pilot Study

Maree (2007:157) stated that the most important consideration in questionnaire design is that it takes time and effort and that the questionnaire may have to be re-drafted a number of times before being finalised. Cooper and Shindler (2008:37) concur that the pilot study enhances the credibility of the research instruments in that it assists the researcher to take into account potential sources of error that may undermine the quality of research and distort the findings and conclusion. The researcher therefore conducted a pilot study to test the reliability and validity of the research tools. The researcher piloted the study with 20 learners from the researcher's school and used their responses to determine whether or not the study would produce usable data or had areas that needed correction.

The pilot study aimed to determine the following: the time that the pilot group spent in answering the questionnaire; whether the layout of the questionnaire was clear; and to elicit any useful comments from the pilot group. The pilot study tested whether the study could be researched and was feasible. Respondents indicated that some of the questions were not easy to understand. The researcher attended to errors such as ambiguity and vagueness in the structured questions. Language usage also needed to be simplified. Once the questionnaire had been piloted with a group of the same cohort of learners as the participating group and the necessary changes effected, the participants were requested to complete the questionnaire. As a result of the pilot study, useful changes were made to the questionnaire. The responses from the participants in the pilot study were not included in the main study.

5.9 Delimitations

According to Denzin and Lincoln (2011:19), delimitations in research refer to what the reader might reasonably expect the researcher to do but what for clearly explained reasons, the researcher decided not to do. In this study, the researcher did not conduct the study with all the learners from the Pinetown District because it would have been too time consuming and almost impossible to accomplish as the researcher is also a grade 12 educator and had a moral obligation to fulfil her responsibility to the learners that she taught. Since the researcher is an educator at a public school, the researcher is not eligible to be relieved of her duties in order to embark on a very extensive large-scale study. Thus, a manageable sample was randomly selected taking all the necessary precautions already outlined earlier in this chapter. This precluded the researcher from exercising any form of bias in the selection of the sample.

5.10 Limitations

According to Marshal and Rossman (2006:42), there is no proposed research project that does not have limitations and none is perfectly done. Although interviews do have number of unique disadvantages such as audio recording equipment can fail leaving the researcher vulnerable to having no data at all, Biggam (2011:165) emphasised that when well conducted, interviews can produce in-depth data that are not possible with questionnaires. The researcher avoided the aforementioned pitfalls by always taking notes as well as video recording. This helped the researcher to keep track of the data collected and in understanding the data. Data collection was limited to just one interview each with educators and learners in order to gain a picture of the perceptions and expectations from the learners, as well as the educators, on the quality of the Life Sciences curriculum in the context of lifelong learning. Such a small-scale study is restricted in terms of reliability and the limitations inherent in a single interview are recognised.

5.11 Confidentiality and anonymity

With regard to issues of confidentiality and anonymity, participants are most likely to answer honestly if they know that their opinions or views cannot be traced directly back to them when the research report is written.

5.11.1 Confidentiality

Maintaining the confidentiality of information collected from research participants means that only the investigator(s) or individuals of the research team can identify the responses of individual subjects. However, researchers must make every effort to prevent anyone outside of the project from connecting individual subjects with their responses (Cohen *et al*. 2011:94). In analysing the qualitative data, no names were used when making reference to the respondents. The parents of the learner participants were given a letter by the researcher informing them that whatever information the researcher obtained from their children would be treated confidentially and under no circumstances would this be made available to anybody else.

5.11.2 Anonymity

Providing anonymity for the information collected from research participants' means that either the project does not collect identifying information of individual subjects or the project cannot link individual responses with participants' identities. A study should not collect identifying information from research participants unless it is essential to the study protocol (Cooper and Shindler 2008:37). In this research study, the researcher did request that learners who wished to participate in the interview provide their names and cell phone numbers. However, to ensure the anonymity of the learners they dropped their completed questionnaires in a sealed box which the researcher provided to the Head of the Life Sciences Department. The sealed boxes were collected by the researcher. The researcher collected each educator questionnaire personally in a sealed envelope (which the researcher provided) thus, ensuring their anonymity. The researcher did not use the names of the schools in the write up.

5.12 Reliability and Validity

The two most important aspects of precision in research are reliability and validity. While reliability is necessary, it alone is not sufficient. For a test to be reliable, it also needs to be valid.

5.12.1 Reliability

Reliability is the degree to which an assessment tool produces stable and consistent results (Dellinger and Leech 2007:312). The reliability of a measure indicates the stability and consistency with which the instrument measures the concept and helps to assess the 'goodness' of a measure (Sekaran and Bougie 2010:30). Mathematically, reliability is defined as the proportion of the variability in the responses to the survey that is the result of differences in the respondents (Dellinger and Leech 2007:312). That is, answers to a reliable survey will differ because respondents have different opinions, not because the survey is confusing nor has multiple interpretations. Before the questionnaire was put into final form, a pilot study was carried out. The questions in the questionnaire were phrased clearly and the researcher ensured that the questions did not lead to ambiguous responses.

5.12.2 Validity

According to Creswell (2009:27), validity is the extent to which a construct measures what it is supposed to measure. In this study, validity was ensured as all the constructs were tested for consistency and reliability of the items by using Cronbach's alpha. Triangulation aims to enhance the credibility and validity of the results. For this research process, triangulation was achieved through two ways. Firstly, according to Cohen *et al*. (2011:101), triangulation was achieved through multiple data collecting instruments; and secondly, by the inclusivity of learners and educators in the research sample.

5.13 Ethical Issues

Ethical clearance for the study was obtained from the Durban University of Technology. Permission was obtained from The Department of Education and District Managers to conduct the research at various schools in the Pinetown district. Permission was also obtained from the principals of each of the selected schools in which the research was conducted. A Letter of Informed Consent was given to the learners to inform them of the details and nature of the study so that they would be in a position to give informed written consent to participate in this study. The learners were given the Letters of Informed Consent to take to their parents, as they were minors. According to Cohen *et al.* (2011:110), the questionnaire will always be an intrusion into the life of the respondent, be it in terms of time taken to complete the questionnaire; the level of threat or sensitivity of the questions; or the possible invasion of privacy. Questionnaire respondents are not passive data providers for researchers. They are subjects and not objects of research. Cresswell (2009:29) indicates that respondents cannot be coerced into completing a questionnaire. In this study, participation by the learners and educators was completely voluntary. They were also informed that the decision whether to become involved and when to withdraw from the study was entirely theirs and that they should not fear reprisal from anyone if they chose not to participate or if they withdrew from the study at any time.

5.14 Conclusion

To achieve dependability, the context and conditions under which the research was carried out, were clearly outlined. Throughout the study, attempts were made to provide rich and detailed descriptions of the participants and the context of the research. Therefore, the study could serve as a guide for other researchers to conduct similar studies, thereby contributing to its transferability.

This chapter focused on a justification for the use of the research methodology employed in this study and the related considerations in the design of the study. This chapter has provided all the details of the research method ranging from research strategy; data collection techniques and their advantages and disadvantages; and a detailed process of the data analysis process that has been used. The minimisation of limitations and potential problems has been addressed by mentioning the approaches that have been used to limit potential criticism of this study. The next chapter will discuss and analyse the results of this study.

CHAPTER 6

ANALYSIS, INTERPRETATION AND DISCUSSION OF THE DATA

6.1 Introduction

In this chapter, the researcher analyses the data that was elicited during the study and discusses the findings of the research according to the research questions. The intention of this chapter is to highlight the themes on learner perceptions and expectations of and experiences on the quality of Life Sciences within the context of lifelong learning. This chapter also brings to the fore the perceptions of educators regarding the quality of the Life Sciences curriculum in the context of lifelong learning. This analysis is based on data from the questionnaires and the interviews used in this study.

6.2 Presentation of findings

The learner questionnaire was the primary tool used to collect data and was distributed to learners at 16 public secondary schools in the Mafukuzela-Gandhi circuit in the Pinetown District of Kwazulu-Natal. In total, 400 learner questionnaires were despatched and 398 were returned, which gave a 99.5% response rate. The research instrument consisted of 62 items, with levels of measurement at a nominal or an ordinal level. The questionnaire was divided into 4 sections which measured the various themes below:

Section A – Biographical Data

Section B – About your Life Sciences teacher

Section C - Life Sciences Curriculum

Section D - Personal details (Optional)

The data collected from the responses was analysed using SPSS version 23.0 statistical software. The results are presented in the form of descriptive statistics using graphs, cross tabulations and other figures for the quantitative data that was collected. Inferential techniques included the use of correlations and chi square test values which were interpreted using the p-values.

The educator questionnaire was used to collect data from Life Sciences educators in the Pinetown District. The educators were given an open-ended questionnaire which elicited responses on their views of the Life Sciences curriculum in the context of lifelong learning. In total, 75 educator questionnaires were despatched and 71 were returned, which gave a 94.7% response rate.

6.2.1 Reliability Statistics

Data was analysed using statistical software SPSS version 23.0. This statistical programme can be used to analyse data collected from surveys, tests and observations. It can perform a variety of data analyses and presentation functions, including statistical analysis and graphical representation of data.

6.2.1.1 Cronbach's Alpha

According to Stevens and Larry (2015:31), Cronbach's Alpha measures how well a set of items (or variables) measures a single uni-dimensional latent construct. When data have a multidimensional structure, Cronbach's Alpha will usually be low. Technically speaking, Cronbach's Alpha is not a statistical test – it is a coefficient of reliability (or consistency) (Stevens and Larry 2015:31). Cronbach's Alpha can be written as a function of the number of test items. Reliability is computed by taking several measurements on the same subjects. A reliability coefficient of 0.70 or higher is considered as "acceptable". The Tables 6.1 and 6.2 reflect the Cronbach's Alpha score for all the items that constituted the learner questionnaire.

Table 6.1: Cronbach's Alpha for Section B

	Number of Items	Cronbach's Alpha
Reliability	4 of 4	.912
Assurance	3 of 3	.929
Tangibles	3 of 3	.858
Empathy	2 of 2	.884
Responsiveness	3 of 3	.807
Overall	15 of 15	.956

Table 6.2: Cronbach's Alpha for Section C

	Number of Items	Cronbach's Alpha
Expectation	12 of 12	.905
Perception	12 of 12	.973

The overall reliability score exceeds the recommended Cronbach's Alpha value of 0.700. This indicates a degree of acceptable, consistent scoring for the various sections of the research.

6.2.1.2 Factor Analysis

Bartholomew, Knotts and Moustaki (2011:33) define factor analysis as a statistical technique whose main goal is data reduction and elaborate that factor analysis is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifested variables. A typical use of factor analysis is in survey research where a researcher wishes to represent a number of questions with a small number of hypothetical factors. According to Field (2009:15), factor analysis attempts to identify underlying variables or factors that explain the pattern of correlations within a set of observed variables.

Factor analysis can also be used to generate hypotheses regarding casual mechanisms or to screen variables for subsequent analysis (for example, to identify co-linearity prior to performing a linear regression analysis). Factor analysis was used to determine whether the knowledge variables measured what they set out to measure. Factor analysis uses mathematical procedures for the simplification of interrelated measures to discover patterns in a set of variables (Child 2006:12). Factor techniques are applicable to a variety of situations. Factors actually do not exist in order to perform a factor analysis. In practice the factors are usually interpreted, given names and spoken of as real things.

6.2.1.3 Kaiser-Meyer-Olkin and Bartlett's Test

According to Field (2009:22), Kaiser-Meyer-Olkin's (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity is recommended to check the case to variable ratio for the analysis being conducted. The KMO and Bartlett's test play an important role in accepting sample adequacy. While the KMO ranges from 0 to 1, the accepted index is over 0.6. The Bartlett's Test of Sphericity relates to the significance of the study and thereby shows the validity and suitability of the responses collected to the problem being addressed through the study. For Factor Analysis to be recommended as suitable, the Bartlett's Test of Sphericity must be less than 0.05. The matrix tables are preceded by a summarised table that reflects the results of KMO and Bartlett's Test.

Table 6.3: KMO and Bartlett's Test for Section B

	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Reliability	.837	1100.676	6	.000
Assurance	.767	941.644	3	.000
Tangibles	.726	544.331	3	.000
Empathy	.500	389.877	1	.000
Responsiveness	.667	497.915	3	.000

From Table 6.3 it can be observed that all the responses under reliability, assurance, tangibles, empathy and responsiveness in Section B of the learner questionnaire showed a high degree of validity. The KMO in each of the five aspects ranges from 0.500 to 0.837 while all the items for the Bartlett's Test are 0.000, which is below the recommended value. Therefore the data collected in this section of the learner questionnaire was suitable and could therefore be used to address the findings.

Table 6.4: KMO and Bartlett's Test for Section C

	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Expectation	.919	2247.906	66	0.000
Perception	.961	5620.674	66	0.000

From Table 6.4, it can be observed that all the responses under expectation and perception in Section C of the learner questionnaire showed a high degree of validity. The KMO is 0.919

and 0.961 respectively, while the items for the Bartlett's Test are 0.000. Therefore the data collected in this section of the learner questionnaire was suitable and could be used to address the findings.

This study satisfied all of the conditions for factor analysis. Factor analysis was done only for the Likert scale items. Certain components divided into finer components. This was explained in the rotated component matrix.

6.2.1.4 Rotated Component Matrix

Factors are rotated for better interpretation since un-rotated factors are ambiguous. According to Costello and Osborne (2005:4), the goal of rotation is to attain an optimal sample structure which attempts to have each variable load on as few factors as possible but maximizes the number of high loadings on each variable. Rotation maximizes high item loadings and minimizes low item loadings, thereby producing a more interpretable and simplified solution. The Rotated Component Matrix attempts to have each factor define a distinct cluster of interrelated variables so that interpretation is easier.

With reference to the quantitative data:

- The principle component analysis was used as the extraction method and the rotation method was Varimax with Kaiser Normalization. This is an orthogonal rotation method that minimizes the number of variables that have high loadings on each factor. It simplifies the interpretation of the factors.
- Factor analysis/loading shows inter-correlations between variables.
- Items of questions that loaded similarly imply measurement along a similar factor. An examination of the content of items loading at or above 0.5 (and using the higher or highest loading in instances where items cross-loaded at greater than this value) effectively measured along the various components.

It is noted that the variables that constituted all sections loaded perfectly along a single component in Section B, except Section C – Expectations. This means that the sections measured what they were meant to measure. Expectations loaded across two sub-themes. The first sub-theme represented by C1 to C6 is "The everyday use of the Life Sciences learned at school" while statements C7 to C11 could be placed in the theme "Life Sciences increases awareness of the environment".

6.2.2 Biographical details of Life Sciences educators

Life Sciences educators were required to indicate whether they were appointed in a permanent or temporary capacity at their schools. The table below indicates the status of the educators that completed the questionnaire.

Table 6.5: Capacity of educator appointment

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Permanent	71	100.0	100.0	100.0

According to the data in Table 6.5, all of the respondents were appointed in a permanent capacity. Therefore, all the participants were skilled professionals who had the expertise to contribute meaningfully to this study and were committed to improving the teaching and learning of Life Sciences.

Educators were also required to indicate whether they were currently teaching grade 12 as this indicated their level of understanding of the grade 12 syllabus, as well as the requirements and criteria of the school-based assessments in Life Sciences.

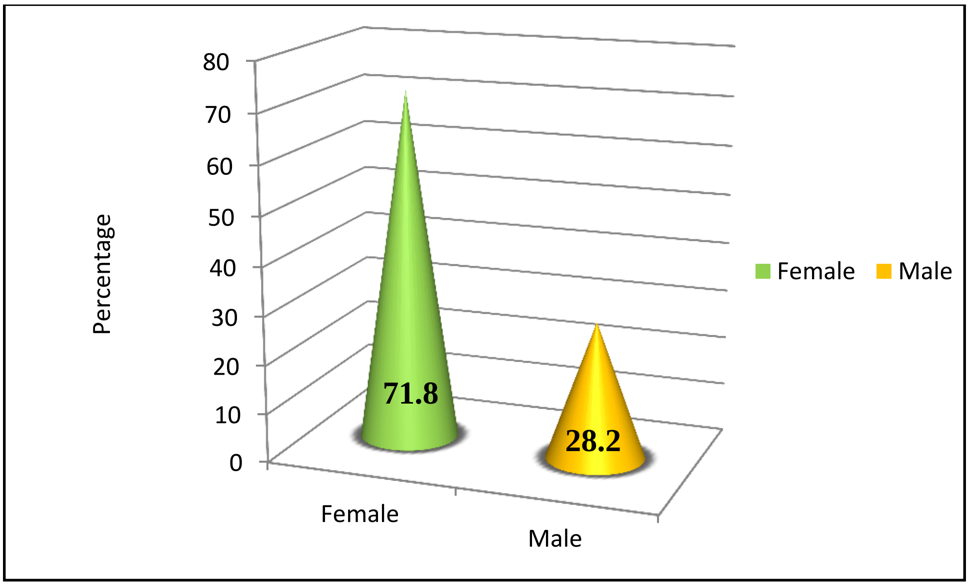
Table 6.6: Educators teaching grade 12

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	71	100.0	100.0	100.0

All of the respondents indicated that they were teaching Life Sciences at grade 12 level (refer to Table 6.6). This was a useful statistic as it indicated that the respondents were up-to-date with the syllabus requirements. These results were an added advantage to the research because all the educators that participated in the study were au fait with the prescribed documents from the Department of Basic Education and were in a favourable position to critique them. Since all the participants engaged with the grade 12 Life Sciences curriculum, they had first-hand knowledge of those topics in the curriculum that posed challenges either to the learners or the educators themselves. Hence, the credibility of the educator responses to the questionnaire was not compromised in any way.

Statistics regarding the gender of the participants were also obtained. This was done to ensure that there was both male and female representation. However, this study did not focus on the impact of gender. Hence the researcher did not provide a detailed analysis of this aspect.

Figure 6.1: Gender of educator respondents



The gender composition of the sample indicated that there were 71.8% female respondents and 28.2% male respondents (refer to Figure 6.1). Thus, both male and female educators participated in the study. However, the majority of the respondents (71.8%) were female educators. This comes as no surprise as the teaching profession is composed of a greater number of females than males. At the interview, the educators stated that there were more females in the profession as they viewed teaching as an occupation that afforded them time in the afternoons to attend to their household chores, and attend to their own children and assist them with their homework.

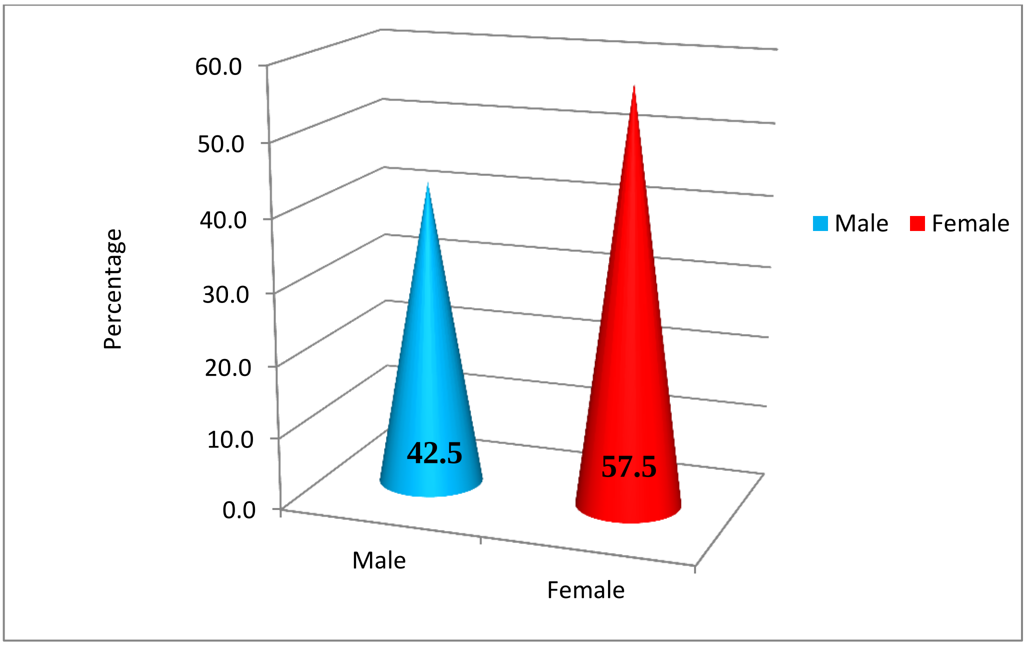
6.2.3 Biographical details of Life Sciences learners

This section summarises the biographical characteristics of the respondents who completed the learner questionnaire, which made up Section A of the questionnaire.

6.2.3.1 Gender

Figure 6.2 describes the overall gender distribution of the learner respondents.

Figure 6.2: Gender of learner respondents



According to Figure 6.2, the ratio of males to females is approximately 2:3 (42.5%: 57.5%). This observation is becoming the new trend in science since, in the past, education statistics in Sub-Saharan African countries showed that females continued to lag behind males in science, mathematics and technology education (Labudde, Neuenschwander, Herzog and Gerber 2000:145). The reason for females lagging behind was that there was cultural pressure, especially in the African community, for males to be more successful than females (Labudde, Neuenschwander, Herzog and Gerber 2000:145). This meant that parents ranked intellectual and educational value lower for girls than for boys, resulting in girls suffering from a negative self-concept. However, in this study, more females than males had chosen to study Life Sciences.

6.2.3.2 Home language

The main home language of the learner participants is reflected in Figure 6.3.

Figure 6.3: Home language of learner respondents

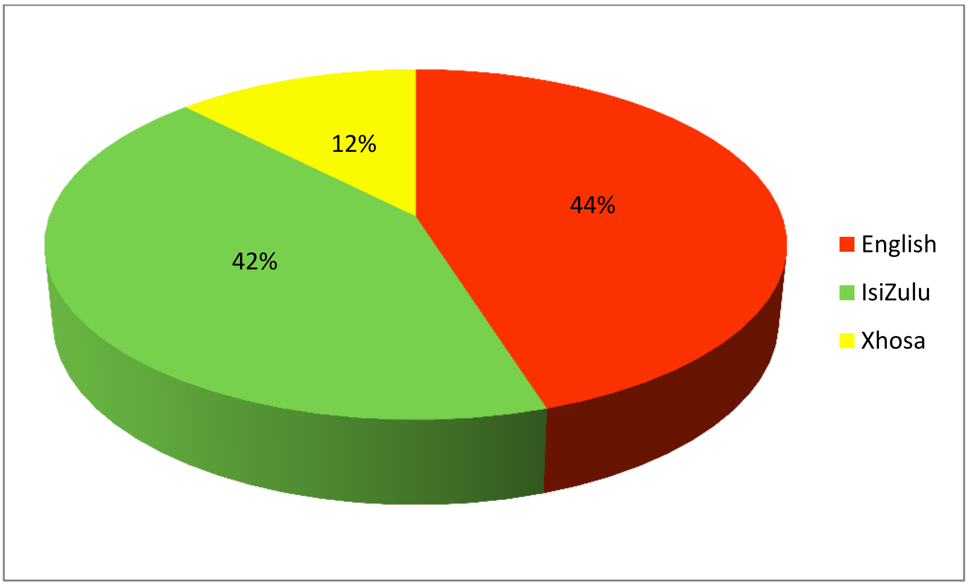
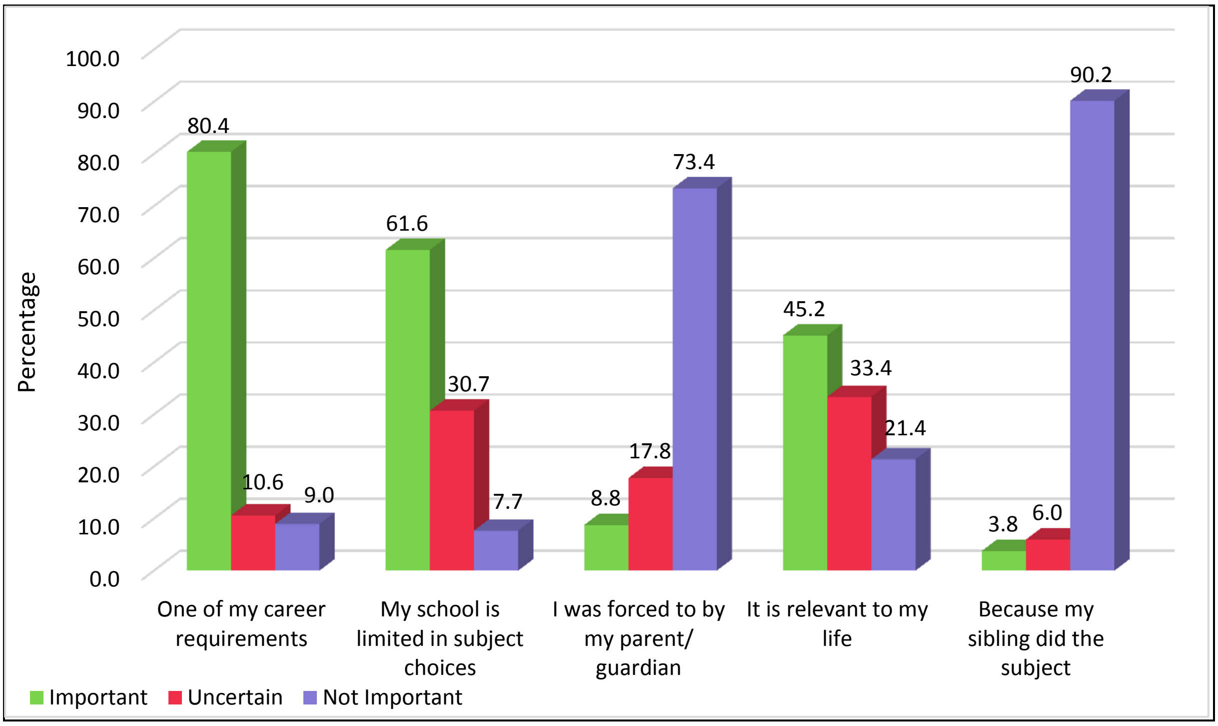


Figure 6.3indicates that a total of 44% of the learner participants were English home language speakers, while 42% of the learners were IsiZulu home language speakers and 12% were Xhosa home language speakers. Hence, a total of 54% of the learners were not English home language speakers. It must be noted that a large percentage of the learners may have experienced a learning barrier since they were English second language speakers.

6.2.3.3 Reasons for studying Life Sciences

Figure 6.4 indicates some of the reasons and importance ratings allocated to why learners chose to study Life Sciences.

Figure 6.4: Reasons for learners choosing Life Sciences



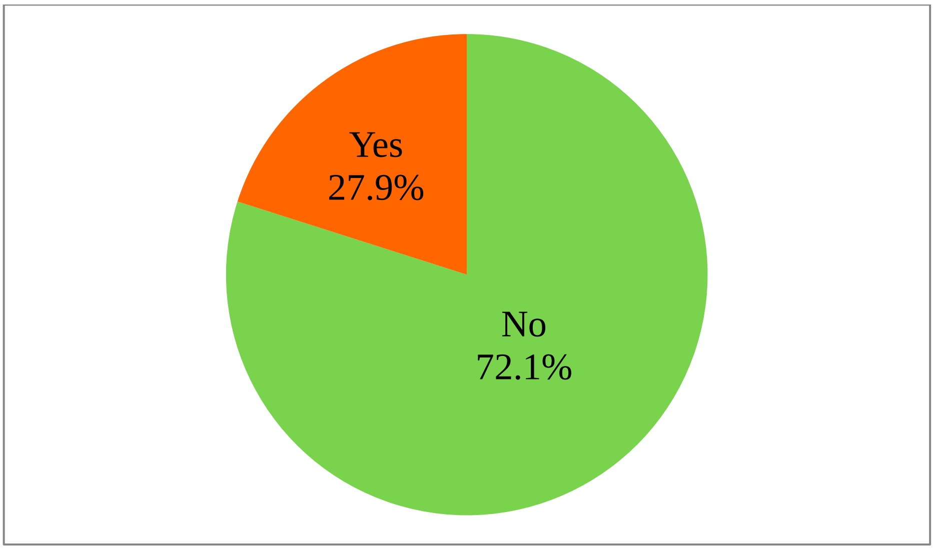
The chi-square tests indicate that the differences in the scoring patterns per option per statement were significant ($p < 0.05$). From Figure 6.4, it may be noted that most respondents (80.4%) chose the subject as it was a career requirement. This finding was further confirmed during the interview when almost 50% the learners stated that Life Sciences provided greater job opportunities. The students that were interviewed were generally positive to science related careers because of the opportunities for employment. The respondents indicated that the number of people choosing science related careers was increasing because of the pay and also many of them stated that a career in science is prestigious. However, more than 60% of the learners indicated that their schools were limited in terms of the subject choices that were available.

Approximately 9% (refer to Figure 6.4) of the learners indicated that family pressure was the main reason for choosing the subject. It was interesting to note that 45% of the respondents considered Life Sciences to be relevant to their lives. However, during the interview the learners stated that many topics of the Life Sciences curriculum had very little or no relevance to them and that they found those topics to be extremely challenging to study. De Villiers (2011:545) study showed that there is a correlation between the grade of difficulty and the level of interest with regard to the content knowledge areas in Life Sciences. Learners claimed that learning about aspects that had no relevance to them had a negative effect on their performance in the subject.

6.2.3.4 Level of learner satisfaction with their achievement in Life Sciences

The level of satisfaction regarding learner performance in the subject is represented in Figure 6.5.

Figure 6.5: Level of satisfaction with performance by learners in Life Sciences



From Figure 6.5, it is evident that the majority (72.1%) of learners were not satisfied with their performance in Life Sciences. According to Onwu (2012:45), poor performance by learners in Life Sciences in many instances could be attributed to the failure of the curriculum in meeting the interests and aspirations of the students. Studies by Rodrigues (2006:175) indicated that students benefit significantly when science curricula are localised. A report by the Australian Academy of Science (Goodrum, Druhan and Abbs 2012:44) stated that when students study real world ideas, problems and issues in science, they tend to make connections with their learning which becomes meaningful to them in their present and possible future life circumstances. A context-based science education should thus focus on developing knowledge and skills from contexts that are familiar to the students, such as social issues which are closely related to students' needs and interests and which reflect the realities of the communities in which they lead their lives.

6.3 Learner questionnaire to assess service quality dimensions of teaching and learning

The results for each of sections B and C of the learner questionnaire were compared to arrive at a parameter for each of the questions and also for each of the five dimensions. The final score was generated by the difference between the interviewee's perceptions and expectations. A negative result should be viewed as an opportunity for improvement and not as a problem.

6.3.1 Section B: About your Life Sciences teacher

This section dealt with the interaction between the Life Sciences teacher and the grade 12 Life Sciences learners. The section that follows analyses the scoring patterns of the respondents per variable per section. Where applicable, levels of disagreement (negative statements) were collapsed to show a single category of "Disagree". A similar procedure was followed for the levels of agreement (positive statements). The results were first presented using summarised percentages for the variables that constitute each section. Results were then further analysed according to the importance of the statements. A gap analysis was done for the perceptions using the maximum ideal score of the expectation (5), as it is expected that customers (learners) would anticipate the best possible service.

6.3.1.1. Assessment of reliability

To determine whether the scoring patterns per statement were significantly different per option, a chi-square test was done. The null hypothesis claims that similar numbers of respondents scored across each option for each statement (one statement at a time). The alternate states that there is a significant difference between the levels of agreement and disagreement. The sig. values (p-values) are less than 0.05 (the level of significance) which implies that the distributions were not similar. Thus, the differences in the way respondents scored (agree, uncertain, disagree) were significant. The graph presented summarises the scoring patterns.

Table 6.7: Items assessing reliability

My teacher is punctual in class	B1
My teacher's teaching methods are effective	B2
My teacher gives proper guidelines which he/she adheres to	B3
My teacher occupies me gainfully during every Life Sciences period	B4

Figure 6.6: Assessment of reliability

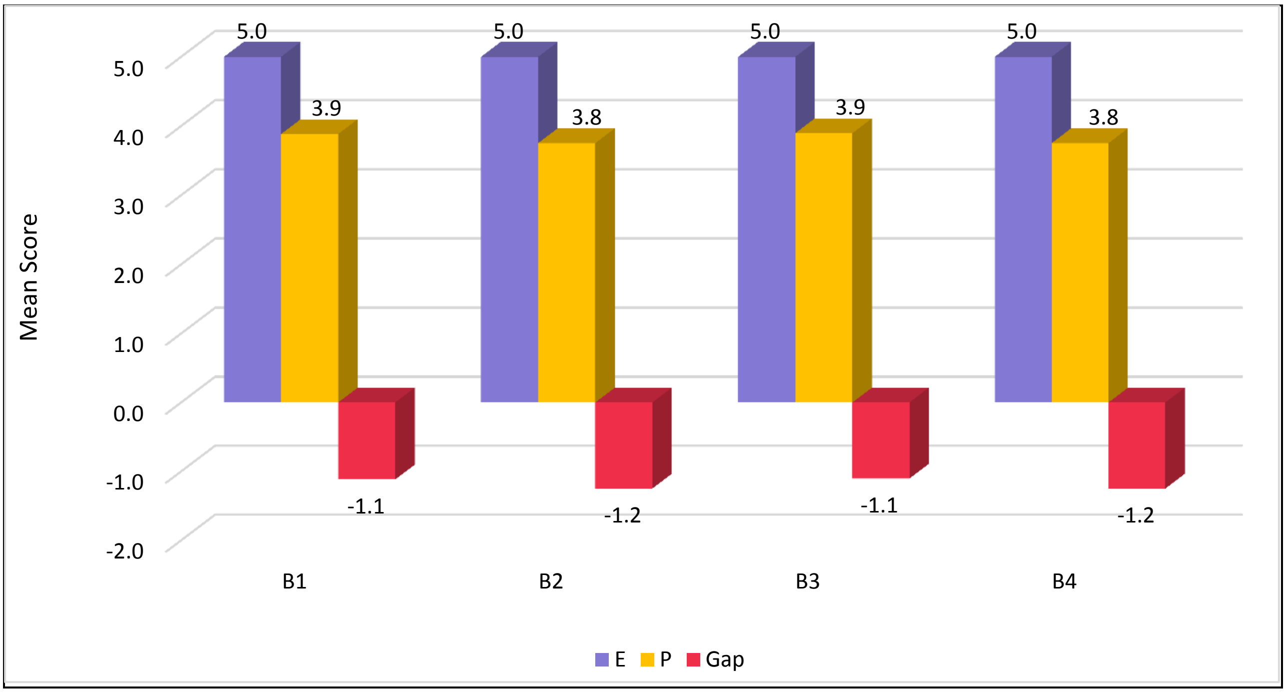


Figure 6.6 indicates that the scores are similar for both expectations and perceptions. Hence, the gap scores are similar as well. According to Sagney, Banwet and Karunes (2004:145), a negative service quality gap is an indication that the expectation of the student is more than their perception of a specific clause. The overall average gap score for reliability was -1.2. Statements B2 and B4 (refer to Table 6.7 and Figure 6.6) contributed slightly more to this than statements B1 and B3. These statements refer to the methods employed by the teacher and the degree to which the teacher keeps the learners occupied. The mean score is 3.8, which corresponds to the high overall percentage (75.8%) for agreement with statements B2

and B4. During the interview, 80% of the learners concurred that their Life Sciences educators did not use innovative teaching methods. Therefore a gap of -1.2 in statement B2 is noted (refer to Figure 6.6). The learners stated that their educators generally used the *"chalk and talk method of teaching and very rarely did any practical lessons with them"*. According to Jensen (2011:35), the success of a science lesson is determined to a great extent by the ability of the educator to organise material and to select and utilize a teaching method appropriate to a particular lesson.

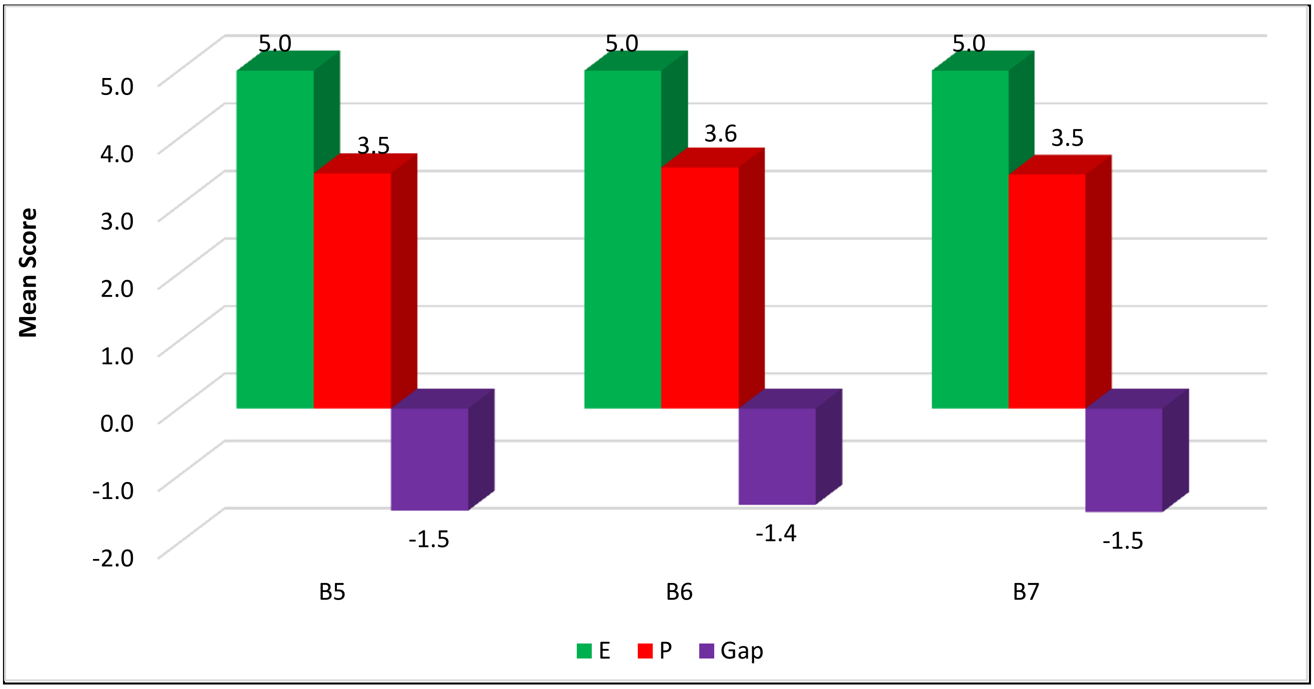
6.3.1.2. Assessment of assurance

This study was based on measuring service quality and focused primarily on how to meet or exceed the expectations of the learners. The study viewed service quality of the Life Sciences curriculum at schools as a measure of how the delivered service level matches the expectations of learners with regard to lifelong learning. The concept of measuring the difference between expectations and perceptions in the form of the SERVQUAL gap score proved very useful for assessing levels of service quality. The overall average gap score for assurance was -1.5 with a mean score of 3.5, which corresponds to a mediocre overall percentage of agreement (55.2%). Parasuraman, Berry and Zeithaml (1988:28) contend that information on service quality gaps can help managers diagnose where performance improvement can best be targeted. They posit further that the largest negative gaps, combined with assessment of where expectations were highest, could be used to facilitate prioritisation of performance improvement. Against this background, it may be noted that in the aspect of assurance in this study, there was a significant gap (refer to Table 6.8 and Figure 6.7) with a high expectation in statement B7.

Table 6.8: Items assessing assurance

My teacher always answers my questions adequately	B5
My teacher is always interested in whatever topic he/she teaches	B6
My teacher makes me feel that doing Life Sciences is useful in everyday life	B7

Figure 6.7: Assessment of assurance



The learners posited during the interview that when they asked the teachers questions during the Life Sciences lessons, they were never satisfied with the response from their teachers as the their teachers would make them feel that those were irrelevant to the lesson being taught. Thus a gap of -1.5 for statement B5 could be noted in Figure 6.7. During the interview many of the learners indicated that their Life Sciences educators *very rarely go the extra mile to make me feel that doing Life Sciences is useful in everyday life and for my teacher, teaching is so routine.* This response from the learners seems to explain the gap of -1.5 for statement B7 as observed in Figure 6.7. According to the National Curriculum and Assessment Policy Statements document (Department of Education 2011:13), the third specific aim of Life Sciences is to enable learners to understand that school science can be relevant to their lives outside of the school and that it enriches their lives. Even though the document stipulated and dealt with the interface of science and society, the teaching approach which ought to facilitate this interface seemed to be largely absent from Life Sciences lessons. According to Onwu (2012:5) a culturally relevant science education that is socially responsible is needed in schools in order to enhance the emancipatory interests of students in such a way so as to enable them to play a responsible role in society. To strengthen his argument, Onwu (2012:5) noted that relevance would entail the use of selected community resources and the incorporation of local issues into the school curriculum. Thus, context-or issues-based learning is invariably viewed as something worthwhile, meaningful, useful and important by the student.

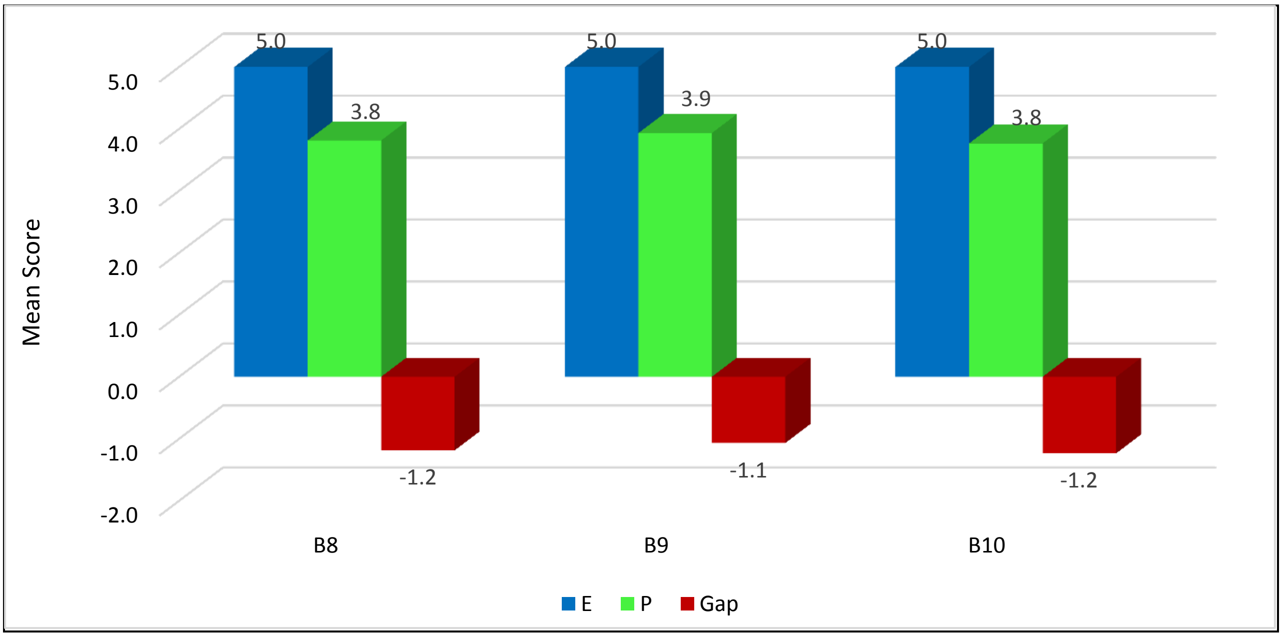
6.3.1.3. Assessment of tangibility

Table 6.9 and Figure 6.8 deal with statements B8, B9 and B10 of the learner questionnaire, which were associated with the aspect of tangibles from SERVQUAL. The data indicated that the scores were similar for both expectations and perceptions. Hence, the gap scores were similar, as represented in Figure 6.8.

Table 6.9: Items assessing tangibility

My teacher includes teaching aids in his/her teaching	B8
The notes and hand-outs from my teacher are appropriate materials for students	B9
I am satisfied with the number/volume of exercises my teacher gives me	B10

Figure 6.8: Assessment of tangibility



The overall average gap score for tangibility was -1.2. From Table 6.9, statements B8 and B10 contributed slightly more to this than B9 (refer to Figure 6.8). The mean score was 3.8, which corresponded to a fairly high overall percentage (73.6%) for agreement. Many of the students in the learner interview stated that the handouts that they received from their Life

Sciences educators were good, but not all the students had the capacity to understand the language used in the worksheets. They also commented that at times they were unable to complete their homework in Life Sciences because they did not understand what was required of them. The students added that when they tried to complete the worksheets that were given to them, many of their answers were incorrect which resulted in many students resorting to not attempting to do their Life Sciences homework at all. The learners stated that the subject Life Sciences had many confusing terms which they felt were not necessary for them to know. They reiterated that many students performed poorly in Life Sciences or opted not to do Life Sciences because of the difficulty level of the language used. It could therefore be assumed that for these reasons statement B9 had a gap score of -1.1 (see Figure 6.8).

A gap of -1.2 for statement B8 as depicted in Figure 6.8 could be attributed to many schools lacking in well-equipped laboratories with a variety of scientific models and apparatus. The lack of resources made it difficult for teachers and learners to conduct scientific investigations under those circumstances. The learners stated that teachers resorted to drawing structures of the experiments on the chalk board and explained everything to the learners without learners being involved in the inquiry activities. Chisholm (2005:87) argued that the Life Sciences curriculum could be implemented with ease in well–resourced contexts with well trained teachers. Rogan and Grayson (2003:1173) describe the shortage of resources as the main factor that made curriculum reform impact negatively on teaching and learning in schools. The students scored tangibility lower in importance than empathy. This does not mean that tangibility is unimportant to students; rather it does not hold the same level of significance as the assurance and empathy dimensions.

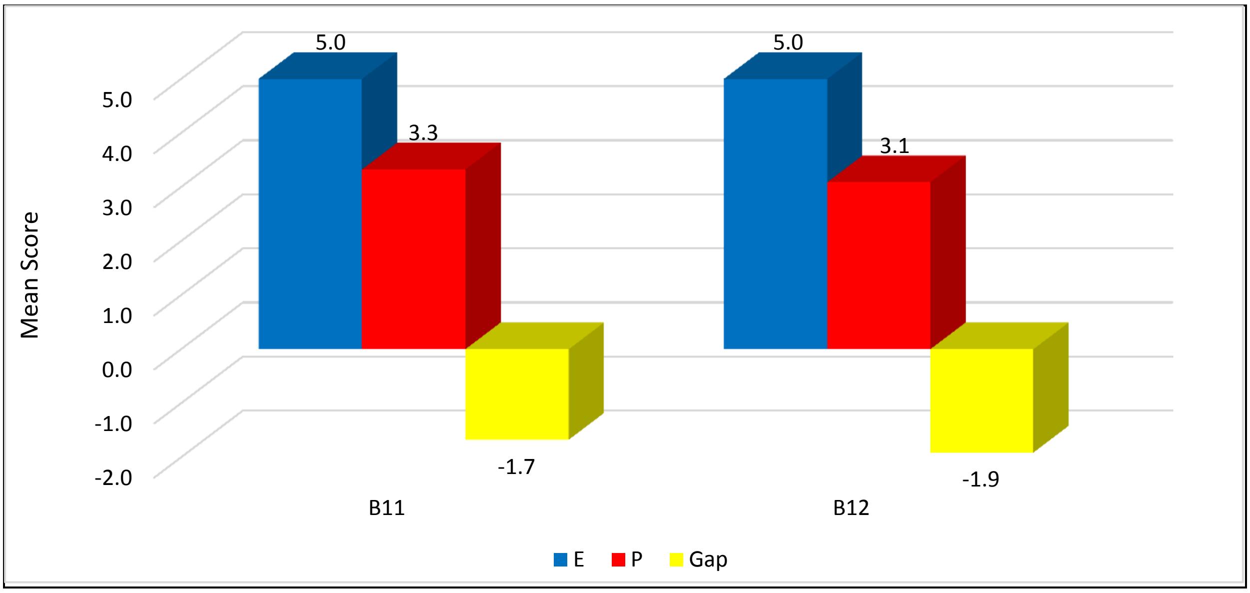
6.3.1.4. Assessment of empathy

Empathy deals with the care and individualised attention that the educators provided to their students. The two questions B11 and B12 as indicated in Table 6.10 refer to the dimension of empathy.

Table 6.10: Items assessing empathy

My teacher encourages me in Life Sciences	B11
I am satisfied with the level of individual attention given to me by my teacher	B12

Figure 6.9: Assessment of empathy



In comparison to the other dimensions empathy ranked the lowest with a mean of 3.2, which corresponded to a very low overall percentage (45%) for agreement. Statements B11 and B12 from Table 6.10 together obtained an overall average gap of -1.8 (refer to Figure 6.9). This was the largest average gap compared to the other dimensions. Students ranked empathy as one of the most important of the five dimensions. In this dimension, the greatest concern was in the level of individual attention given to the student by the Life Sciences teacher, which had a large gap of -1.9. The fact that empathy has the largest gap averages across the students suggested that they were not satisfied with the amount and kind of empathy they received.

In explaining this observation, the learners stated at the interviews that they wanted their Life Sciences educators to display empathy towards their understanding and their performance in Life Sciences as they believed it was a challenging subject. They further elaborated that empathy is critical in the job of a teacher because this will inspire confidence in the students. According to Shelley (2005:22), expectations influenced experience in order to construct what becomes reality for the student. When a student's expectations are met, he or she is more likely to remain in a particular school. When expectations are unmet, the student may consider dropping out or transferring to an institution with a better fit (Lovelock and Wirtz 2007:43). The interviews elicited views and opinions from students that also supported this interpretation. Learners stated that students had certain expectations of a school, in particular of the teachers. If those expectations were not met, learners had the tendency to drop out of Life Sciences or, in many cases, they changed schools.

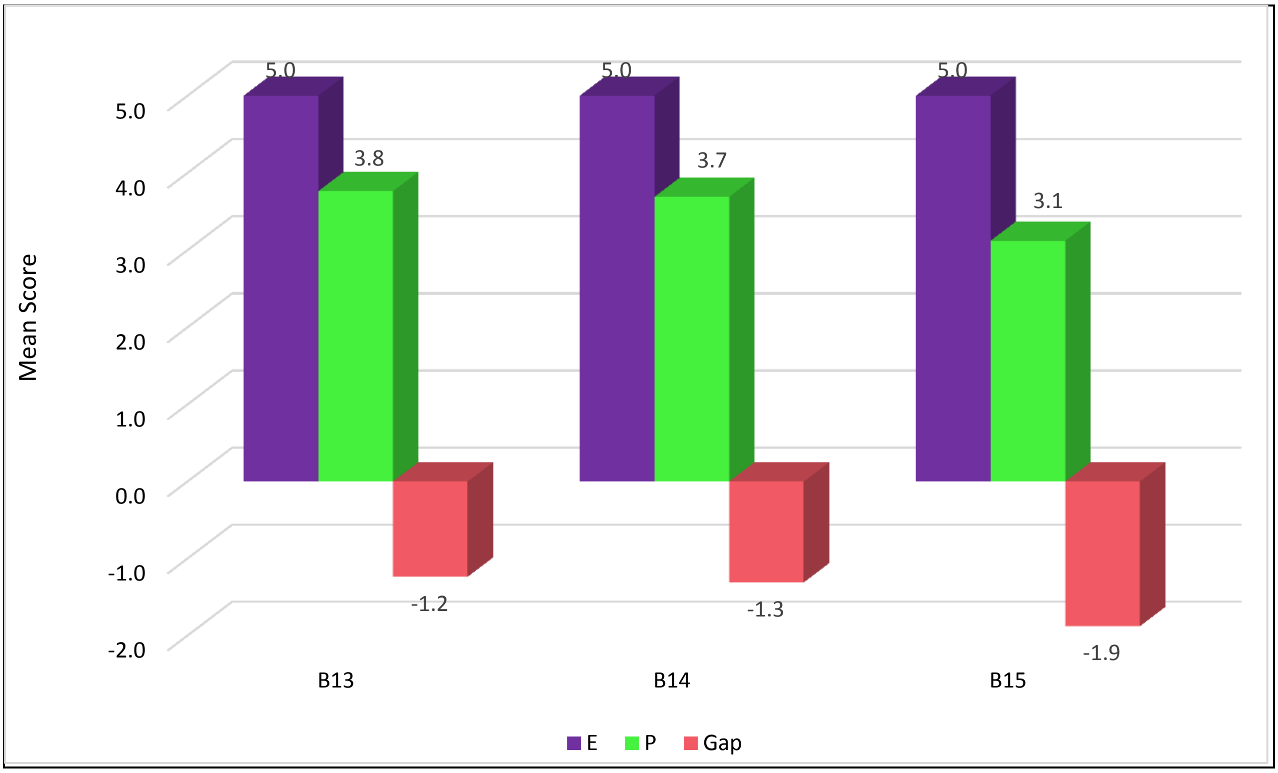
6.3.1.5. Assessment of responsiveness

Responsiveness as stated by Parasuraman, Berry and Zeithaml (1988:28) dealt with whether the teachers at a school were willing and available in helping to explain when students were in doubt. Table 6.11 denotes the three statements of Section B of the learner questionnaire that belong in the dimension of responsiveness.

Table 6.11: Items assessing responsiveness

I am satisfied with the frequency at which my teacher gives exercises	B13
My teacher marks my work timeously	B14
My teacher displays willingness in addressing my academic problems	B15

Figure 6.10: Assessment of responsiveness



The mean for this dimension was 3.5, which corresponded to an overall percentage of 59% for agreement. The overall average gap for responsiveness was -1.5 with the last statement, B15, having the largest gap of -1.9. This implies that students attached a high degree of importance to the willingness of their Life Sciences educators to help students, to listen to and be responsive to their academic problems. Hence, there was no disparity between the gap scores for statements B12 from Figure 6.9 and B15 from Figure 6.10. In fact, the gap scores for both those statements were exactly the same (-1.9) (refer to Figures 6.9 and 6.10). This confirmed that the learners yearned for individual attention and assistance from their Life Sciences educators.

The African students at the interview indicated that they would like their Life Sciences teachers to be more concerned with their educational progress and help them with their language and study skills. The African students also stated that in subjects where they had African teachers teaching them, the teachers explained the challenging aspects in IsiZulu and then in English. However, there were other African learners who pointed out at the interview that resorting to "code switching" was not very beneficial as most of the scientific words could not be translated to IsiZulu. They re-affirmed that Life Sciences was like another language laden with terminology which they had never heard of. To them, this was a major challenge which impacted on their understanding of the lessons. Their view was that Life Sciences teachers should explain the work in English but should consider their language barrier and teach the lesson at a very slow pace. To corroborate this point Wellington and Osborne (2001:1) stated that one of the major difficulties experienced by learners when learning science was learning the language of science. Schaffer (2007:5) also argued that it was important for Life Sciences educators to pay attention to language to improve the quality of science education and every lesson should, by implication, be a language lesson. The participants pointed out that even the textbook may be difficult for a learner from a different culture to understand and, where possible, the teacher should give the necessary guidance to learners from different backgrounds.

Stemming from the discussion outlining the views of students regarding their Life Sciences educators, it must be noted that with the recent curriculum transformation in South Africa coupled with calls for improving quality, it is imperative that educators update and improve their skills. According to Levin (2008:290), the era is passing when it was assumed that a person equipped with a teaching certificate was prepared for lifelong service as an educator.

Educators as professionals need to keep abreast of new developments in the curriculum, extend their expertise and acquire new competencies.

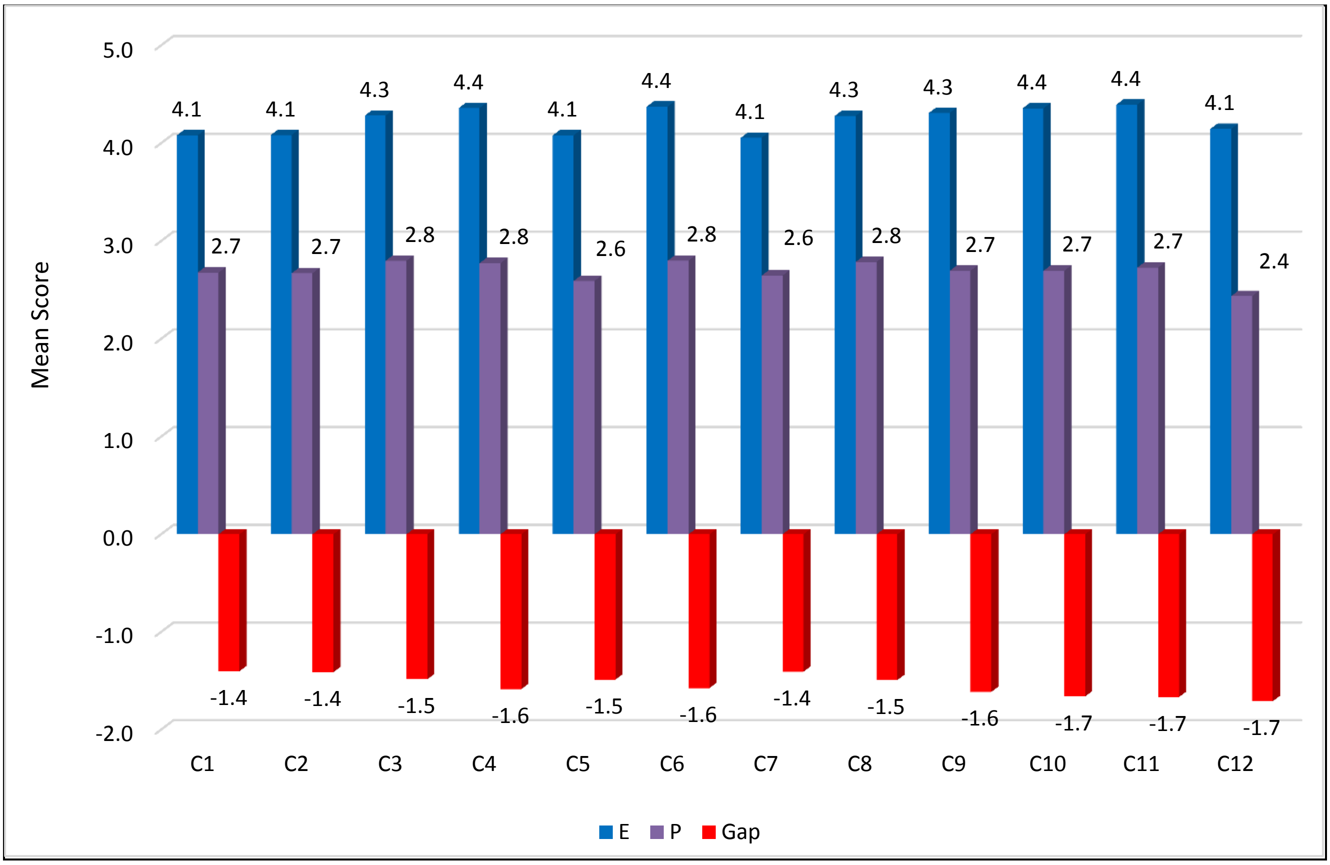
6.3.2 Section C: The Life Sciences curriculum

This section of the learner questionnaire dealt with learner expectations and perceptions of the Life Sciences curriculum in the context of lifelong learning. As indicated in Table 6.12, there were 12 statements related to the curriculum. For each statement, learners had to tick the appropriate box on the 5 point Likert scale that reflected their feeling regarding their expected service (what kind of service they expect to receive) and perceived service (what was their opinion/perception of the quality of the service they actually received) in terms of the Life Sciences curriculum. The results were then analysed according to the importance of the statements. A gap analysis was conducted by finding the difference between the students expected service and their perceived service. Figure 6.11 illustrates the results of the gap analysis.

Table 6.12: Items assessing the Life Sciences curriculum

Knowing Life Sciences will help me in my career	C1
Life Sciences courses would be very helpful no matter what I decide to study	C2
Life Sciences is important in everyday life	C3
Knowing Life Sciences will help me in many ways as an adult	C4
In day-to- day life I often use the Life Sciences learnt at school.	C5
Life Sciences has taught me how to take better care of my health	C6
Life Sciences has made me more critical and sceptical	C7
Life Sciences has increased my curiosity about things that we cannot yet explain	C8
Life Sciences has increased my appreciation of nature	C9
Life Sciences has shown me the importance of our way of living	C10
Life Sciences is interesting	C11
Everybody should learn Life Sciences at school	C12

Figure 6.11: Assessment of the Life Sciences curriculum



The difference between perceptions and expectations (P-E) for all statements in this section of the learner questionnaire was negative, revealing that there were considerable faults in the curriculum which jeopardised the quality of the service being offered, in this case relating to the quality of the Life Sciences curriculum. It must be noted that statement C11 which read *"Life Sciences is interesting"* was amongst those with the highest gap (-1.7) (refer to Figure 6.11). The students attributed this to the method of their engagement with the Life Sciences curriculum. In the interview, learners stated that Life Sciences had repeatedly failed to excite and attract students to choose the subject because Life Sciences was frequently taught as rote memorisation of complex and meaningless facts. They went on to argue that the Life Sciences curriculum was presented as a set of facts which had to be listed in the correct sequence. There was very little provision in the curriculum for developing analytical and interpretative skills amongst students.

Most of the respondents in the learner interview stated that the Life Sciences curriculum that they were exposed to was hardly influenced by contextualised teaching. Instead, the emphasis was on structured teaching approaches that were purely content based. They stated that they felt disconnected from the Life Sciences lessons as the content was not relevant to their lives. An elaboration of relevance, as argued by the students, entailed the use of selected community resources and the incorporation of local issues into the school Life Sciences curriculum.

The learners also raised a concern in the interview that in order for students to be motivated to study Life Sciences, it would be necessary for the content to become embedded in a meaningful context as seen from their points of view. The learners stated in the interview that plant and animal biology were fraught with concepts and terminology that can be misunderstood and misinterpreted. Others were adamant that some topics like plant hormones, meiosis and reproductive mechanisms in animals were boring for them to learn. According to DeWit and Osborne (2008:111), students were put off learning Life Sciences if they found the subject matter boring. Furthermore, Cleaves (2005:475) found that there was a link between finding a subject boring and perceptions of it as difficult. In other words, when students find the subject matter boring, they find learning that subject matter challenging and therefore generally do not excel.

The learners felt strongly about the need to know and have a chance to actively participate in issues at stake. The responses presented by the learners seem to confirm that they chose Life Sciences not because it had relevance to their everyday life but, as stated earlier, approximately 80% of respondents who completed the questionnaire indicated that they chose Life Sciences to meet their career requirements. This was in keeping with the smallest gap of -1.4 for statement C1 which read *"Knowing Life Sciences will help me in my career"*. Clearly, students are very interested in pursuing such scientific advances, with the exception of ethics, in their studies. To provide a more informed understanding of students' interests, interview responses were considered in the light of the group responses. The following statement is representative of student responses from those interviewed. Students were asked to clarify why they were quite interested in the key idea of cloning. *Cloning? It's intriguing. I saw an ABC show by some English Lord who said identical twins were clones. Well they would have to be if you think about it. Clones have the same DNA and so do identical twins. But then most clone stuff you hear about is between a parent and child like Dolly the Sheep, not between siblings like twins. So it is interesting and I would like to study it. For curiosity sake I guess … Since you ask the question in relation to plants …yes please if we can do it at* *school!* One student was very keen to see DNA and the notion of DNA actually being extracted outside a forensic laboratory was exciting for her. However, her enthusiasm waned at the thought of her actual class ever participating. It seems a talkative class was not permitted to undertake hands-on experiences in this case: *Me extract DNA? Yes, that would be great, but I doubt I will ever even see it for real. You need fancy scientific equipment in a sterile lab, you know like on CSI.* Interviewer: *Actually that is not quite true. You do see it like that on TV, but there are simple procedures you can do in your kitchen at home, or in the school lab to extract DNA from fruit.* Student: *You're kidding! WOW that is cool. How do I do it? Is it hard? I bet my class won't ever do it – we talk too much so we have to copy notes instead of doing practical work.* It is evident from this excerpt that those students were victims of a common practice of decreasing practical activities in science. Students show intense interest in practical experiments in science. However, some do not experience as *much practical work as they would like.*

Various studies (Lyons 2010:292 and Sjoberg 2010:34) highlighted that students need to feel the relevance of the subject to society and to their own world but, in reality, what is taught is often disconnected from cutting-edge science and from today's applications of science and technology, which tends to dampen interest. The interviewed educators also alluded to the call for Life Sciences to be made more pertinent and empowering to learners if one wished to prepare future citizens who are able to deal with complex everyday issues in socially responsible ways. This argument is further supported by Gilbert (2004:970) when he stated that in context-based learning, educational topics adopted from everyday life and society should be used not just to provoke the situated learning of Life Sciences, but also to allow students to recognise the importance of Life Sciences for understanding scientific phenomena. Taking into consideration the aforementioned concerns expressed by the educators and learners, it may be noted that the element of lifelong learning has been given very limited prominence, if any, in the Life Sciences curriculum.

6.4 Educator questionnaire to assess quality dimensions of the Life Sciences curriculum

This section focuses on the questionnaire that the Life Sciences educators completed and it outlines the analysis of the data obtained. It also incorporates responses of educators from the interview.

6.4.1 Relevance of the grade 12 Life Sciences curriculum

The data obtained from the educator questionnaire indicates the opinions of educators on the level of relevance of the grade 12 Life Sciences topics that were currently being taught.

Table 6.13: Relevance of the grade 12 Life Sciences curriculum

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely Relevant	8	11.3	11.3	11.3
	Partially Relevant	63	88.7	88.7	100.0
	Total	71	100.0	100.0	

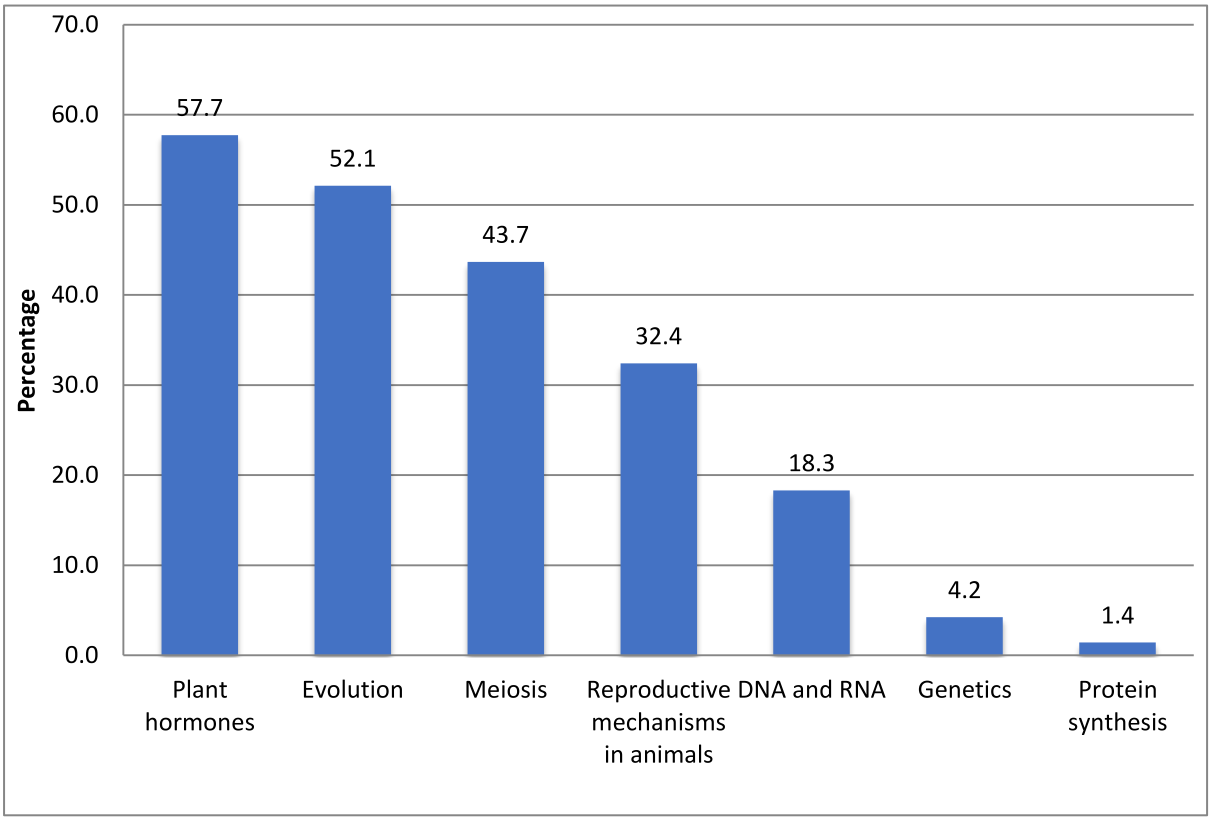
A very small percentage, only 11%, of the educators felt that the Life Sciences curriculum was completely relevant (refer to Table 6.13). These educators could have been new teachers who might have felt that this information would be handed to the Department of Education as some teachers did believe that this research was being conducted for the Department of Education, despite being told that the information would be treated confidentially. However, a large percentage of the educators (89%) did indicate that the Life Sciences curriculum was not completely relevant. Many of them stated that the major part of the curriculum was exactly the same content that they had studied over 35 years ago when they were students at school. The educators also stated that the learners generally displayed apathy to Life Sciences homework because they found the content to lack relevance to their lives. The educators also added that by learners not completing homework exercises in Life Sciences, the learners were not actively engaged in lessons through participation. Consequently, this did not auger well for their performance in tests and examinations.

The educators stated in the interview that time did not permit them to relate all aspects of the syllabus to the everyday experiences of the child. They did however agree that teaching Life Sciences against a context-based background would be more enlightening and would add meaning to the lessons. The educators were adamant that the focus of the grade 12 academic year was undoubtedly the statistics of the final examination and that their core function was to prepare students for that examination. Hence, they felt that they could "*not waste time*" attending to what they considered to be less significant, such as answering petty questions that learners pose and ensuring that learners understand the everyday value of Life Sciences. During the interview the educators also stated that they were unable to address each and every student's academic challenge in Life Sciences due to the reasons outlined earlier. The educators added that not many children were choosing Life Sciences because the felt that the subject was very demanding in terms of the number of assessment tasks as well as the volume of and the difficulty level of the content. As a result, many schools had a single unit of around 50 learners per class in grades 10, 11 and 12. The educators also felt that they were burdened with other extra-curricular and co-curricular activities at school which impacted on their level of preparedness for their lessons.

The frequency at which the topics "plant hormones", "evolution" and "meiosis" appeared for non-relevance was high. Reproductive mechanisms in animals also showed quite a high frequency for non-relevance. In the interview the educators indicated that when they taught the topic "Meiosis" in grade 12, they had to make reference to Mitosis that the learners had studied in grade 10. They stated that it was a daunting task getting the learners to recall the content from two years previously. Many of them stated that they had to spend at least 15 minutes recapping grade 10 work. The thinking of many of the educators was that these two topics should not have been studied during different years of the FET phase but rather within the same year so that the learners would be able to see how those processes differ or in what ways they were similar.

The educators were required to provide a list of the topics that they believed to have very little or no relevance to the students. Figure 6.12 highlights the views of educators with regards to relevant and irrelevant topics in the grade 12 Life Sciences curriculum. From figure 6.12 it may be noted that 57.7% and 32.4% of the educators indicated that plant hormones and reproductive mechanisms in animals respectively had no relevance to students.

Figure 6.12: Topics of relevance as rated by educators of grade 12 Life Sciences



From figure 6.12 it may be noted that a total of 52.1% of educators felt that the topic Evolution was of no relevance in the curriculum. Despite different religions and backgrounds, the students and teachers were, respectively, forced to learn and teach Evolution which was a controversial theme. Some of the learners and teachers who have deeply entrenched religious beliefs indicated that they found it difficult to accept evolution. Some educators mentioned that there were a few changes or additions to the curriculum which they considered to be quite negligible. They maintained that more appropriate and current aspects should be included into the Life Sciences curriculum, specifically in grade 12, as those students would be going into tertiary institutions that offer a wide range of courses. Educators argued that the grade 12 Life Sciences curriculum did not prepare students who wanted to pursue studies in various science-related fields after completing their schooling.

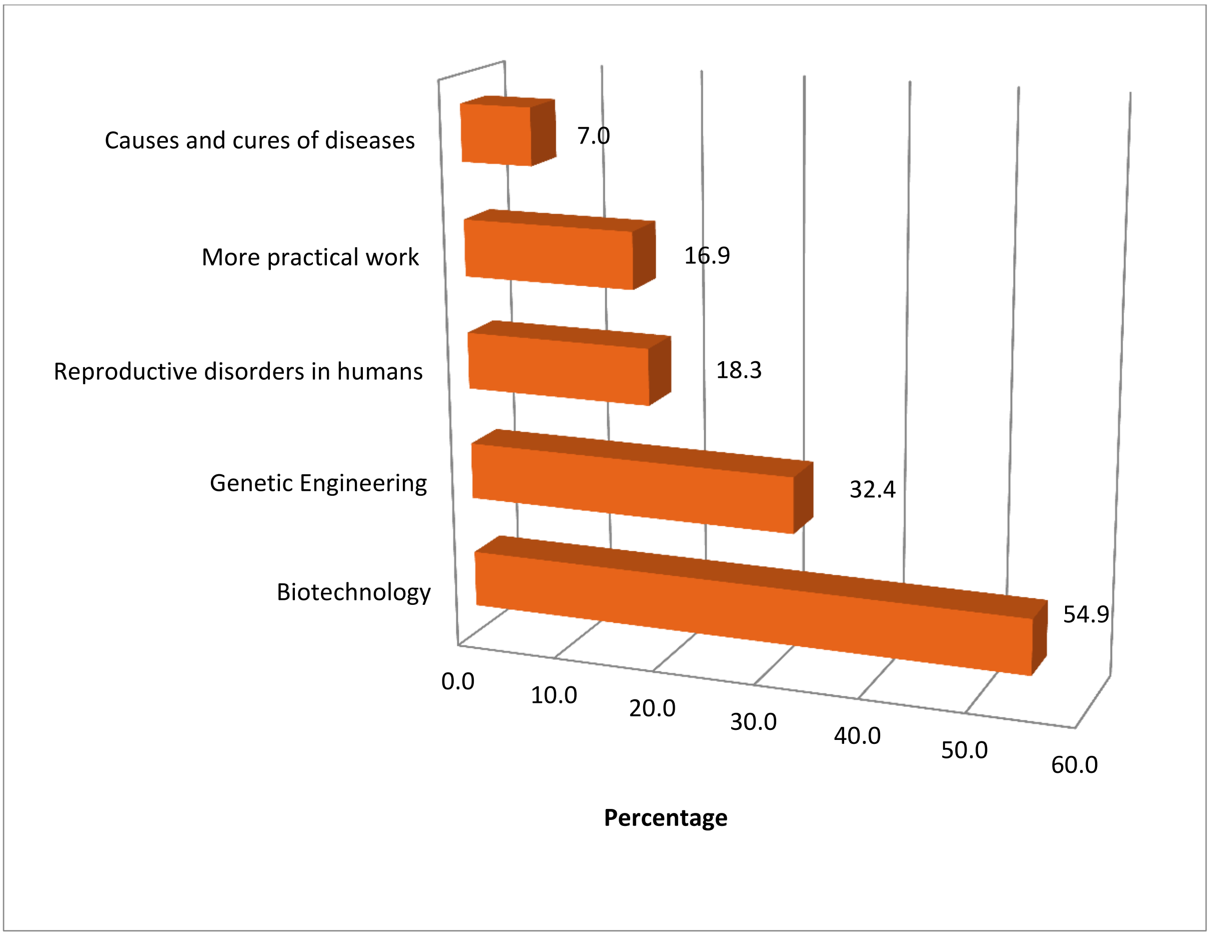
The educators stated that they would like to assist learners by providing individual attention to facilitate the learning process but cited various reasons for their inability to provide individual attention to their students. In the interview, the educators stated that in Life Sciences, the syllabus was extensive and the volume of work that had to be completed by the end of August did not permit them to engage individually with their students and attend to the unique concerns that their students might have. Another educator retorted that there were ten assessment tasks which the students had to complete by the end of September in Life Sciences. Educators explained that once each assessment task was marked, they needed to discuss the marking memoranda and engage in remedial teaching. The educators did however agree that making remedial teaching more personalised would have been beneficial to the learners, but time did not permit. Hence, remedial teaching involved an overview of the more serious challenges encountered by the majority of the learners. Another educator stated that the class sizes were too large to provide individual attention to learners. It was stated that there were up to 60 learners in a Life Sciences class and therefore not displaying any empathy to the learning challenges experienced by learners was beyond the control of the educators.

6.4.2 Topics for inclusion into the grade 12 Life Sciences curriculum

The educators were of the view that the grade 12 Life Sciences curriculum did not provide students with the necessary knowledge and skills to become employable after completing their schooling. Figure 6.13 illustrates a few topics that educators thought should be incorporated into the curriculum. Some of the educators stated that the Life Sciences curriculum should be made relevant and meaningful to the students and not become a forgotten body of knowledge. To this end, the educators were required to provide a list of topics that they thought would be beneficial to their students. They were allowed to list as many topics as possible, thus multiple responses were presented.

The educators iterated that if the topics they suggested for inclusion into the grade 12 Life Sciences curriculum were incorporated into the curriculum, then they should be taught in detail. In other words, educators should have received training from experts in those fields before the teaching of those topics. The frequency at which topics such as biotechnology and genetic engineering were selected for inclusion into the curriculum was high. Figure 6.13 has reference in this regard.

Figure 6.13: Topics for inclusion in the grade 12 Life Sciences curriculum



According to the educators that were interviewed, topics like genetic engineering and biotechnology, if introduced vigorously into the Life Sciences curriculum, would help to address current global challenges facing humanity in general, and Africa in particular.

Another cause for concern was that many teachers indicated that the changes taking place from NCS to the newly introduced policy (CAPS) were taking place very quickly. In South Africa, major curriculum reform in Life Sciences occurred four times and the teachers in the study believed that they needed more information and time to be trained before the implementation of the curriculum. Before they acclimatized to one policy, they were expected to catch-up with another and move to another change. A teacher remarked that "*I feel these changes are happening very fast and it is confusing us to such an extent that we do not know whether we are doing the right thing or not''*. The process of curriculum change should therefore be gradual because quality is important. Many teachers emphasised in the interview that they had to implement policies that they could not clearly interpret and understand. This was a result of inadequate training and a limited understanding of the new educational approach. Lyman, Lyman, Green and Dezendorf (2005:108) have asserted that it is important to understand curriculum change environments, before initiating any curriculum change activity. In the absence of this, the result would be that the environment where the changes in curriculum are needed to be implemented would not be conducive for the changes to take place effectively. The state of laboratories and the fact that other schools did not have laboratories at all; large class sizes; and limited resources were all indicators that the environments where the new curriculum changes had to be implemented had been overlooked by the curriculum planners or developers.

Educators also indicated that they were not consulted about the topics that should be included in the new Life Sciences curriculum and that, in some instances, they implemented certain aspects of the new policies for the sake of compliance. However, one educator did mention that the draft syllabus was on the internet and educators could have made recommendations if they wished. Almost all of the remaining educators stated in the interview that they had no knowledge of this. Educators re-iterated that curriculum development was vital to teaching and learning and therefore the Department of Education ought to have informed educators of the process of curriculum development via official circulars. They were adamant that requesting recommendations without properly elected educator representatives via the internet was not a suitable method employed by the Department of Education to address queries or suggestions put forward. As pointed out by Kirk and Macdonald (2001:565) teachers' contributions are particularly important in respect of curriculum development. Consequently it may be noted that it does not auger well for teaching and learning when educators become recipients of the curriculum and not partners in the curriculum development process. During the interview educators also stated that inadequate training for the new curriculum, poor or no laboratory equipment for conducting experiments and large class sizes also impacted on teaching and learning of Life Sciences.

6.5 Correlations

Bivariate correlation was performed on the (ordinal) data. The results indicated the following patterns: positive values indicated a directly proportional relationship between the variables and a negative value indicated an inverse relationship. For example, the correlation value between *“My teacher is punctual in class”* and *“My teacher is always interested in whatever topic he/she teaches”* is 0.670. This is a directly related proportionality. Learners indicate that the more interested the teacher is in the subject, the earlier the teacher would come to lessons, and vice versa. It could also be noted that the correlation value between “*My teacher encourages me in Life Sciences”* and “*My teacher makes me feel that doing Life Sciences is useful in everyday life”* is 0.800. This implies that the more encouragement the learners received from the teacher, the greater the feeling that Life Sciences was useful in everyday life. Another example of a positive correlation about the educators was that the more the teacher answers the learners’ questions adequately, the more satisfied the learners were with the level of individual attention given to them by their teacher.

There were also correlations regarding the Life Sciences curriculum. The correlation value between the statements “*Life Sciences has taught me how to take better care of my health*” and “*In day-to- day life I often use the Life Sciences learnt at school”* was 0.822. This denoted that the more students had learnt how to take care of their health in Life Sciences, the more they found themselves using the knowledge in their daily lives. There was also a correlation between “*Life Sciences is interesting”* and “*Everybody should learn Life Sciences at school”.* It could be noted that the more interesting Life Sciences was, the more students felt that everybody should learn Life Sciences. Another important observation was that the statement “*Life Sciences has increased my curiosity about things that we cannot yet explain*” correlates with the statement “*Life Sciences is important in everyday life*”. Thus, it could be noted that if the content of the Life Sciences curriculum increased the curiosity of students about phenomena that they did not have answers to, then they would consider Life Sciences to be important in everyday life. It could therefore be concluded, based on the correlations between the statements, that the quality of the Life Sciences curriculum determined whether students found the subject matter to inculcate lifelong learning.

Despite the small number of participants in this study, the information could be used to raise issues in terms of the Life Sciences curriculum and the challenges facing educators when new curricula are designed. This study had shown that there is a correlation between the grade of difficulty and the level of interest with regards to the content of the Life Sciences curriculum.

6.6 Hypothesis Testing

The traditional approach to reporting a result requires a statement of statistical significance. A p-value is generated from a test statistic. A significant result is indicated with "$p < 0.05$".

For section C, a paired t-test was done to determine whether the difference between Expectations and Perceptions were significant. Table 6.14 illustrates the results of the t-test.

Table 6.14: Paired Samples Test for Section C

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	C1.1 - C1.2	1.40050	1.42606	.07157	1.25980	1.54121	19.568	396	.000
Pair 2	C2.1 - C2.2	1.41058	1.53089	.07683	1.25953	1.56163	18.359	396	.000
Pair 3	C3.1 - C3.2	1.48485	1.61708	.08126	1.32509	1.64461	18.272	395	.000
Pair 4	C4.1 - C4.2	1.58543	1.67858	.08414	1.42001	1.75084	18.843	397	.000
Pair 5	C5.1 - C5.2	1.49622	1.72419	.08653	1.32610	1.66635	17.290	396	.000
Pair 6	C6.1 - C6.2	1.57538	1.68206	.08431	1.40962	1.74113	18.685	397	.000
Pair 7	C7.1 - C7.2	1.40806	1.66507	.08357	1.24377	1.57235	16.849	396	.000
Pair 8	C8.1 - C8.2	1.49246	1.66568	.08349	1.32832	1.65661	17.875	397	.000
Pair 9	C9.1 - C9.2	1.61713	1.66045	.08334	1.45329	1.78096	19.405	396	.000
Pair 10	C10.1 - C10.2	1.66080	1.79364	.08991	1.48405	1.83756	18.472	397	.000
Pair 11	C11.1 - C11.2	1.67003	1.79911	.09029	1.49251	1.84754	18.495	396	.000
Pair 12	C12.1 - C12.2	1.70854	1.78448	.08945	1.53269	1.88439	19.101	397	.000

It was noted that the p-values [Sig. (2-tailed)] for all of the pairs were less than the level of significance which was 0.05 (see Table 6.14). That meant that the differences between expectations and perceptions were significant.

6.7 Conclusion

The best way to determine the strengths and weaknesses of a school's instructional service is to assess it. Information provided from this kind of assessment provides a means of identifying areas where student satisfaction is already strong and areas where it can be improved. Strategies for improvement can be developed that will have a positive impact on student satisfaction with their instructional experience. An ongoing assessment will provide tangible evidence of the effectiveness of such strategies. This study suggested that the SERVQUAL instrument was both a reliable and versatile instrument that may be an alternative for institutional researchers seeking to measure student satisfaction with instructor and curriculum services. In this chapter, the data was presented within the five themes of the SERVQUAL instrument. It was evident that what really mattered were the views of the students regarding their engagement with the Life Sciences curriculum and the Life Sciences educator. If customer service is to be the number one priority, it must be a core value of an institution—one that is clearly defined and measured. This sort of endeavour can go a long way toward increased student retention.

The findings of the research revealed that educators experienced many challenges which hindered the successful and effective implementation of the Life Sciences curriculum. The respondents painted a gloomy picture about conditions that prevailed in schools: for example, respondents indicated that a shortage of or poorly equipped laboratories impacted on effective teaching and learning. The quality of the Life Sciences curriculum itself did not hinge on lifelong learning. It did not have very much relevance to the lives of the learners and, consequently the learners were learning about things that were abstract to them. Another finding was that educators found it challenging to relate the grade 12 Life Sciences curriculum to the everyday experiences of learners because time was a limiting factor. Teachers had to complete the syllabus quite early to prepare the learners for the final examination, since there was much emphasis on the results of the examination from school as well as the provincial and national departments of education. Thus, the subject Life Sciences comes across as being exam-driven. Educators could not deviate from the syllabus as it was very prescriptive. This exam-driven nature of Life Sciences had resulted in rote memorisation of scientific facts by students without any or very little attention being paid to the analysis and application of knowledge.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

In this chapter, the researcher highlights the themes on learner perceptions and expectations of and experiences on the quality of Life Sciences in the context of lifelong learning. This part of the research will revisit the research questions; reflect on the research process that has been undertaken; offer conclusions based on the findings; and present recommendations that emerged out of this study. The limitations of this study are also highlighted.

The conclusions and recommendations were organised using the framework of the research questions: (a) What are the perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning?; (b) What are the perceptions and expectations of grade 12 learners regarding their Life Sciences educators?; and (c) What are the perceptions of grade 12 Life Sciences educators on the relevance of the grade 12 Life Sciences curriculum to lifelong learning? The researcher also highlighted the need for and the significance of studies dealing with the quality of the Life Sciences curriculum regarding lifelong learning. Based on the findings, this study will develop a quality framework comprising the key components of a Life Sciences curriculum to facilitate lifelong learning.

7.2 Conclusions of the study

In comparing the findings in relation to the research questions against the literature that the researcher interrogated, it became apparent that the grade 12 Life Sciences curriculum has to be re-structured. Although new changes in the curriculum have been made with the aim of making a positive effect in education since the dismantling of the apartheid system in South Africa, much needs to be done to make it work for the betterment of education when it comes to lifelong learning. It is essential to distinguish between those factors that need intervention from the Department of Education and those that could be dealt with by the school itself in order to improve the quality of science education that the learners receive. For example, curriculum support; supply of teaching and learning resources; a fully functional science laboratory; and the content offered require the active involvement of the various levels of the education department. Factors such as staff development, educator preparedness and parent involvement could be managed and dealt with by the school management team (SMT).

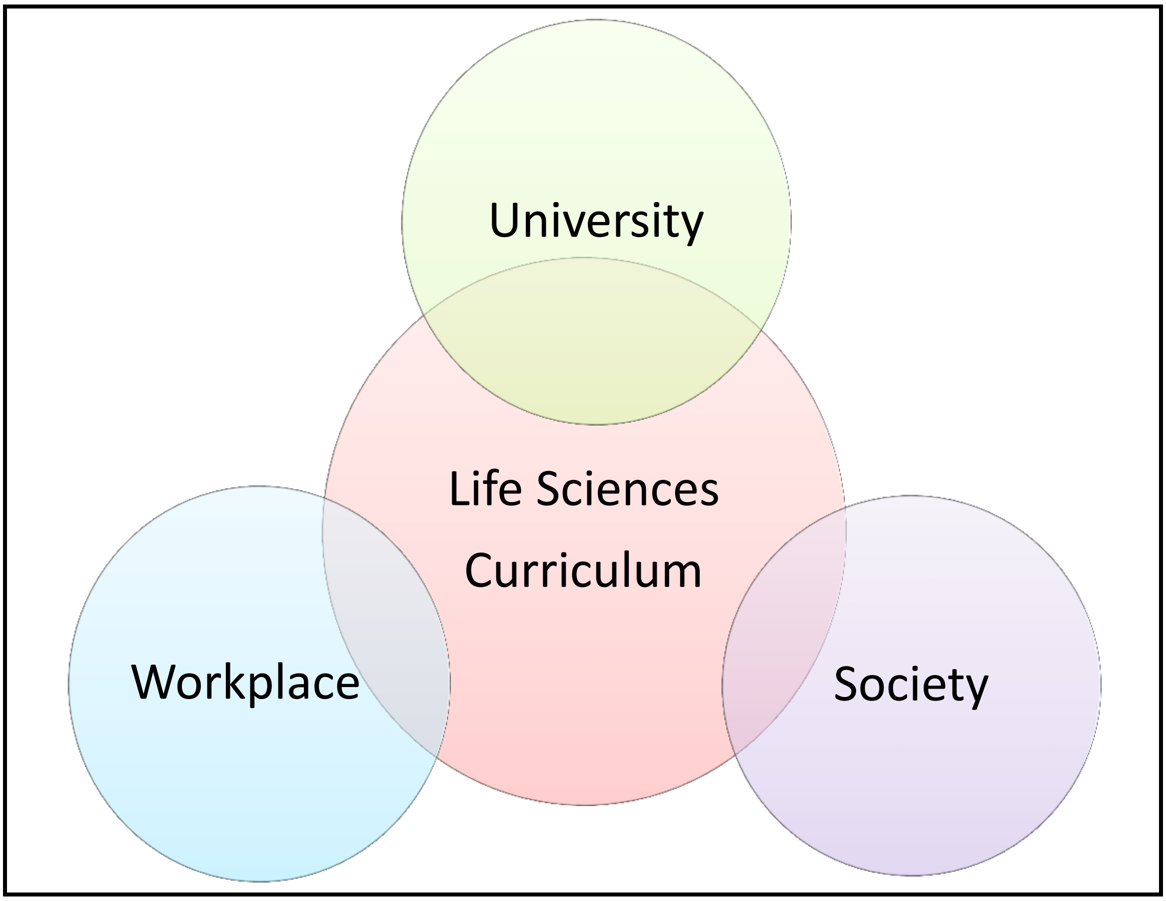
The conclusion in this chapter is developed along the objectives of the study. Three objectives guided this study. These objectives are:

- To determine the perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning;
- To determine the perceptions and expectations of grade 12 learners regarding their Life Sciences educators; and
- To determine the perceptions of grade 12 Life Sciences educators on the relevance of the grade 12 Life Sciences curriculum to lifelong learning.

7.2.1 Perceptions and expectations of grade 12 learners regarding the quality of the Life Sciences curriculum in respect of lifelong learning

One of the findings was that the quality of the Life Sciences curriculum itself did not hinge on lifelong learning. It did not have very much relevance to the lives of the learners and, as such, the learners were learning about things that were abstract to them. The literature cited in this research alluded to the idea that students of science should understand the relevance of scientific discoveries rather than just concentrate on learning scientific facts and theories that seemed distant from their realities (Lederman 2008:18). An early warning about the rhetoric of lifelong learning was made as early as 1994 by Andre Kraak who had argued that though the new ministry had produced coherent proposals for reconstructing education in South Africa, these proposals faced a number of serious problems, especially in relation to lifelong learning (Kraak 1998:22). This argument could further be supported by studies by Knapper (2005:13) which also talk about a shift in emphasis from pure knowledge acquisition to practical knowledge utilisation. It is evident that the Life Sciences curriculum needs to be more relevant to learners in South Africa if the knowledge, skills and values attained by learners is to be applied in their daily lives. This study recommends that in order for the Life Sciences curriculum to be made relevant to learners, there must be a close fit between the curriculum and university, industry and society.

Figure 7.1 Roles of a relevant Life Sciences curriculum



Source: Self-generated by researcher

According to Bybee and Fuchs (2006:350), for a Life Sciences curriculum to be relevant and prepare students for lifelong learning, it must equip students with the skills and knowledge to meet the needs of universities, the workplace and /or play a meaningful role in society as illustrated in Figure 7.1. Based on the findings of this study, if a Life Sciences curriculum is developed around the premise that it must prepare learners to fit the roles identified in Figure 7.1, such a curriculum would be effective in achieving its aims.

In the same vain, Hoppers (2006:4) highlighted two tensions between lifelong learning and globalisation. The dominant world players, according to Hoppers (2006:4), do not perceive Africa as having anything to contribute to wider global agendas nor do most Africans want to become a carbon copy of Westernisation since the West is perceived as robbing Africans of their identity. One could thus infer that, internationally, South Africa is seen to be lacking in its contribution to any scientific knowledge. In view of this, indigenising lifelong learning could be of greater value to South African society. Ogunniyi (2011:963) purports that *"indigenous knowledge systems reflects the wisdom about the environment developed over centuries by the inhabitants of South Africa, and much of this valuable wisdom believed to have been lost in the past 300 years of colonisation now needs to be rediscovered and utilised to improve the quality of life of all South Africans"*. Infusing indigenous knowledge (IK) or social practice into the Life Sciences curriculum is significant, because the incorporation of IK into the mainstream science curriculum is a way of increasing the socio-cultural relevance of science. With this inclination towards relevance and social responsibility, there would be an increasing interest in students towards their communities.

It must also be emphasised that not every student has the same interests or pays attention to the same consequences. Many learners are not intrinsically motivated by Life Sciences. According to Hofstein and Bybee (2012:14), careers in science and technology might therefore benefit more from Life Sciences teaching being oriented on the societal dimension. On the other hand, students who are interested in and intrinsically motivated by Life Sciences from the beginning could equally benefit from the individual and vocational dimensions. According to this investigation, when students believed that the topics they were dealing with in science had personal relevance and meaning for their lives they were more likely to experience enjoyment and interest from engaging with science content. The question is then raised as to –"*How often do students see their science curriculum as being about understanding their physical world, their biological world and their interactions within their physical and social contexts?"* According to the findings from this investigation, personal meaning and relevance was an important factor in students' enjoying science and focusing their attention to expand their knowledge and understanding. As purported by Izard (2007:271), students' general enjoyment of science and general interest in learning science had developed out of their previous experiences of learning science. Consequently the importance of both early experiences with science and the maintenance of a sense of fun and excitement while learning science cannot be overlooked.

It is therefore recommended that a Life Sciences curriculum take into consideration student interest, relevance and student expectations for it to satisfy the goal of lifelong learning. To be effective, a Life Sciences curriculum must be relevant to the lives of students. To make curriculum relevant, curriculum designers must include topics that resonate with learners and teachers. The relevance of a specific topic is clearer to students when they understand how it fits within the big picture. A few examples of themes that link to lifelong learning emerged from the data. These themes include topics such as biotechnology, genetic engineering and human reproductive disorders.

7.2.2 Perceptions and expectations of grade 12 learners regarding their Life Sciences educators

Another finding of the study was that there was rote memorisation of scientific facts by the students without any or very little attention being paid to analysis and application of knowledge. The Life Sciences programme of study is very *"content heavy"* and this could be encouraging teacher-directed work at the expense of learner-centred work. If the foundation for lifelong learning is to be laid at school, a key concern must be the development, to some degree, of pupils' capacity to engage in independent study. Schuetze (2006:300) stated that this calls for teachers, including science teachers, to co-operate in helping their pupils acquire an appropriate range of learning skills, including information, investigation and communication skills. Students should be encouraged to articulate their own ideas and work independently or contribute to group efforts.

Globalization and economic necessity compound the urgency for students to develop the skills and knowledge they need for success. The interconnectedness of our global economy, ecosystem, and political networks require that students learn to communicate, collaborate, and problem solve with people worldwide. Employers demand fewer people with basic skills and more people with complex thinking and communication skills (Levine 2012:16). Perkins (2010:15) proposed that students need seven survival skills known as higher-order thinking skills, namely critical thinking and problem solving; collaboration and leadership; agility and adaptability; initiative and entrepreneurialism; effective oral and written communication; accessing and analysing information; and curiosity and imagination which are more demanding and beneficial to teach and learn than rote learning skills. Literature by Schleicher (2012:34) further suggested that students were not developing higher order thinking skills because it was not being explicitly taught and because it was more difficult to assess than factual retention. Perkins (2010:15) also stated that through rote learning, students can learn information, but typically don't have much practice applying the knowledge to new contexts; communicating it in complex ways; using it to solve problems; or using it as a platform to develop creativity.

In the context of this study it could be argued that factual-based Life Sciences teaching should give way for knowledge-based education so that learners are able to design and solve problems; access and assess information critically and effectively; analyse and question; and organise and critically evaluate. In order for lifelong learning to be implemented effectively, the model by Soni (2012:19) may be utilised to demonstrate the paradigm shift that needs to occur in the Life Sciences curriculum. This model is represented in Table 7.1.

Table 7.1 Characteristics of traditional and lifelong learning models

	Traditional learning	Lifelong learning
Emphasis	Basic skills	Education embedded in ongoing work activities
Mode	Knowledge absorption	Knowledge construction
New topics	Defined by curricula	Arise incidentally from work situations
Trainers	Expound subject matter (Teaching)	Engage in work practice (Facilitating)
Problems	Given	Constructed
Method to solution	Mostly personal work	Group work
Role	Expert - Novice model	Reciprocal learning
Assessment	Basis for promotion	Guide learning strategies
Structure	Pedagogy(logical structure)	Work activity

Source: Lifelong learning - Education and Training (Soni 2012)

An analysis of Table 7.1 reveals that there is greater emphasis on the construction of knowledge and problem situations in lifelong learning as opposed to traditional teaching where knowledge is defined by the curriculum and is simply absorbed by learners. In lifelong learning, there is a significant emphasis on the need for individuals to take responsibility for their own learning. According to Bell (2010:41), lifelong learners are not defined by the type of education or training in which they are involved but by the personal characteristics that lead to such involvement. By acknowledging the range of factors that act as both a motivator and barrier to engagement in education and training, lifelong learning policies should be able to promote participation in learning for its own sake, rather than as a means to a specific end (employment).

Since education standards and the purposes of education are changing, curriculum frameworks, instructional methods and assessment strategies must also change. These must have a sense of how each of the knowledge, skill and attitude-based objectives contribute to understanding the big picture i.e how they all fit together. This study recommends that developing critical skills should be emphasised in the Life Sciences curriculum and teaching. It is imperative that 2lst-century skills are developed effectively in all spheres of education, more especially in Life Sciences so that some students could use their skills to engage in solving global challenges that affect all of humanity; others would use their skills in their tertiary studies; while some would use these skills in their work-place or even in their everyday lives. By engaging in Life Sciences in this manner, students will understand the fit between the skills they acquired and the role thereof in their daily lives, thus leading to lifelong learning.

7.2.3 Perceptions of grade 12 Life Sciences educators of the relevance of the grade 12 Life Sciences curriculum in the context of lifelong learning

The findings of the research revealed that educators experienced many challenges which hindered the successful and effective implementation of the Life Sciences curriculum. Adapting the Life Sciences curriculum is an important issue in terms of creating customer-oriented service. The TQM literature states that successful quality improvement requires the commitment of all stakeholders (Dale 2013:6) and that commitment should not just involve supporting the efforts of others. In practical terms this means recognising that when things go wrong the responsibility for finding a solution always lies with all whom are involved in the curriculum. TQM principles focus on long-term quality improvement and curriculum developers should analyse what they are doing and plan to include all stakeholders to improve the curriculum. Curriculum development should be restructured and transformed from a hierarchical process to a team-based, problem-solving and self-directed learning process by including all stakeholders. This study revealed that there was a lack of extensive participation by educators in policy and curriculum development. The Department of Basic Education may probably be under the impression that they are aware of teachers' needs, even without determining these needs by means of consultation. Strategies should be applied to establish these needs formally. Direct prior consultation should therefore form an important part of any curriculum dissemination. This process of prior consultation has two advantages. Firstly, it could serve to counter the perception that policy planners are not in touch with present educational practice. Problems concerning credibility could arise if teachers perceive curricula to be imposed upon them from the "top down" by those who are "*not adequately informed"* (according to the respondents). Secondly, prior consultation and the acknowledgement of teachers' input would ensure that teacher participation is incorporated timeously. This opportunity could serve as an incentive for teachers to gain access to and take ownership of the curriculum in a more significant way. An analysis of literature suggests that most educators advocate for increased teacher involvement in all stages of curriculum development as a way to improve curriculum. Carl (2009:30) reported that without adequate participation, the chances of successful implementation are greatly diminished. Furthermore, it has been found that lack of participation may lead to misconceptions of what is expected. Greater participation may also lead to greater job satisfaction (Carl 2009:30). According to Taylor (2004:15), teacher participation in the development of curriculum enhances the success of the implementation of that curriculum and, as such, is obliged to support it. In other words, teachers commit to the curriculum.

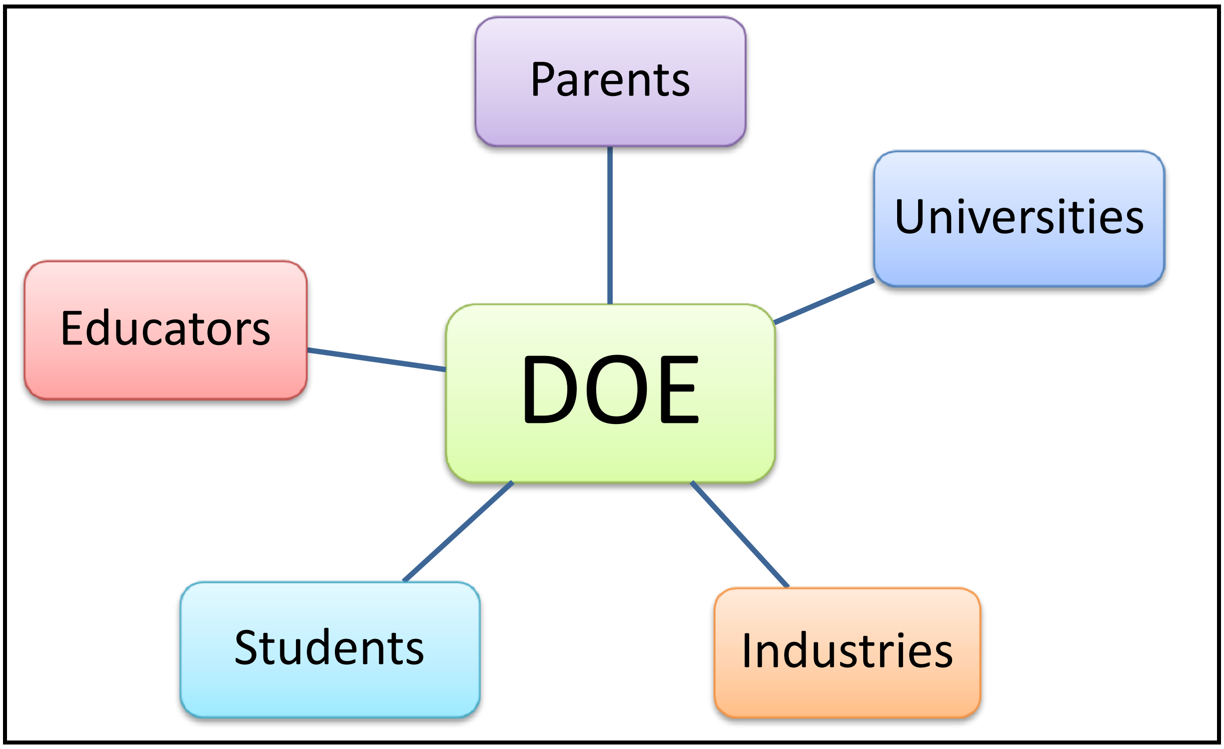
Curriculum development officers sometimes believe that few teachers should be given responsibility to develop the curriculum and that the entire task should be left to them (Mosothwane 2008:45). Those who object to teacher involvement argue that curriculum is a specialist area and only people who are specialized in curriculum development should participate (Bayona 2005: 152). This group contends that teachers have not received formal training as curriculum developers and hence should not participate in curriculum development. Bayona (2005:44) notes that, "*to become deeply involved in the development of the school curriculum, one needs not only teacher training qualifications in a specialist subject area or areas, but also knowledge, skills, and experience in the field of curriculum development"* However, Carl (2009:33) argues that since teachers are neither trained nor supported as curriculum developers and would, in fact, experience the utmost difficulty if faced with the prospect of developing the curriculum as an on-going task, in-service training (INSET) would be required. Proper training of teachers through a good INSET programme is the most important mechanism for developing teachers' skills to participate in the curriculum development process.

Quality teacher involvement is essential, not only for the sake of institutional and curriculum development in schools and the country's curriculum, but also for nurturing the personal and professional growth of the teacher. Teacher participation can therefore bring positive results.

It is a recommendation of this study that teachers are not viewed as mere recipients who implement the curriculum in the classroom. They should be included in the initial process of meaningful decision-making where they will be able to make a contribution. For the role of teachers to include the role of developers, it is recommended that curriculum development committees be formed at school, local and regional levels so that those who are chosen for national panels present views that truly represent those of teachers at the three levels.

The need to involve and win over grassroots educators is not seen as a crucial element of this phase of the policy development process. Curriculum research by Carl (2009:30), concluded that many countries have shown the importance of building the professional capacity of educators and involving them centrally as key agents in the design and implementation of new curricular approaches. It is not expected that all teachers would participate directly, but their ideas and those from curriculum development education officers combined would lead to the production of a quality Life Sciences curriculum. This study recommends the involvement of a team of role-players in Life Sciences curriculum development which must include personnel from universities, schools (educators), industries, students, community members such as parents and the Department of Basic Education. Figure 7.2 illustrates the synergy that must co-exist amongst all role-players with the common goal being an effective Life Sciences curriculum that will prepare students for lifelong learning.

Figure 7.2 Key role-players in curriculum development



Source: Self-generated by researcher

Whilst the findings of this study alluded to the inclusion of educators in curriculum development, the inclusion of personnel from industry would shed light on the competencies that industry requires of students seeking employment immediately after exiting grade 12. Representation from universities in this process will ensure that the curriculum that students engaged with in grade 12 provided a foundation for the courses that they were to follow upon entering universities. The inclusion of parents and students would provide guidance on the type of Life Sciences curriculum that would take into consideration context related issues. Curriculum policy exposes the gaps in the curriculum policy formulation process. For example, the construction of policy as estranged and the findings of the preliminary survey highlight the lack of teachers' and industrialists' participation in the curriculum policy reform process. It is thus a recommendation of this study that the voice of the learner, parents and educators is considered. The illustration in Figure 7.2 demonstrates that for a Life Sciences curriculum to prepare students for lifelong learning, it is essential for key role-players to form the core of a curriculum development team.

This study also recommends that a centralised curriculum monitoring team under the control of the national and provincial education departments be maintained in South Africa since it helps to distribute resources equally amongst schools and ensures that the implementation of a new curriculum is easily monitored. Curriculum monitoring education officers of the Life Sciences curriculum should possess both subject matter knowledge and pedagogical knowledge. A combination of both cognate and instructional knowledge would produce competent and knowledgeable education officers who would drive Life Sciences curriculum reforms towards a quality curriculum for South African secondary schools.

7.3 Recommendations of the study

This study has argued that education restructuring in the new South Africa has been a long-term challenge since the dismantling of the apartheid regime. The approach to the national education policy-making process may be found to be seriously wanting if national policy makers intend their policies to be an intervention in the social power relations in education. Greater curriculum intervention in Life Sciences is urgently needed to empower the more disadvantaged education communities and ensure that the curriculum benefits all learners as a lifelong learning endeavour. It is indeed crucial to set up a new terrain in curriculum development that can be used to enhance Life Sciences education.

(a) Science curriculum at different phases

Consistent with the general aims, the objectives, content and pedagogy for different stages of the curriculum are summarised as follows:

- **At the foundation phase:** The child should be engaged in joyfully exploring the world around and harmonising with it. The objectives at this stage should be to nurture the curiosity of the child about the natural environment; to engage in exploratory and hands on activities to acquire basic cognitive skills (psychomotor, observation, classification, inference, etc.); and to develop basic language skills, namely speaking, reading and writing not only for science but also through science.
- **At the intermediate phase:** The child should be engaged in learning simple principles of science through familiar experiences. Scientific concepts should be derived mainly from activities and experiments.
- **At the senior phase: S**tudents should be engaged in learning science as a composite discipline. They should be involved in activities and analyse issues about the

environment and health. Systematic experimentation should direct their learning of or verification of theoretical principles in science. Science content at this stage should not be regarded as a diluted version of secondary stage science.

- **At the FET phase:** Life Sciences should be introduced as a separate discipline as is currently the case. There must be greater emphasis on experiments and problem-solving with two streams, namely academic and vocational, being pursued. At this stage, core topics of Life Sciences, that incorporate recent advances should be carefully identified and treated with appropriate rigour and depth. The tendency to superficially cover a large number of topics in this discipline should be avoided.

A paradigm shift in the science curriculum at all stages should be introduced. There must be emphasis on exploration, inventiveness and creativity through activities and experiments that should be contextualised as far as possible. Implementation of co-curricular and extra curricula components through the expansion of existing non-formal channels such as project exhibitions and children's science congresses must be encouraged in all schools. Life Sciences teachers must focus more on what students learn and how well they can use their knowledge about a subject than on covering a pre-designed syllabus. The provision of a high quality Life Sciences education for citizenship as a lifelong endeavour for all students should continue to be energetically addressed. Its establishment would help more students to appreciate the intrinsic worth of Life Sciences in the context of lifelong learning.

(b) Examination system

In the absence of a national effort in improving assessment methods, a conservative examination system continues to dictate what happens in Life Sciences classrooms across the country. Examinations should therefore contain carefully designed experiment-based questions; questions testing critical understanding; and a demonstration of the ability to solve problems. Rote learning should be discouraged. Inquiry skills should be supported and strengthened by language, design and quantitative skills. Scientists, educationists and teachers should develop a common platform and launch new ways of testing students which would reduce the high level of examination-related stress and curb the multiplicity of entrance examinations other than formal scholastic competence.

(c) Teacher empowerment

No reform, however well motivated and well-planned, can succeed unless a majority of teachers felt empowered to put it in practice. Creative ideas for reforming education may come from many sources but only teachers can provide insights that emerge from direct experience in the classroom itself. This expertise could be developed through a number of ways, namely

- Peer group systems of interaction amongst teachers should be created within school and between schools to empower educators in Life Sciences;
- Administrators at school must discontinue the practice of giving extraneous non-academic responsibilities to teachers at the cost of their teaching duties; and
- The teacher training education system should develop appropriate Life Sciences teacher education modules to empower educators to engage their students in skills and knowledge that develop lifelong learning.

There must be a greater recognition of what students bring to their studies and how different teaching methods engage with their learning. The diversity in students' learning strategies must be met by the use of suitable teaching methods. The curriculum must be closely matched to the purposes of Life Sciences education for citizenship. The assessment of what has been learned must be closely matched to the purposes of that curriculum and, central to all of these aims, the supply, development and retention of high quality teachers must be actively pursued.

(d) Re-design of the Life Sciences curriculum

It must be noted that the Life Sciences curriculum in the FET phase has not been developed in a progressive manner, with there being very little evidence of lifelong learning strategies. Table 7.2 details the topics for the theme *"life processes in plants and animals*" as per the CAPS document and the proposed topics recommended by the researcher for inclusion into the grade 12 Life Sciences curriculum. On perusing the CAPS and traditional learning column, it is evident that topics are merely listed for each of grades 10, 11 and 12 without any progression, despite the document reading "*Life Sciences: concept and content progression"* (Department of Basic Education 2011:10).

Table 7.2 Proposed Life Sciences curriculum for the FET phase in schools

	CAPS – Traditional learning	Lifelong learning topics
	Theme	**Theme**
	Life processes in plants and animals	**Life processes in plants and animals**
Grade 10	Support and transport systems in plants • Support systems in animals • Transport system in mammals	Support and transport systems in plants • Support systems in animals • Transport system in mammals • Transformations to support life: photosynthesis • Animal nutrition • Energy transformations: respiration • Gas exchange
Grade 11	• Energy Transformations to support life: photosynthesis • Animal nutrition • Energy transformations: respiration • Gas exchange • Excretion	• Excretion • Reproduction in vertebrates • Human reproduction • Nervous system • Senses • Endocrine system
Grade 12	• Reproduction in vertebrates • Human reproduction • Nervous system • Senses • Endocrine system • Homeostasis	• Biotechnology • Genetic engineering • Forensic Science • Biomedical Science • Environmental Science **NB. Include indigenous knowledge**

Source: Adapted from South Africa (Department of Basic Education 2011)

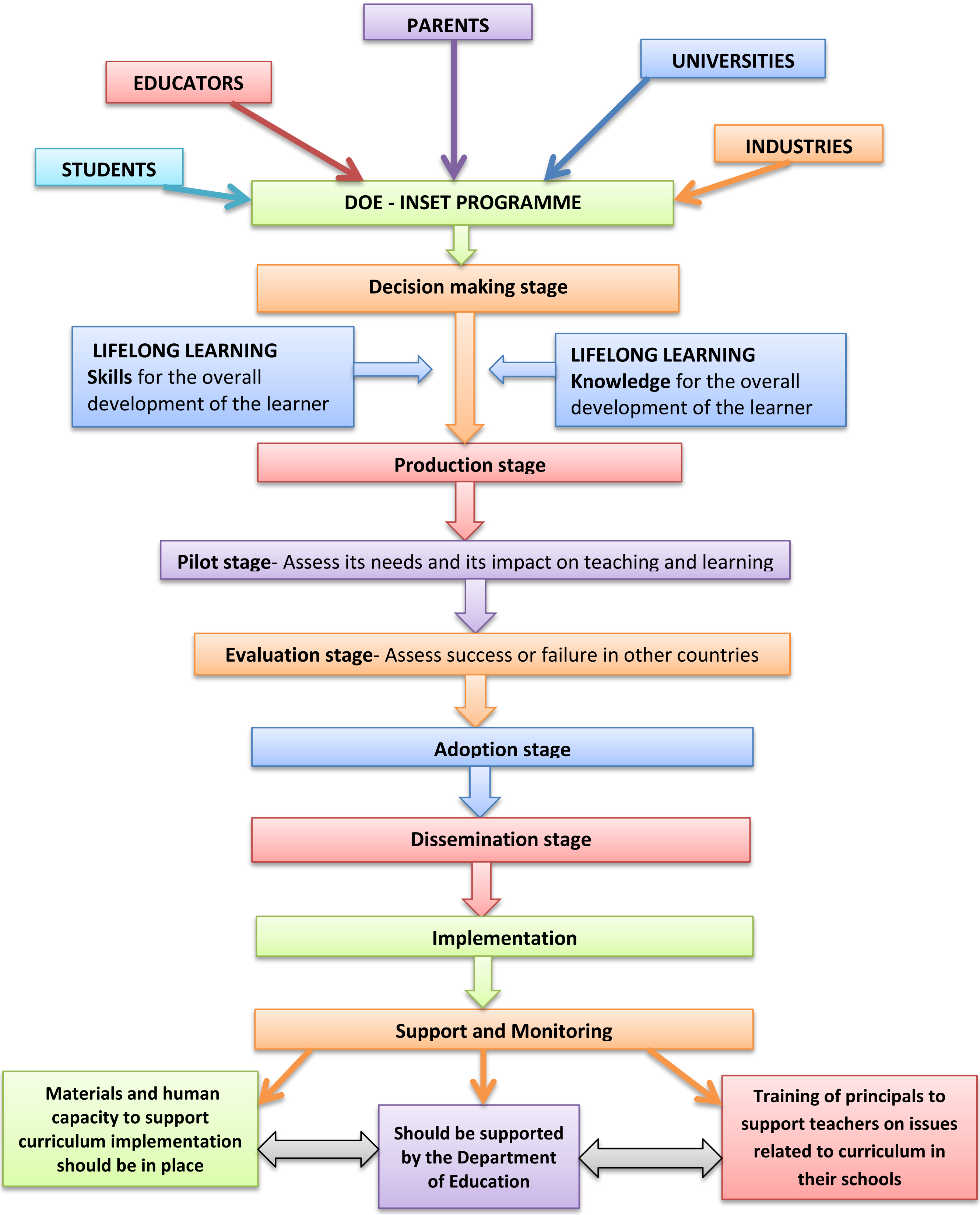
An area of contemporary science that is of particular appeal is that of modern biotechnology. Numerous television shows are popular with today's youth and as a result issues relating to DNA manipulation and forensic techniques are commonplace outside the Life Sciences classroom. In recognition of these advances in biotechnology application and their high interest factors, coupled with the low interest in school science, the inclusion of modern biotechnology in Life Sciences classrooms would be highly beneficial. Although some aspects of biotechnology were included into the CAPS curriculum, the findings of this study revealed that the students and educators would prefer a greater emphasis on biotechnology. Students have well developed ideas of what is of interest and relevance to them in relation to modern biotechnology key ideas. Teachers and curriculum designers should be encouraged to determine these interests and to relate the interests to subject matter in order to provide a base for new knowledge. As recommended by the researcher, there are other topics of interest that should also be introduced into the grade 12 Life Sciences curriculum, as depicted in Table 7.2.

The proposed curriculum for grade 12 Life Sciences emphasises that indigenous knowledge should be given a space in the implementation process. While the CAPS document mentions that "*educators have the freedom to expand concepts and to design and organise learning experiences according to their local circumstances"* (Department of Basic Education 2011:10), the final examination unfortunately does not cater for aspects of "*local circumstances*" as the Department of Basic Education provides all grade 12 Life Sciences educators with an examination guideline which must be adhered to. Based on the recommendations highlighted in this chapter, the researcher proposes a model for Life Sciences curriculum design in the context of lifelong learning.

7.4 Proposed model for the preparation of effective curriculum development and implementation in Life Sciences

The main aim of the study was to investigate the quality of the grade 12 Life Sciences curriculum in the context of lifelong learning in public schools in the Pinetown District. Based on the outcomes of the study, a model for the planning of revised changes in the curriculum has been proposed within the context of lifelong learning. The key recommendations of this study are summarised as follows:

Figure 7.3: A proposed model for the preparation of quality curriculum development, dissemination and implementation in the context of lifelong learning in Life Sciences.



Source: Self-generated by researcher

The model in Figure 7.3 begins with the team of role-players of the Life Sciences curriculum development which includes personnel from universities, schools (educators), industries and the department of basic education as well as parents and students converging to undergo in-service training in curriculum planning and development. Having undergone in-service training, the model proposes that the team, during the decision-making stage, deliberate on the contents of the Life Sciences curriculum in the context of its specific aims and objectives-one being lifelong learning. In other words, curriculum designers must consider the skills and knowledge that need to be developed in order to cascade lifelong learning through the Life Sciences curriculum. During the production stage, an effective curriculum should be generated to cater for all South Africans intending to study Life Sciences in the FET band. Rogan and Grayson (2003:1174) emphasize that it is necessary for the theory of implementation to take the diversity of schools into account.

An evaluation plan must also be put in place by curriculum workers and developers to assess the success or failure of curriculum development before its implementation. This can be done in the form of piloting of the new developed curriculum, which will enable curriculum developers to assess its needs and measure its impact before unforeseen damage could be done. The piloting process will help to find out:

- How the curriculum is affecting the teaching and learning of Life Sciences at schools?;
- What changes should be made to make the new changes in curriculum affect teaching and learning in a positive way?; and
- What resources need to be provided for positive effect of the new changes in curriculum?

The evaluation plan should always be in place to assess the effectiveness of the pilot project. It is important for curriculum planners to learn from the mistakes or success of others. There are countries which might have experienced the same problems and it is advisable that people who are planning the curriculum learn from the success and mistakes made by other countries when it comes to developing a new curriculum or even making changes in the Life Sciences curriculum.

The model further indicates that there must be intense training of all Life Sciences teachers according to the future needs of the curriculum before its implementation. This is reflected as the dissemination stage in Figure 7.3. According to the model, principals have to give enough support and monitoring and they must be trained in order to be grounded in the changes in the curriculum. The positive effect of a new Life Sciences curriculum could also be achieved by ensuring that monitoring and support by the Department of Education is at a high level. This can be achieved by ensuring that the relevant materials and human capacity to support curriculum changes are in place. Resources or material have also been mentioned as factors affecting monitoring and support. In South Africa, the many Life Sciences curricula have attempted to incorporate modern educational trends but have failed to consider issues such as a largely unqualified or underqualified workforce; the huge class sizes; the extent of the changes being asked for; and the over-zealous time-frames for implementation (Kidman 2010:355). Research by Sanders (2010:435) found that many teachers have been unable to understand the new curriculum jargon and struggle to implement any new content areas added to the curriculum.

Lifelong learning has become an important strategic force, especially for a country that has to depend on the knowledge and skills of its people in order to compete in the global economy. The learning of science is essential for sustainable development in the future and for active participation in society and societal issues. Based on this, it is automatically assumed that all students need a certain level of scientific knowledge in order to become literate citizens. For South Africa to keep abreast of changes in methods of production, scientific and technological advancement and the challenges of the information and knowledge age, it has to adopt a high quality Life Sciences education which must be embedded in lifelong learning.

7.5 Limitations of the study

The following limitations of the study are indicated in order to direct future studies. More research is still needed on the subject.

- The study was done in only one district, which is the Pinetown District, out of 12 districts of Kwa-Zulu Natal.
- The research only focused on the grade 12 Life Sciences curriculum. Further research is needed in the other grades of the FET phase.
- The research only focused on some teachers and learners from the Pinetown District. Not all of the teachers and learners formed the sample. The researcher used random sampling to reduce the learner sample size and purposive sampling to obtain the educator sample, since the administration of questionnaires was anticipated to be

problematic as schools were located at a distance from each other. Further research is needed in other districts.

- Interviews had to be scheduled by special arrangement with educators and learners to avoid disruption to classes. As the researcher is also employed as an educator, the researcher could not visit the schools during teaching time. Arrangements were thus made to conduct interviews at the end of the school day when learners and educators were tired.

7.6 Conclusion

For an overwhelming majority of students, Life Science is just another demanding and difficult subject to be learnt by rote, with no meaningful learning outcomes whatsoever. Yet a small minority of students do come out of the system with outstanding competencies. In essence, there seems to be small islands of excellence in a sea of mediocrity. For any qualitative change to occur in Life Sciences education, the curriculum must undergo a paradigm shift. Rogan and Grayson (2003:1178) emphasise that more work needs to be done on implementation issues in South Africa in order to make curriculum impact in its intended manner in schools. Witz and Lee (2009:419) allude to the factors impacting the success of curriculum reform, namely the inability of reform makers to accurately diagnose the systemic problems or correctly evaluate programmes before implementation. The inability of curriculum developers to evaluate the process of curriculum implementation could have serious consequences for learners and communities at large.

To encourage schools and teachers to implement this paradigm shift, there needs to be a fundamentally overarching reform of teacher empowerment. In essence the national educational policy makers need to strike some sort of balance between top-down policy initiative and bottom-up participation to improve the fit between the intention of the curriculum and the conditions on the ground. Scientific proficiency cannot be achieved through isolated efforts. All interested stakeholders, including students, parents, teachers, administrators and policy makers, must work together to improve the quality of the Life Sciences curriculum at school. However, Jansen (1999:59) emphasises that curriculum development as a long term development needs a rearrangement of content, including textbook revision. Successfully articulating learners through their Life Sciences classes would allow them to have a better opportunity to succeed in today’s global environment.

This study sought to investigate perceptions of learners and educators on the quality of the Life Sciences curriculum in the context of lifelong learning. This study also explored the need for lifelong learning in a Life Sciences curriculum. In this light, it is important to note that a paradigm shift towards lifelong learning implies a shift in how one thinks about learning and knowledge. Lifelong learning assessment is not so much the assessment of how much fixed knowledge learners possess. It is the assessment of the ability of learners to reconstruct knowledge and engage with change. Future studies should reflect on *what* should be assessed and *how* learners should be assessed to ensure continuous lifelong learning.

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APPENDIX 1

LETTER OF INFORMATION FOR PRINCIPALS AND EDUCATORS

Title of the Research Study: A quality study of the grade 12 Life Sciences curriculum: Perceptions and expectations for lifelong learning
Principal Investigator/s/researcher: Mrs. I. Naidoo, (JSED; FDE; B.Ed.(Hon); M.Ed)
Co-Investigator/s/supervisor/s: Professor P. Singh. (PhD.)
Brief Introduction and Purpose of the Study: Governments in many countries including South Africa are concerned about the declining interest by students in science (Kidman, 2010) and the fact that science education is not catering for future needs and challenges. The quality of education in science is therefore being questioned as it is perceived by some as being ineffective and 'useless' (Cheng, 2003) for the new generation. To enhance student interest in science, Christidou (2006) advises that the careful selection of topics and a revised science curriculum should emphasize those topics that contribute to students' lifelong learning. The aim of this study therefore is to examine the perceptions and expectations of the quality of the Life Sciences curriculum content by grade 12 learners and educators in the context of lifelong learning.

Outline of the Procedures: The research will be conducted in the Tongaat, Verulam and Phoenix wards in the Mafukuzela-Gandhi Circuit. The learner sample will be done by obtaining name lists of all the grade 12 Life Sciences learners from the schools under study. The names of the learners for each school will be fed randomly into the computer and using Microsoft Excel Sampling: Data Analysis option every sixth learner was selected until 20 learners were drawn from each school to obtain 440 participants. A total of 22 grade 12 Life Sciences educators comprise the educator sample. The learner questionnaire will collect data to determine the perceptions and expectations of grade 12 learners regarding the quality of content of the Life Sciences curriculum in the context of lifelong learning; while the data obtained from the educator questionnaire will assist the researcher to determine the grade 12 educators' perceptions and expectations of the quality of the Life Sciences curriculum content in the context of lifelong learning. Interviews may be conducted with the educators where responses are unclear or incomplete in an attempt to seek clarity or where more information is required. The educators will be given one week to complete the questionnaire. An arrangement will be made with the school secretary/member of the administrative staff to collect the completed educator questionnaires in a sealed box (which I will provide) thus ensuring anonymity. The researcher will call at each school to collect the educators' questionnaires.

Risks or Discomforts to the Participant: The researcher assures you that there are no risks or discomforts for you to endure.

Benefits: Based on the findings, this study will develop a quality framework comprising the key components of a Life Sciences curriculum to facilitate lifelong learning. This will be provided to curriculum developers for serious consideration to be given when drawing up a Life Sciences curriculum content.

Reason/s why the Participant May Be Withdrawn from the Study: Please note that you are under no compulsion to participate in the study and you have the autonomy to withdraw at any stage from the study without any consequences. However your participation in the study will be sincerely appreciated as it will influence the findings of the study tremendously.

Remuneration: Not applicable

Costs of the Study: Not applicable

Confidentiality: Your responses will not be disclosed to other educators or anyone at school. All data and details provided by you will be kept confidential; only the researcher and her promoter will have access to the information that you provide. Your name, as well as the names of the learners and the name of the school will not appear in my report, or in any papers or presentations that I make related to the study.

Research-related Injury: Not applicable

Persons to Contact in the Event of Any Problems or Queries: Please contact the researcher, Mrs.I.Naidoo (0329441665) or my supervisor, Prof. P.Singh (031 3735599) or the Institutional Research Ethics administrator on 031 373 2900 should you have any queries.

CONSENT

Statement of Agreement to Participate in the Research Study:

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

________________________	____________	________	__________________
Full Name of Participant	**Date**	**Time**	**Signature**

I, Indarani Naidoo (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Indarani Naidoo	14/04/2014	______________________
Full Name of Researcher	**Date**	**Signature**

APPENDIX 2

LETTER OF INFORMATION FOR PARENTS/GUARDIANS

Title of the Research Study: A quality study of the grade 12 Life Sciences curriculum: Perceptions and expectations for lifelong learning

Principal Investigator/s/researcher: Mrs. I. Naidoo, (JSED; FDE; B.Ed.(Hon); M.Ed.)

Co-Investigator/s/supervisor/s: Professor P. Singh. (PhD.)

Brief Introduction and Purpose of the Study: The aim of this study therefore is to examine the perceptions and expectations of the quality of the Life Sciences curriculum content by grade 12 learners and educators in the context of lifelong learning.

Outline of the Procedures: The names of the learners for each school was fed randomly into the computer and using Microsoft Excel Sampling: Data Analysis option every sixth learner was selected until 20 learners were drawn from each school to obtain 440 participants. The educators will be asked to administer the questionnaires to the selected learners in each of their classes. The learners will be given one week to complete the questionnaire; on completion they will drop off their questionnaires in a sealed box with the Head of the Life Sciences Department. This will ensure anonymity of the learners.

Risks or Discomforts to the Participant: The researcher assures you that there are no risks or discomforts for you or your child/ward to endure.

Benefits: Based on the findings, this study will develop a quality framework comprising the key components of a Life Sciences curriculum to facilitate lifelong learning that curriculum developers could use when drawing up a Life Sciences curriculum content.

Reason/s why the Participant May Be Withdrawn from the Study: Please note that your child/ward is under no compulsion to participate in the study and he/she has the autonomy to withdraw at any stage from the study without any consequences. However his/her participation in the study will be sincerely appreciated as it will influence the findings of the study tremendously.

Costs of the Study: You or your child will not incur any costs by participating in the study.

Confidentiality: Your child's/ward's responses will not be disclosed to any educators or anyone at school. All data and details provided by your child/ward will be kept confidential; only the researcher and her promoter will have access to the information that is provided. The names of the learners and the name of the school will not appear in my report, or in any papers or presentations that I make related to the study.

Persons to Contact in the Event of Any Problems or Queries: Please contact the researcher, Mrs.I.Naidoo (0329441665) or my supervisor, Prof. P.Singh (031 3735599).

CONSENT

Statement of Agreement to Participate in the Research Study:

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

______________________	___________	_______	________________
Full Name of Participant	**Date**	**Time**	**Signature**

I, Indarani Naidoo (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Indarani Naidoo	14/04/2014	_____________________
Full Name of Researcher	**Date**	**Signature**

APPENDIX 3

LETTER OF INFORMATION FOR LEARNERS

Title of the Research Study: A quality study of the grade 12 Life Sciences curriculum: Perceptions and expectations for lifelong learning

Principal Investigator/s/researcher: Mrs. I. Naidoo, (JSED; FDE; B.Ed.(Hon); M.Ed.)

Co-Investigator/s/supervisor/s: Professor P. Singh. (PhD.)

Brief Introduction and Purpose of the Study: To enhance student interest in science, careful selection of topics and a revised science curriculum should emphasize those topics that contribute to students' lifelong learning. The aim of this study therefore is to examine the perceptions and expectations of the quality of the Life Sciences curriculum content by grade 12 learners and educators in the context of lifelong learning.

Outline of the Procedures: The names of the learners for each school was fed randomly into the computer and using Microsoft Excel Sampling: Data Analysis option every sixth learner was selected until 20 learners were drawn from each school to obtain 440 participants. The questionnaires will be administered by the Life Sciences educators at each school. You will be given one week to complete the questionnaire; on completion you will drop off your questionnaires in a sealed box at the Head of the Life Sciences Department. This will ensure your anonymity.

Risks or Discomforts to the Participant: The researcher assures you that there are no risks or discomforts for you to endure.

Benefits: Based on the findings, this study will develop a quality framework comprising the key components of a Life Sciences curriculum to facilitate lifelong learning.

Reason/s why the Participant May Be Withdrawn from the Study: Please note that you are under no compulsion to participate in the study and you can withdraw at any stage from the study without any consequences. However your participation in the study will be sincerely appreciated as it will influence the findings of the study tremendously.

Costs of the Study: You will not incur any costs by participating in the study.

Confidentiality: Your responses will not be disclosed to any educators or anyone at school. All data and details provided by you will be kept confidential; only the researcher and her promoter will have access to the information that is provided. The names of the learners and the name of the school will not appear in my report, or in any papers or presentations that I make related to the study.

Persons to Contact in the Event of Any Problems or Queries: Please contact the researcher, Mrs.I.Naidoo (0329441665) or my supervisor, Prof. P.Singh (031 3735599).

CONSENT

Statement of Agreement to Participate in the Research Study:

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

______________________	___________	_______	________________
Full Name of Participant	**Date**	**Time**	**Signature**

I, (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Indarani Naidoo	14/04/2014	
Full Name of Researcher	**Date**	**Signature**

APPENDIX 4

Questionnaire for Learners

Dear Learner

I am a Doctoral student in the department of Quality Management from the Durban University of Technology. As part of the requirement of the programme, I am undertaking a research study at your school. The aim of this study is to examine the perceptions and expectations of the quality of the Life Sciences curriculum content by grade 12 learners in the context of lifelong learning. I will be grateful if you would spend a few moments of your time to respond to my questionnaire to enable me to complete my programme. Please be assured that this will be used for academic purposes only and the necessary confidentiality will be adhered to.

This questionnaire consists of 4 sections.
Section A: There are **4** questions about you.
Section B: This section consists of **15** questions based on your Life Sciences educator.
Section C: This section will deal with your expectations and perceptions of the Life Sciences curriculum in the context of lifelong learning.
Section D: This is an optional section for those participants who wish to participate in an interview.

SECTION A: ABOUT YOU

Please answer the questions that follow by placing a tick (√) in the appropriate box.

1. I am a:

Male		**Female**	

2. My home language is:

English	**Isizulu**	**iXhosa**	**Other**

3. Below is a list of some of the reasons that learners choose to study Life Sciences. Use numbers 1 to 5 to indicate the reason/s that you are studying Life Sciences at school. **Number 1 will be the most important factor and number 5 will be least important.**

One of my career requirements	
My school is limited in subject choices	
I was forced to by my parent/ guardian	
It is relevant to my life	
Because my sibling did the subject	

4. I am satisfied with my performance in Life Sciences:

YES		NO	

SECTION B: ABOUT YOUR LIFE SCIENCES TEACHER

Please tick (√) in the appropriate box. Do not tick more than one box. There are no correct or incorrect answers.

	1 Strongly Disagree	2 Disagree	3 Not sure	4 Agree	5 Strongly Agree
Reliability					
1. My teacher is punctual in class.					
2. My teacher's teaching methods are effective.					
3. My teacher gives proper guidelines which he/she adheres to.					
4. My teacher occupies me gainfully during every Life Sciences period.					
Assurance					
5. My teacher always answers my questions adequately.					
6. My teacher is always interested in whatever topic he/she teaches.					
7. My teacher makes me feel that doing Life Sciences is useful in everyday life.					
Tangibles					
8. My teacher includes teaching aids in his/her teaching.					
9. The notes and hand-outs from my teacher are appropriate materials for students.					
10. I am satisfied with the number/volume of exercises my teacher gives me.					
Empathy					
11. My teacher encourages me in Life Sciences.					
12. I am satisfied with the level of individual attention given to me by my teacher.					
Responsiveness					
13. I am satisfied with the frequency at which my teacher gives exercises.					
14. My teacher marks my work timeously.					
15. My teacher displays willingness in addressing my academic problems.					

SECTION C: LIFE SCIENCES CURRICULUM

This section will deal with your expectations and perceptions of the Life Sciences curriculum in the context of lifelong learning. For each of the following statements, please place a tick in the appropriate box on the 5 point Likert scale, that reflects your feeling regarding your expected service(what kind of service you expect to receive) and perceived service (what is your opinion/perception of the quality of the service you actually receive) in terms of the Life Sciences curriculum. **KEY**

1- strongly disagree 2- disagree 3. Neutral 4- agree 5- strongly agree

Please make any additional comments/suggestions where applicable. There are no incorrect answers.

No.	**Statement**		**1**	**2**	**3**	**4**	**5**
1.	Knowing Life Sciences will help me in my career.	Expected Service					
		Perceived Service					
Further Comment:							

No.	**Statement**		**1**	**2**	**3**	**4**	**5**
2.	Life Sciences courses would be very helpful no matter what I decide to study	Expected Service					
		Perceived Service					
Further Comment:							

No.	**Statement**		**1**	**2**	**3**	**4**	**5**
3.	Life Sciences is important in everyday life.	Expected Service					
		Perceived Service					
Further Comment:							

No.	**Statement**		**1**	**2**	**3**	**4**	**5**
4.	Knowing Life Sciences will help me in many ways as an adult.	Expected Service					
		Perceived Service					
Further Comment:							

No.	**Statement**		**1**	**2**	**3**	**4**	**5**
5.	In day-to- day life I often use the Life Sciences learnt at school.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
6.	Life Sciences has taught me how to take better care of my health.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
7.	Life Sciences has made me more critical and sceptical	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
8.	Life Sciences has increased my curiosity about things that we cannot yet explain.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
9.	Life Sciences has increased my appreciation of nature.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
10.	Life Sciences has shown me the importance of our way of living.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
11.	Life Sciences is interesting.	Expected Service					
		Perceived Service					
Further Comment:							

No.	Statement		1	2	3	4	5
12.	Everybody should learn Life Sciences at school.	Expected Service					
		Perceived Service					
Further Comment:							

SECTION D: CONTACT DETAILS

****This section is completely optional**

Please be advised that you are only required to complete this section if you are willing to participate in an interview if more information or clarity is required regarding your responses on this questionnaire.

Please be assured that:

- The information that you provide will remain completely confidential.
- Your personal details provided here will only be assessed by my supervisor and me.

Name of learner**.**	
Contact number	

Thank You

APPENDIX 5

EDUCATOR QUESTIONNAIRE

(Please tick (√) in the appropriate box)

1. Teaching status:

Permanent	Temporary	SGB post

2. Personal particulars

	Female	Male
Gender		

3. Are you currently teaching or have taught Life Sciences in grade 12 in the last 3 years?

YES	NO

4. What is your view on the relevance of the grade 12 Life Sciences content for lifelong learning? 1- Completely relevant; 2 – Partially relevant; 3- Not relevant.

1	**2**	**3**

5. If you placed a tick (√) in blocks 2 or 3 please provide a list of the topics or aspects from the grade 12 Life Sciences curriculum that you consider not relevant for lifelong learning.

___

___

___

6. Please indicate topics or aspects that you consider to be relevant for lifelong learning and should be included in the Life Sciences curriculum.

___

___

___

___

Thank You

APPENDIX 6

Interview Questions for learners

The purpose of the interview is to gather information about the state of the Grade 12 Life Sciences curriculum.

Gender: _____________ Current status: __________________________________

1. How would you best describe your interaction with Life Sciences/ Biology that you study at school?

____

____

2. Why did you feel that way about the subject?

____

____

3. How has the knowledge that you acquired in Life Sciences/ Biology helped you in everyday life?

____

____

4. Why do you feel this way?

____

____

5. Which topics or aspects of the curriculum do you consider to be beneficial to your understanding of your everyday life experiences?

____

____

6. Elaborate on your response to question 5 above.

____

____

____

____

____

____

Thank You

APPENDIX 7

Interview questions for educators

1. What is your feeling towards the changing Life Sciences curriculum?

2. Do you think that the change from Nated 550 to CAPS was a necessity?

3. Does CAPS prepare the learners for lifelong learning? Why do you say so?

4. If the curriculum changes again, what would you like to change?

5. Who should be actively participating in curriculum change in Life Sciences?

6. Why do you say so?

7. What topics would you like included in the curriculum?

8. Of what benefit would these topics be to the learners?

Thank You for your time and patience

APPENDIX 8

DUT DURBAN UNIVERSITY OF TECHNOLOGY

FACULTY OF MANAGEMENT SCIENCES

28 February 2014

Reference: Proposal Approval: I Naidoo, Student number 21243502

Dear Mrs Naidoo

DOCTORATE DEGREE OF TECHNOLOGY: QUALITY

This serves to confirm the approval of your research proposal by the Faculty Research Committee, at its meeting on 25 October 2013, as follows:

1. Research proposal and provisional dissertation title:

A QUALITY STUDY OF THE GRADE 12 LIFE SCIENCES CURRICULUM: PERCEPTIONS AND EXPECTATIONS FOR LIFELONG LEARNING

Promoter: Prof P Singh Co-

promoter: Prof R Sookrajh

Please note that any proposed changes in the dissertation title require the approval of your supervisor/s, the Faculty Research Committee, as well as ratification thereof by the Higher Degrees Committee.

2. Research budget to the amount of **R15 000.00**

Please note that this funding is not a scholarship or bursary and is therefore not paid directly to you, but is controlled by your supervisor. Any proposed changes to use of this funding allocation require the approval of your supervisor and the Faculty Research Committee.

The Institutional Research Committee has stipulated that:

(a) This University retains the ownership of any Intellectual Property (patent, design, etc.) registered in respect of the results of your Masters/Doctors Degree in Technology studies as a result of the award and the provisions of the above Act;
(b) Should you find any of the terms above not acceptable then you are given the option to decline the Research budget award to your project in writing.

May we remind you that in terms of Rule G25(2)(b), if you fail to obtain the Masters/Doctors degree within the maximum time period allowed after first registering for the qualification, Senate may refuse to renew your registration or may impose any conditions it deems fit. You may apply to the Faculty Research Committee for an extension.

Please note that you are required to convert your registration from the informal to the formal course and re-register each year.

Should you experience any problems relating to your research, your supervisor must be informed of the matter as soon as possible. If the difficulties persist, you should then approach your Head of Department and thereafter the Executive Dean of the Faculty.

Please refer to the 2014 General Rule Book concerning the rules relating to postgraduate studies, which include *inter alia* acceptable minimum and maximum timeframes, submission of thesis/dissertations, etc. You are also advised to read the Postgraduate Students' Guide which is available on the DDT website.

Please do not hesitate to contact this office for any assistance. We wish you success in your studies.

Kind regards,

[redacted]

Dr R Balkaran

FRC Chairperson: Faculty of Management Sciences

Cc Promoter: Prof P Singh

APPENDIX 9

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma Tel: 033 392 1004
Ref.:2/4/8/754

Mrs I Naidoo
6 Tariq Road
Riyadh Township
Verulam
4339

Dear Mrs Naidoo

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS
Your application to conduct research entitled: **"QUALITY OF GRADE 12 LIFE SCIENCES CURRICULUM CONTENT: PERCEPTIONS AND POSSIBILITIES FOR LIFELONG LEARNING",** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 04 April 2016 to 30 June 2017.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report. Dissertation / thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu- Natal Department of Education. Pinetown District

____

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 04 April 2016

KWAZULU-NATAL DEPARTMENT OF EDUCATION POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201.
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CALL CENTRE: 0860 596 363; Fax: 033 392 1203 WEBSITE: WWW.kzneducation.gov.za