

**Supporting Environment and Sustainability Knowledge in the Grade 10 Life Sciences
Curriculum and Assessment Policy Context: A case study of the Fundisa for Change
Teacher Education and Development Programme Pilot Project**

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ABSTRACT

In the context of yet another curriculum revision in South Africa, this study investigates how teachers can be supported to meet the environmental discourse requirements as outlined in the revised curriculum in the Life Sciences. The study takes place in the context of a National Case Study which has resulted in a development of a national network, curriculum framework and resources for teacher education, with specific focus on the integration of environment and sustainability in the South African teacher education system.

The study intends to provide insights into what constitutes adequate professional support and assistance to teachers that enables them to understand and work with the environment and sustainability content knowledge requirements of the Life Sciences Curriculum and Assessment Policy Statement (CAPS). The study seeks to inform future curriculum implementation decisions and teacher education programmes.

The study is designed as a qualitative case study inquiry that has used open-ended, individual and focus group interviews, direct field observation and document analysis to generate data. The study revealed that:

- Teachers developed confidence from an in-depth analysis of the CAPS curriculum.
- Teachers have content gaps in environment and sustainability knowledge and these can be addressed through professional development that emphasises rich subject knowledge.
- Teachers are not familiar with teaching methods that can be used to teach environmental and sustainability content knowledge.
- Teachers struggle to see the relationship between teaching and assessing.
- Teachers do not have enough and adequate resources for teaching and learning.
- Training given to teachers should be interactive to enable them to recontextualise training received in their work places.

- Teacher training should go beyond content knowledge that teachers have to teach, but should also consider how teachers can teach and assess that knowledge.
- It is important to have a strong framing for selection and sequencing of content knowledge and a relatively weak framing for pacing and hierarchical rules in teacher training workshops.
- Professional development has the potential to lead to whole school development.

The study recommends that:

- Recontextualisation should be grounded on interpreting the policy requirements
- Teacher pre- and in-service training should focus on developing teachers' understanding of the foundational knowledge in the Life Sciences
- The links between Life Sciences pedagogy and environmental pedagogy should be made explicit.
- Good quality resources should be provided for teachers and they should be supported to use these appropriately.
- Teachers' academic literacy needs to be developed.

Further recommendations:

- Further studies should be conducted that would look at how teachers can be supported to work with environment and sustainability content knowledge within other subjects or other content areas of Life Sciences. This could provide some insights in terms of looking at the patterns, similarities or differences between different cases.

It would be valuable to trace the teachers who participated in this pilot to observe how they recontextualise the training in their classroom practices. There is no point in attending a course or training if it will not impact one's practice. Some insights into classroom practices were gained through reflective interviews from the teachers who had taught the biodiversity content, but this was not observed in practice.

Dedication

This thesis is dedicated to my family for their unwavering support and who endured my long absences from home, with threats of 'disowning' me. A special dedication is to my mother who was with me when I started on this journey but did not live long enough to see its completion.

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ACRONYMS

ANC	African National Congress
CAPS	Curriculum and Assessment Policy Statement
C2005	Curriculum 2005
DHET	Department of Higher Education and Training
DoBE	Department of Basic Education
EEASA	Environmental Education Association in Southern Africa
EECI	Environmental Education Committee Initiative
EEPI	Environmental Education Policy Initiative
ESD	Education for Sustainable Development
EWT	Environment Wildlife Trust
FET	Further Education Training
HEQF	Higher Education Qualification Framework
HSRC	Human Sciences Research Council
IC	Interim Curriculum
INSET	In-service Education and Training
IQMS	Integrated Quality Management System
LoLT	Language of Learning and Teaching
NATED 550	National Assembly Training and Education Department
NCF	National Curriculum Framework
NCS	National Curriculum Statement
NEEP-GET	National Environment Education Programme – General Education Training
OBE	Outcomes-Based Education
OPD	Official Pedagogic Device
ORF	Official Recontextualising Field
PGP	Personal Growth Plan
PD	Pedagogical Device

PRF	Pedagogic Recontextualisation Field
RDP	Reconstruction and Development Programme
RSA	Republic of South Africa
SANBI	South African National Biodiversity Institute
UNESCO	United Nations
WESSA	Wildlife and Environment Society of South Africa

CHAPTER 1: INTRODUCTION AND CONTEXT

As a result of all the restructuring and policy changes that have taken place within the context of South African education, one of the most important concerns for teachers being asked to implement the new curriculum is that they will be provided with adequate professional support and assistance (Du Toit & Sguazzin, 2000a, p. 12).

1.1 Broader context of the study

South Africa is implementing a new curriculum in grade 10 this year (2012). This curriculum is a revision and re-orientation of the National Curriculum Statements and seeks to integrate curriculum and assessment policy into one easy to follow document. This version of the curriculum is named the Curriculum and Assessment Policy Statement (CAPS). CAPS puts emphasis on depth of content knowledge, pedagogical content knowledge and progression. Environment and sustainability content and concepts are integrated into a number of the subjects, particularly Life Sciences, which integrates up to 50 % of environmental content knowledge.

The issue of teacher education for environment and sustainability education gains a new dynamic in the context of CAPS and its requirements. Knowledge development and understanding is the core framing tenet of CAPS. According to recent research, teachers have a poor understanding of sustainable development and thus little capacity for integrating environmental issues and sustainable development into teaching and learning (Lotz-Sisitka, 2011).

The development of Fundisa for Change, a National Environmental Education Teacher Development Network, was a response to the failure of numerous efforts to make systematic impact in strengthening environment and sustainability in Teacher Education (*ibid*). The network was formed in 2011 by partners from higher education, government, parastatals and NGOs. The network has conceptualised a new approach to Environment and Sustainability Teacher Education within the CAPS curriculum policy and the new Higher Education Qualifications Framework for Teacher Education which requires teacher education

institutions and programmes to foreground knowledge in their accredited programmes (RSA, 2011). The network is strengthening environmental learning in the CAPS by implementing the Fundisa for Change Teacher Education Programme.

Its initial focus was on developing materials for an environmental education professional development programme for teachers that is aligned with the CAPS and teacher development policy environment. This study focuses on the pilot phase of the Fundisa for Change conceptual framework, materials and monitoring and evaluation framework in in-service teacher education contexts with a view to improving the teachers' environmental content knowledge, teaching practice and assessment practice.

1.2 Aim of the study

The aim of the study is to provide insights into what constitutes adequate professional support and assistance to teachers that enables them to understand and work with the environment and sustainability content knowledge requirements of the Life Sciences CAPS curriculum. It aims to answer the important question of how best teachers can be supported in their crucial role of being change agents for a more sustainable world. It seeks to inform future curriculum implementation decisions and teacher education programmes.

Research question:

How can teachers be supported to understand and work with the environment and sustainability content knowledge in the CAPS grade 10 Life Sciences curriculum?

The goals of the research are to:

1. Investigate the scope and nature of the environment and sustainability content knowledge in the CAPS Grade 10 Life Sciences curriculum, and how this is related to teachers' existing knowledge and knowledge recontextualisation.

2. Investigate the nature of the support given to teachers, by the Fundisa for Change programme, to enable teachers to understand and work with this new knowledge focus in Grade 10 Life Sciences (in the field of recontextualisation amongst teacher educators)
3. Investigate factors that enable/constrain teachers in understanding and working with the environment and sustainability content knowledge in grade 10 Life Sciences CAPS.

1.3 My interest in the study

The inclusion of environmental education in the school curriculum cannot be disputed but the way it has been implemented is primarily flawed. One of the obstacles that have been noted is teachers' lack of capacity to implement environmental content in the curriculum, (Reddy, 2011).

I am a grade 10 Life Sciences teacher expected to integrate environment and sustainability content knowledge in my teaching of Life Sciences within a curriculum that is content referenced. CAPS expects Life Sciences teachers to be knowledgeable about environment and sustainability content knowledge in order to teach a curriculum that has knowledge development and understanding as its core framing tenet. In light of this, my interest as a Life Sciences teacher is to investigate how Life Sciences teachers can be supported to have the capacity to work with environment and sustainability content knowledge in teaching Life Sciences in the CAPS curriculum.

1.4 Framing of the study

This study draws on Basil Bernstein's theory of the Pedagogic Device, with particular to the recontextualisation of knowledge. The focus of the study is on how the Official Pedagogic Discourse (curriculum policy) is recontextualised in the Pedagogic Recontextualising Field (PRF), (teacher education practice) (Bernstein, 1996).

The tools of critical realism were used to interrogate factors, mechanisms or structures that

either enable or constrain teachers in working with environment and sustainability content knowledge in their teaching of Life Sciences. Critical realism's approach to education, according to Huckle (2004), is aimed at revealing the structures and processes that produce and reproduce interests that prevent people from realising their potential, exposing knowledge ideologies that sustain those interests and reflect and act on alternative structures, processes and knowledge which enables agency.

1.5 Contextual profile of research site

The population of the study is a group of Life Sciences teachers in KwaZulu Natal in Mooi River involved in the Fundisa for Change Life Sciences pilot programme from May 2012 to October 2012. To get teachers to be part of the pilot, an invitation was sent to schools in the area and the schools selected the teachers. The choice of schools was based on (a) historic relationship between the school and the implementers of the programme: EWT and WESSA, (b) close proximity to the venue chosen for the workshop or (c) links to Eco-schools as invitations were also sent to Eco-schools¹ in that area. The schools are not all from the same education district office. Some came from Umgungundlovu district, and others are schools that are considered in their districts as underperforming schools.

Fifteen teachers from 12 schools came to the first workshop. Six were township schools and 6 rural schools, some of the schools had two teachers attending the workshop. All the rural schools and 4 of the township schools were no-fee schools at the time of the study and two of the township schools were fee-paying schools in quintile² 3 and 4 respectively.

Teaching staff numbers at the schools ranged between 11 – 39, with learner enrolment ranging between 350 – 1300. Teacher: learner ratios ranged between 1:35 and 1:70. In all the schools English is the language of instruction with isiZulu being the home language of the majority of the teachers and learners.

¹ The Eco-school Programme is an international sustainability schools initiative that is aimed at creating awareness and action around environmental sustainability in schools and their surrounding communities as well as supporting ESD (Education for Sustainable Development) in the national curriculum.

² The quintile system is a funding system used to categorize schools. Quintile scores are calculated based on national census data for school area based on income, unemployment rate and level of education (literacy rate). More money is allocated to poorest schools and less funds allocated to least poor schools. Quintile 1 is poorest schools and quintile 5 is least poor, therefore quintile 3 and 4 are middle ratings.

Seven of the teachers have 3-years' teaching diplomas and an Advanced Certificate in Education or Further Diploma in Education, seven have degrees up to Honours level and one has an electrical engineering certificate. Teaching experience and teaching of Life Sciences ranges between 1 -25 years, most having taught Life Sciences when it was still Biology.

Most of the teachers teach Life Sciences because they enjoy it and only one of the teachers, not trained as a Life Sciences teacher, teaches it because nobody else was available in her school to teach it.

1.6 Overview of the study

The following chapter provides a broad theoretical and historical context for the study. It explores the introduction of environmental education in the South African national curriculum. It also takes a look at the trends in the professional development and training of teachers, particularly in South Africa. It concludes with a content analysis of the Life Sciences grade 10 CAPS curriculum.

Chapter 3 is a description and discussion of the overall design of the study, its methodological approaches and methods of data generation and analysis. The chapter also discusses ethical issues, validity and trustworthiness of the study.

Chapter 4 provides a description of the recontextualising process. It presents the data generated from document analysis, interviews and observations. It starts with an analysis of the Official Pedagogic Discourse (curriculum policy) and presents teachers' experiences of the orientation workshop on the teaching of the CAPS curriculum. The chapter also presents an analysis of the materials used by the Fundisa for Change facilitators in the pilot of their programme. It gives a brief description of the teachers' contextual profiles and starting points. This is followed by an outline of the Fundisa for Change training process and concludes by detailing teachers' experiences of the pilot.

Chapter 5 provides a Bernsteinian interpretation in analysing the findings presented in chapter four. It also uses the critical realist framework of a stratified ontology to explain the factors that influenced the recontextualisation outlined in chapter four. The findings are

further articulated in the form of analytical statements, which address the research question. The analytical statements are categorized according to teachers' engagement with the curriculum policy and according to the Fundisa for Change recontextualisation process. This presents a concluding summary for the study. It also presents recommendations arising from the study and recommendations for further research.

CHAPTER 2: LITERATURE REVIEW

Any curriculum is embedded within a system of institutions, qualifications, and so on, which also require change if the curriculum is to change. In other words, one cannot just change the curriculum content or pedagogy; one has to change the whole system (Hoadley & Jansen, 2009, p. 212).

2.1 Introduction

The chapter starts off by providing background to Bernstein's theories briefly mentioned in chapter 1. It also provides insight into the international influences that led to the incorporation of environmental education into the South African national curriculum as well as the development process of its successful integration in all the subjects in the curriculum. It also discusses the issue of knowledge in the curriculum. It further discusses lessons that have been learned in teacher professional development processes, particularly in South Africa. It also traces a brief history of Life Sciences and concludes with an overview of what is entailed in the Life Sciences CAPS curriculum document.

2.2 Theoretical framework: Bernstein's pedagogic device

This framework provides useful lenses for interrogating how an official national curriculum is recontextualised in teacher development programmes, which is the focus of this study.

According to Singh (2002), specialist expert knowledge needs to be pedagogised in order to be accessible to those outside the specialist domains. The producers of this knowledge do not have the time or resources for pedagogising this knowledge resulting in the pedagogising being done in the field of recontextualisation. This has implications for 'what' knowledge is available to be pedagogised, and 'how' this knowledge is transformed into pedagogic forms (in the case of this study, by teacher educators). Bernstein (1990) also emphasised that during the recontextualisation process, a space is created for the ideologies of the agents in the field to be at play thus influencing how the official pedagogic

text is refocused. Teachers at the reproduction field adapt this pedagogised knowledge further as they work with learners in the classroom (Singh, 2002).

Bernstein (1990) defines the pedagogic device as a terrain for the production, reproduction and transformation of culture. He describes it as a relay system for the formation and delivery of educational knowledge. He further states that it provides a language for interpreting and describing the pedagogic discourse through distributive rules, recontextualising rules and evaluation rules. The pedagogic discourse is a principle that removes (delocates) a discourse from its actual practice and context, and relocates it according to its own principles of selective reordering and focusing. In the process of the de- and relocation, the original discourse is subject to transformation. It is a recontextualising principle which selectively appropriates, relocates, refocuses and relates other discourses to constitute its own orientation and modifications for the purpose of their selective transmission and acquisition.

According to Bernstein (1990), the rules that provide a language for the pedagogic discourse are hierarchically related; recontextualising rules regulate the evaluative rules, and are in turn regulated by the distributive rules. Distributive rules regulate discourse and/or practice i.e. who may transmit what to whom and under what conditions thus setting limits of legitimised discourse. Recontextualising rules regulate pedagogic discourse which answers the question, what discourse is embedded in what discourse? Pedagogic discourse embeds an instructional and a regulative discourse. Pedagogic discourse is a recontextualising discourse which embeds competence in order and order in competence. Evaluative rules regulate pedagogic practice which can either be visible or invisible. According to Geirsdóttir (2008) quoted in Jónsdóttir and Macdonald (2008), a regulative discourse is about identity, i.e. who people are and how they do things as well as what they envision for the future. In terms of instructional discourse, it refers to the knowledge and skills to be acquired, how they will be taught and in what sequence and how they will be assessed.

Pedagogic practice is provided by a set of three rules, hierarchical, sequencing and criteria rules that act selectively on the content of any pedagogic practice. These rules are the 'how' and 'what' of any pedagogic practice. Hierarchical rules focus on what the knowledge transmitter has to learn to transmit and what the knowledge acquirer has to learn to be an

acquirer. Sequencing rules focuses on how much one has to learn in a given time (pace), representing progression in the learning process. Criteria rules involve criteria that the acquirer is expected to take over and apply in own practice and those of others. This enables the acquirer to understand what counts as legitimate practice, Bernstein (1990).

Pedagogic practice can either take the form of being visible or invisible. It is visible when the hierarchical, sequencing and criteria (regulative rules and the discursive order) are made explicit and invisible when the rules are implicit (*ibid*).

Distributive rules, recontextualising rules and evaluation rules are linked to three hierarchically related fields; the production field, recontextualising field and reproduction field. According to Singh (2002), these fields are hierarchically related, in that, recontextualisation of knowledge cannot take place without the original production of knowledge, and reproduction cannot take place without recontextualisation.

The production field which is the 'intellectual field' of the education system, it is where new knowledge (text) is developed and positioned mainly in institutions of higher education and private research organizations. In the context of this study it would include science faculties in universities and organizations such as SANBI (South African National Biodiversity Institute) who produce biodiversity knowledge. In the recontextualising field there is a relocation of text and practices from the production field. This field is comprised of two contexts, the official pedagogic recontextualising field (ORF) and the pedagogic recontextualising field (PRF). The ORF includes specialised departments and sub-agencies of the state (national and provincial) and local educational authorities (district officials) with their research and systems of inspectors (subject advisors), (Bernstein, 1990, p. 192). In the case of this study these would for example be the Life Sciences curriculum committee appointed by minister, Angie Motshekga (who wrote the CAPS) and Life Sciences subject advisory services (amongst others).

The PRF consists of university and polytechnic departments of education and others e.g. Department of Environmental Affairs, colleges of education and private foundations e.g. Lewis Foundation in the case of this study and text writers and readers and publishing houses. The PRF may also 'extend to fields not specialized in educational discourse and its

practices, but which are able to exert influence both on the State and its various arrangements and/or upon special sites, agents and practices within education' (*ibid*).

The pedagogic discourse has relative autonomy as it enables agents in the PRF to exist and affect official pedagogic practice. In the South African context, environmental educators in the EEI (see section 2.3.2) lobbied for the inclusion of environment education in the national curriculum, starting in 1996 until the first revision of the post-apartheid curriculum. Environmental education is now an integral part of all the subjects in the South African national curriculum (Irwin & Lotz-Sisitka, 2004).

The degree of autonomy of the PRF can affect the pedagogical discourse reproduced in schools, essentially through initial and in-service training of teachers and through the textbooks written. The state can limit the influence of the PRF through its official pedagogic discourse (OPD), e.g. textbook writers send their textbooks for screening before the textbooks can be approved and included in the catalogue sent to schools. The state also specifies the minimum Requirements for Teacher Education Qualifications is based on the Higher Education Qualifications Framework (HEQF).

The OPD contains official rules that control the production, distribution, reproduction, interrelation, and change of legitimate pedagogic texts, their social relations of practice and organization. The OPD is an embedded discourse and the realization of the interrelations between instructional discourse and regulative discourse (Bernstein, 1990).

Bernstein also talks about the specific instructional discourse which controls the rules that legitimise the specialised competences of any agency in the pedagogic device fields, and about the specific regulative discourse which provides and legitimises the official rules controlling order, relation and identity.

Bernstein uses two principles in the structuring of pedagogic discourse, classification and framing. Framing regulates the regulative discourse and the instructional discourse (Bernstein, 1996). Classification is concerned with the organization of knowledge into a curriculum, framing is related to the delivery of knowledge through pedagogic practices. The principle of framing refers to "the locus of control over the selection, sequencing, pacing

and criteria of the knowledge to be acquired” (Bernstein, 1996, p. 101). Classification establishes the recognition rules, the ‘what’ and ‘who’ in pedagogic discourses while framing establishes the realisation rules, the ‘how’ in pedagogic practices (Bernstein, 1990, p. 35).

According to Morais and Neves (2001, p. 217), “pedagogic innovation is possible whenever teachers undergo a process of professional development where they have access to an education which promotes the acquisition of recognition and realisation rules and socio-affective dispositions appropriate to implementing such acquisition”.

Recognition rules to differentiate and recognise specificity in a particular context and realisation rules control the creation and production of specialised relationships within that context; both these rules establish the context. Realisation rules establish what counts as legitimate text but they are limited by recognition rules, (Bernstein, 1990).

Bernstein (1996) also distinguishes between two pedagogic models, the performance and the competence models. In Bernstein’s terms, the performance model of pedagogic practice puts emphasis on particular skills that an acquirer requires to produce a specific product.

The competence model is perceived to be empowering (*ibid*).

Bernstein (1999) distinguishes between two forms of knowledge, school knowledge and everyday common sense knowledge. He refers to the school knowledge as official knowledge and the common sense knowledge as local knowledge. Vertical knowledge differs from horizontal knowledge in that distributive rules regulate its access, acquisition, transmission, potentials and mediation through selective recontextualising. Horizontal knowledge on the other hand is local, segmented and context specific for maximising engagement with learners (Bernstein, 1996, p. 171). Criticism on horizontal knowledge is its inability to move beyond the local context (Peden, 2008).

2.3 Environmental Education in the Official Pedagogic Discourse in South Africa

In this section I will discuss how environmental education came to be in the South African national school curriculum.

2.3.1 International influences on curriculum change in South Africa

Irwin and Lotz-Sisitka (2004) note that the history of environmental education has evolved into considerations of the integration of social, economic, political and ecological aspects both internationally and in South Africa. They trace the development of environmental education prior to 20th century up until post 1994 in the South African context.

Irwin and Lotz-Sisitka (*ibid*) point out that traditional education in Africa consisted of a curriculum that empowered local people to understand their natural resources in a way that will enable them to develop skills to adapt to their natural environment and to benefit from it.

The Ahmedabad Declaration, drafted in the context of the UN Decade of Education for Sustainable Development in 2007 during the fourth international environmental education conference, traces the evolution of environmental education from the first international conference on environmental education in Tbilisi in 1977, to the second one in Moscow in 1987 and the third in Thessaloniki in 1997. This 2007 Declaration marks 30 years of international environmental education dialogues. This declaration sets new agendas for action in environmental education in the 21st century.

The Declaration believes that “through education, human lifestyles can be achieved that support ecological integrity, economic and social justice, sustainable livelihoods and respect for life.” (UNESCO 2008, p. 1)

In mobilising the 2007 Declaration vision, there is a call for the reconsideration of tools, methods and approaches and the foundations and purpose of education and how it relates to how people live their lives. The Ahmedabad Declaration states that education processes that support and champion Education for Sustainable Development must be relevant, responsive and accountable. The 2007 Declaration adds that Education for Sustainable Development views education as a lifelong, holistic and inclusive process (*ibid*).

Emphasis with regard to education and training is on situated learning processes that consider methods and pedagogy, and fundamental change in the purpose and practices of education. There is also recognition of the need to 'know' nature in order to transform societies to live sustainably (*ibid*). The Declaration also emphasises the importance of understanding the links between environment, society, culture and economics, and understanding the nature and causes of risks and issues that impact on socio-ecological systems from local to global levels.

Reaffirming the recommendations made in the Thessaloniki in 1987, the Ahmedabad Declaration recognises education as an '*effective driver of change*', (*ibid*, p. 4). This suggests that education systems should employ pedagogies that integrate environmental education and ESD principles and transformative learning approaches to enhance progression in environmental learning. The valuing of indigenous knowledge systems for re-thinking of practices for sustainability is also emphasised. The Declaration argues for the acceptance of indigenous knowledge systems as legitimate in the educational process. This is evident in the South African national curriculum-CAPS (see section 4.3.3.1)

2.3.2 Environment and sustainability education in South Africa

According to Irwin and Lotz-Sisitka (2004), the emergence of environmental education in South Africa was influenced by the Belgrade Charter of 1975 and the 1977 Tbilisi Principles. They state that the South African formal curriculum focused on conservation of natural resources and the principles of ecology. However, they assert that environmental education in southern Africa had always considered the social, political, economic, cultural, urban and ecological aspects of the environment as being inseparable. They also observe that the development of environmental education in South Africa has been rich because the debates, contestations and contradictions that emanated during the development process created spaces for intellectual deliberations (*ibid*).

South Africa ultimately had its first international conference on environmental education in 1982 in Natal, which resulted in the establishment of the Environmental Education Association of Southern Africa (EEASA). Subsequently, certain institutions of higher learning

in the late 1980s and early 1990s established Environmental Education courses and programmes for teachers in their Education faculties (*ibid*).

In 1992, during the transition period in South Africa, EEASA coordinated a Policies and Procedures survey in response to a call to develop an education curriculum policy within formal education. This initiative resulted into the establishment of the Environmental Education Policy Initiative (EEPI) which then became the Environmental Education Curriculum Initiative (EECI) (*ibid*).

1994 saw the tabling of a socio-economic policy framework, the Reconstruction and Development Programme (RDP), (RSA, 1994) by the ANC. This policy emerged as a response to the realization that South Africa was confronted by serious economic, social, political, moral, cultural and environmental problems. One of the key programmes of the RDP is meeting the basic needs of the South African citizens, with environment seen as one of the basic needs. In meeting this particular need, it was said that the government must work towards equitable access to natural resources through ensuring that all South African citizens, present and future, have the right to a decent quality of life through sustainable use of resources.

This was enshrined in the South African Constitution, in the Bill of Rights (RSA, 1996) that states:

Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. (p. 6)

The RDP further proposes that the reconstruction of education and training requires a body of teachers, educators and trainers committed to RDP goals and who are competent in carrying them out. This requires that they be able to understand and respond flexibly to the challenges of the new approaches to curriculum, method, delivery and certification which an integrated system of education and training demands.

In 1995 the White Paper on Education and Training (RSA, 1995) was released. The Paper presented the framework for the transformation of the Education and Training system in South Africa. A principle in this White Paper notes that:

"Environmental education, involving an interdisciplinary, integrated and active approach to learning, must be a vital element of all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources" (p. 18).

The environmental educators in the EECI participated in the development of the first outcomes-based education, Curriculum 2005 (C2005) and a revised *National Curriculum Statement* (NCS) in order to integrate environmental education in the school curriculum. In C2005, environment was a phase organiser in all the learning areas. Having environmental education as a phase organiser instead of making it a subject in the curriculum meant that all the teachers in the education system would have to engage with it, i.e. teachers would have to consider an environmental focus in their teaching (Irwin & Lotz-Sisitka, 2004).

The EECI members in lobbying for the inclusion of environment in the curriculum placed emphasis on the importance of knowledge integration by highlighting the inter-relatedness of environmental, developmental, and educational issues in their quest to raise knowledge, skills, and awareness of sustainable development in all learning areas (Chisholm, 2005).

C2005 was revised to NCS in order to promote a greater emphasis on subject-related content based knowledge to balance out an over-emphasis on outcomes and integration which characterised C2005 (Lotz-Sisitka & Janse van Rensburg, 2000). With the revision of C2005 to NCS, a national project for environmental education in the formal curriculum was established by the Education Minister, at the time (Irwin & Lotz-Sisitka, 2004). The project, National Environmental Education Project for General Education and Training (NEEP-GET) was established in 2001 to support teachers in developing lesson plans for environmental learning to encourage learners to explore the complexity of environmental issues in their contexts. One of the principles that underpinned the NCS curriculum is the recognition of the relationship between social justice, a healthy environment, human rights and inclusivity

(NEEP-GET, 2004). Environmental education is now an integral part of all the subjects in the South African national curriculum (see section 4.3.3.1).

2.4 Education for Sustainable Development

Wals (2007) states that education for sustainable development is about making people understand the complex features of the natural and man-made environments arising from the interaction between the biological, physical, social, economic and cultural perspectives. It enables people to participate in environmental management and through their participation solve sustainability issues. Furthermore, creating a sustainable world requires people to focus on how ecosystems work, recognising connections and interrelationships, Capra (2007) in Wals (*ibid*). Teachers need to understand the concepts dealt with in their subjects to be able to identify opportunities for exploring sustainability issues in their teaching.

Littledyke (1997) has identified the following as deterrents in environmental education:

- limited policy development, lack of coordination and teaching support, and poor resourcing in many schools;
- lack of scientific understanding of environmental issues in many teachers;
- inappropriate or limited understanding of the nature of science and its role in environmental problems

Littledyke (*ibid*) claims that confidence in science concepts can improve understanding of environmental issues and provide an important platform for environmental education. Moreover he asserts that the development of environmental education should be supported by corresponding development of teachers' understanding of science and confidence in teaching science. He also suggests that pre- and in-service science courses should also consider the epistemological basis of science as well as the processes and concepts which need to be taught so that environmentally appropriate science pedagogy can be developed.

This suggests that foundational knowledge of key scientific concepts and principles that underpin ecological processes is important in addressing environmental issues for developing real solutions for them.

Peden (2008), adding to the debate above, argues that ESD is reluctant to define core concepts and knowledge base, and that brings challenges particularly in South Africa where there are debates about knowledge in South African education. He states that ESD foregrounds social issues at the expense of the natural environment. He argues for inclusion of disciplinary knowledge of both natural and social sciences in environmental education. Peden also notes that successful building of disciplinary knowledge requires an introduction of core environmental literacy course in teacher education programmes. He adds that educators from different school disciplines should use their specialisations to create environmental education that will provide learners with knowledge to work creatively between human society and natural environments (*ibid*).

Bertram (2011) further asserts that teachers need propositional knowledge of a discipline in order for them to be able to access new content knowledge on their own. She defines discipline propositional knowledge as 'deep conceptual disciplinary knowledge' which should be taught systematically by an expert. Similarly, Baxen and Soudien (1999) argue that deep disciplinary knowledge is required in working with integrated and progressive pedagogy of which environment and sustainability are an example, especially in a curriculum like CAPS, that foregrounds the progression and sequencing of knowledge to be taught in each grade. Pedagogical knowledge becomes necessary only when teachers have to make the disciplinary knowledge accessible to their learners (Bertram, 2011).

There is a belief that teachers teach a topic from their understanding of the purpose of teaching that subject and the nature of the discipline and that their choice of content, teaching methods and resources used is influenced by their value orientations to the subject they teach (Gudmundsdottir, 1999 cited in Bertram, 2011).

Bertram (2011) suggests that, from reviews that have been done previously of curriculum implementation, the training of teachers should be subject-specific instead of focusing solely on how to implement a particular curriculum, as curriculum changes over time.

She also maintains that to meet individual teachers' needs with regards to disciplinary knowledge, teachers should be separated according to their levels of subject content knowledge. She argues that workshops whose purpose is to develop teachers' content knowledge should go beyond giving teachers only facts about the discipline but rather should develop teachers' knowledge of the discipline's structure and organisation. She claims that it is possible to develop teachers' ability to organise systematic learning in a grade and subject they are going to teach through explicitly stating how curriculum knowledge is sequenced in that particular subject.

2.5 Knowledge in the curriculum

We live in times that require people to be knowledgeable, which politicians call a knowledge society (Young, 2008). Knowledge empowers people to make informed decisions. The inclusion of environmental education in the South African curriculum was influenced by the need to produce citizen who would have knowledge about the environment to be able to address environmental and sustainability issues faced by the country.

Reporting on research done by Pile and Smythe with grade 4 and 7 Geography teachers, (Taylor and Vinjevold, 1999) note that current emphasis on knowledge issues in the South African curriculum implementation posits that the quality of teaching and learning can only be improved if the knowledge foundations of teachers are systematically built. Pre- and in-service programmes must teach and deepen systematic understandings of conceptual knowledge and high-order skills in teachers.

The study (*ibid*) also indicated that teachers were unable to process subject content facts because they lacked background discipline knowledge. Secondly, teachers have low levels of conceptual (propositional) knowledge to teach at the levels required and have a poor grasp of their subject. Thirdly, teachers are unable to perceive links between different parts of the curriculum because they do not have a holistic understanding of what they are teaching.

Hoadley and Jansen (2009) argue that teachers' subject content and conceptual knowledge is the most important resource they need in their teaching. They believe that rich subject knowledge enables the teacher to integrate prescribed content knowledge with other subject content knowledge, and with global knowledge and learners' lives, thus enriching

the learning process. They also note that there is a strong argument that emancipation comes from giving learners access to strong discipline-based knowledge as this kind of knowledge will allow them access to positions of power and influence in society.

According to Wheelahan (2010), access to discipline-based theoretical knowledge should be the aim of education. The premise of such a statement is that access to knowledge is an issue of social justice, because society uses knowledge to conduct its debates and controversies. She also argues that disciplinary or domain-based contents are carriers of the concepts needed for thinking about and changing the world and engaging in conversations in society. The principal goal of education should therefore be to provide students with access to knowledge and unless learners have access to theoretical knowledge they are denied the necessary means to participate in these conversations. However, few of these knowledge theorists discuss what knowledge is being included, and simply assume that existing disciplinary knowledge is the most appropriate knowledge that needs to be included and learned in education systems.

Integration of environment and sustainability knowledge into disciplinary contexts raises some questions about *what* knowledge is being included and/or excluded. One can suggest that the intention behind including environment and sustainability concepts in the Life Sciences content knowledge is to enable learners to engage in societal conversations relating to issues of sustainable development, and that these are 'valid inclusions' within this knowledge-focused debate; and legitimate societal conversations. Few of the 'knowledge theorists' in education (mentioned above) consider issues of introducing *new knowledge into disciplinary conversations*, as is the case with environment and sustainability knowledge which is often associated with 'newness', complexity and uncertainty (Lotz-Sisitka, 2011) creating an interesting 'knowledge context' for examining questions of knowledge and its recontextualisation in education.

Taylor and Vinjevold (1999) reiterate this notion by stating that when learners do not have content knowledge they are unable to develop systematic understanding of ideas. They therefore maintain that learners should acquire high level content knowledge and high-order problem-solving skills; this demands a depth and sophistication in teachers' grasp of

academic subjects. Similarly, Summers, Kruger and Childs (2000), claim that the best teaching comes from good subject knowledge.

Teachers teach with understanding if and when they have a conceptual understanding of subject matter Borko and Putman (1995). Taylor and Vinjevold (1999), remarking on a study conducted by Reeves & Long with grade 7 Science teachers, indicate that teachers' conceptual knowledge is significantly improved through subject-focused in-service training.

2.6 Teaching

The national curriculum, and the teachers who deliver it, are two fundamental elements of successful school performance, with the curriculum making the necessary provisions while the teachers exercise their expertise to deliver those provisions (Chatzifotiou, 2006). In light of this argument, teachers in South Africa need the necessary expertise to interpret and deliver the provision of the CAPS curriculum that is content- knowledge driven (see section 2.10). As many researchers point out, effective implementation consists of recontextualisations involving curriculum teaching and learning support materials, teaching methodology, behaviour, beliefs and understanding on the part of teachers who are expected to implement the curriculum (Fullan & Pomfret in Fullan & Hargreaves, 1992; Hoadley & Jansen, 2009; Taylor & Vinjevold, 1999).

The way teachers understand teaching will have an influence on what they do in the classroom, as a consequence, teachers therefore need to be clear about the nature of teaching (Hirst, 1974). Hirst (*ibid*) asks some interesting questions about the activity of teaching:

- How would a person determine whether a teacher is teaching or not, on entering a classroom?
- What needs to be happening in the classroom to get to that conclusion?

He (*ibid*) concludes that teaching activities can be characterised by looking at the purpose of those activities i.e. clarifying the intention of the teaching activity. He believes that the intention of teaching activities is learning and as such learners involved in these activities

should in fact learn what was intended. The teaching activity should therefore comprise of what has to be learnt so that it is clear to learners what they need to learn.

In teaching a subject Hirst (*ibid*) asks the following questions:

- In what ways and to what extent is the effective teaching of a subject determined by the nature of the subject itself?
- Are teaching methods used determined by the characteristics of what is to be taught?

Hirst (*ibid*) argues that in teaching a subject, the intention is that learners understand the information in such a way that they are able to think in the way characteristic of the particular subject.

Carl (2009) posits that teachers extend and develop the curriculum of the subject they teach through their selection of suitable and relevant textbooks, their interpretation of the curriculum, Departmental requirements, syllabus, their extension of core and learning contents, as well as through planning for learner assessment.

According to Gewirtz and Cribb (2009), good teaching requires technical and practical wisdom in addition to subject knowledge and as such it is important that teachers be autonomous. This will enable them to make decisions about the kind of values they want their learners to embrace, kind of curricula, pedagogies and forms of assessment that are most valuable. Autonomy will also enable them to respond to changing circumstances. Similarly, Darling-Hammond & Ball (1999) cited in Fullan (2007) argue that teachers' selection of text and other materials is influenced by what they understand about the content they need to teach. How they teach is influenced by how well they understand their learners and the way they assess their learners depends on their depth of subject content knowledge and the way in which they understand and interpret their learners' work.

Palonsky (1993, cited in Cutter-Mackenzie & Smith, 2003) notes there is an assumption that good teachers in the teaching profession have a special knowledge base, skills and understanding which enables them to present and communicate that knowledge. Grossman (1995) also cited in Cutter-Mackenzie & Smith (*ibid*) further argues that what teachers teach

and how they teach it is influenced by how much content they know. He claims that teachers put more emphasis on the content they know and less on what they are not confident with. These arguments imply that teachers could avoid teaching environment and sustainability content knowledge if they do not have adequate knowledge, skills and understanding to teach it as was found in some of the environmental education research (Lotz-Sisitka & Janse van Rensburg, 2000; Lotz-Sisitka, 2002). This has implications for how teachers are prepared to teach a curriculum that integrates environment and sustainability content knowledge and at the same time puts emphasis on acquisition of content knowledge as opposed to the achievement of outcomes.

Smyth (1995b) maintains, “The teacher is the ultimate key to educational change and improvement” (p. vii). In addition, Guskey (1995) argues that schools can only be improved when the skills and abilities of school teachers are improved. Professional development should therefore be relevant to teachers’ needs. Moreover, Hargreaves (1995) observes that it is believed that good teaching is about teachers knowing what to teach and how to teach it and mastering teaching skills but also claims that developing that idea of good teaching through professional development is elusive. Hargreaves (*ibid*) in citing Little (1993), observes that teachers reject knowledge and skill –based workshops if they are not aligned to their work contexts.

Conde and Sanchez (2010) suggest that in order to achieve the aims of environmental education for sustainable development in schools, teachers need to know what is in the curriculum and how to work with it. Education, according to Stables (2004) is a continuous, uncertain interpretation of curricula by teachers.

2.7 Teacher development

Investing in education means investing in teacher development as all learners deserve to be taught by good teachers who are qualified to teach the subject they teach and are up to date with curriculum changes. Therefore the quality of the training and development they receive will determine the quality of the education society receives (Day, 1999).

The UNESCO (2004) report identifies six areas which are seen to provide potency in the education quality debate. The six areas are:

- appropriate, relevant and inclusive educational aims
- relevance and breadth in curriculum content
- actual time available for learning, and its use
- effective teaching styles
- appropriate language(s) of instruction
- regular, reliable and timely assessment, both summative and formative. (UNESCO, 2004: 146-158)

The report mentions that the six areas above enable the identification and clarification of the problem of education quality. According to the report, the problem of quality education is in part about values, for defining what aims for a public system of education are 'appropriate' and what content is 'relevant' to learners. Another problem is the lack of clarity on kinds of teaching most conducive to learning.

According to Carl (2009), teachers need systematic empowerment to improve their teaching. He also believes that successful implementation of a curriculum depends on how well teachers have been informed and prepared for curriculum changes as well as on their willingness to embrace the changes. He insists that teachers acquire the skills they need to be more effective through in-service training programmes. This implies that in-service training programmes should support teachers in ways that will enable them to improve their teaching.

The key to educational change is the teacher as teachers develop, define and interpret the curriculum (Smyth, 1995a). According to Day (1999), professional development of teachers is important in enhancing the quality of teaching. He (*ibid*) states that teachers will only be able to do their work if they are well prepared, if teachers keep up to date with change and renew their knowledge, skills and visions for good teaching. Subject knowledge and teaching methods need to be updated as teaching occurs in a world that is predominantly complex, uncertain and dynamic (Lotz-Sisitka, 2011). Day (1999) asserts that professional development is integral and essential in efforts to improving standards of teaching, learning

and achievement and enhancing quality teaching by supporting a school's greatest asset, the teachers.

Professional development that enables teachers to increase their professional knowledge is a complex process that consists of planned learning activities intended to benefit teachers, schools and the education system. "Professional development is not something that can be forced, because it is the teacher who develops (actively), and not the teacher who is developed (passively)." (Day, 1999, p. 97).

The maintenance of good teaching requires that teachers regularly keep up to date with curriculum content knowledge, their subject knowledge, teaching methods and assessment strategies as teaching occurs in a society dominated by change, uncertainty and increasing complexity (*ibid*), as the environmental education literature also shows (Summers et al., 2000; 2001; 2003).

Day (1999) defines in-service training (INSET) as a planned series of events intended to meet teachers' needs in relation to the demands of the education system. Therefore teachers in INSET programmes should acquire the intended knowledge, skills and attitudes they need to incorporate into their practice in ways that will improve education quality and learners' achievement of education goals (Eraut et al., 1987 in Day *ibid*). In-service education and training helps one decide what to do as well as do what is needed to be done more consistently, effectively and efficiently (Steadman et al., 1995 cited in Day *ibid*).

Schuell (1986, cited in Moon, 2001), argues that for a course to achieve its desired outcomes effectively, the participants should be engaged in activities that will lead to the achievement of the outcomes.

Shulman (2004) argues that teachers draw from seven domains of knowledge in doing their job. Teachers draw on content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners, knowledge of educational contexts and knowledge of educational ends.

Borko and Putman (1995) state that there should be a conceptual framework for developing teachers' knowledge base. Their framework closely resembles Shulman's seven domains of the knowledge base. Borko and Putman (*ibid*) also argue that Shulman's seven domains should be used as a conceptual framework for designing professional development programmes.

Borko and Putman (1995) speak of subject-matter knowledge and pedagogical content knowledge amongst other knowledge bases. They define subject-matter knowledge as knowledge of facts, concepts and ideas in a subject, the principles and meanings that underpin the subject, the connections or links between the ideas in a subject as well as how knowledge is generated in a discipline. They argue that content knowledge enables teachers to teach for understanding. This has implications for professional development programmes since they should be tailored to broaden teachers' understanding of subject matter and the nature of inquiry within their subjects.

Efforts to improve teacher practices should therefore help teachers to acquire new knowledge they will use to teach for understanding. They state that what teachers know about a subject influences how they teach it. They explain that studies show that teachers' conceptual understanding of subject matter is important in teaching for understanding. In addition, Gough (2003, cited in Summers, Corney & Childs, 2003), points out that teachers need to attach some meaning to concepts before they can teach them.

Borko & Putman (1995) see pedagogical content knowledge as encompassing an understanding of the topics in a subject and how they have been organized to facilitate their teaching. It also involves knowing the curriculum and the materials that go with it. Professional development, in trying to develop this particular knowledge base, would have to pay attention to giving teachers an in-depth understanding of the appropriate materials that are available to teach specific content knowledge and to understand the progression within and across the grades.

Shulman (2004) defines subject matter as the content knowledge of a discipline, content knowledge consisting of facts, concepts and processes in the discipline and the relationships

among them. Pedagogical content knowledge involves teaching of content knowledge. Knowledge of curriculum involves knowledge about teaching and learning support materials and how curriculum is packaged and the progression within a grade and across the grades.

Shulman (2004) also claims that a textbook or syllabus initiates the teaching and learning process. The text in these teaching materials becomes a vehicle for the achievement of educational purposes. He further claims that with a text and educational purposes a teacher can start pedagogical reasoning and action. This involves activities of comprehension, transformation, instruction, evaluation and reflection.

According to him (*ibid*), comprehension requires that teachers critically comprehend content to be taught and how ideas in the content relate to other ideas within the same subject and across other subjects. Transformation involves critical interpretation and analysis of the text preparing it for learner comprehension, choosing appropriate teaching strategies that are tailored to learners' needs. Instruction is characterised by presenting clear explanations and descriptions, giving work to learners and checking it, engaging learners actively in the teaching and learning through asking questions. Evaluation entails assessing learner understanding and self-evaluation to improve one's teaching. Reflection gives a teacher the opportunity to critically analyse the learners' performance and their own performance based on evidence from learners' work. This leads to new understandings about educational purposes, subject knowledge, learners, teaching and results and learning from experience (*ibid*).

Guskey and Huberman (1995) observe that there is a constant expansion of the professional knowledge base which necessitates new types of expertise in the education system so that teachers keep up to date with the emerging knowledge base and are better prepared to use it in their practice. They state that in-service training and professional development is crucial for educational improvement as it allows teachers to expand their professional knowledge base. Likewise, Borko and Putman (1995) claim that helping teachers expand their knowledge systems will result in their changing their practice. They assert that the knowledge that teachers possess influences their thinking which in turn determines their practices. They point out that by enriching and elaborating teachers' knowledge, teachers

will be motivated to teach differently from how they were taught and how they were prepared to teach.

With the introduction of a new curriculum, come new requirements and expectations for teachers. The success of the transformation is dependent on the nature and quality of professional support received by teachers. Teacher education programmes should be tailored to meet the new curriculum demands. The challenge is getting the teachers who are already in the field to be on board with the new developments. This then has significant implications for the extent of professional development that will be accorded teachers already in the profession.

2.8 Teacher training and development in South Africa

When a new curriculum is introduced, especially when it differs from the previous, the expectation is that intensive and extensive professional development of teachers would be necessary to prepare teachers for its implementation. Fiske and Ladd (2004, cited in Ono & Ferreira, 2010) noted that the training of teachers for OBE had been far from adequate, the Department of Education introduced a “cascade” model through which teachers were trained and in turn had to pass their knowledge on to their colleagues. This model apparently resulted in a watering down and/or misinterpretation of information. During the process teachers also complained about the lack of competency of the trainers. The same model was used again with the introduction of the NCS curriculum. This model is criticised by Janse van Rensburg and Mhoney (2000) who stated, *“Short, once-off teacher development sessions are a waste of time in addressing the kinds of conceptual learning that our context seems to require.”* (p. 57). They state that a process-oriented model for professional development is what is required.

There seems to be a tension between the quality of training the Department of Education provides to teachers and what they propose in the Integrated Quality Management System (IQMS) document (RSA, 2003). According to the IQMS document, the main objective of the Department of Education and teachers is *“to ensure quality public education for all and to constantly improve the quality of learning and teaching and for this we are all accountable*

to the wider community" (p. 3). It further states that it is the responsibility of the Department to provide facilities and resources to support learning and teaching. In addition, successful educational outcomes are dependent on the empowering, motivation and training of educators and that quality management is to monitor and support that process.

Three programmes are in place to enhance and monitor the education system performance. These are developmental appraisal, performance measurement and whole school evaluation. According to the IQMS document (*ibid*), the development appraisal aims to determine individual educator's competence i.e. areas of strength and weaknesses in order to draw up programmes to provide support and create opportunities for individual development to assure continued growth. This monitoring process involves observation of the educator by their immediate supervisor and peer in practice using a performance measurement tool. Teachers are then required to draw up a personal growth plan (PGP) after they have been appraised so that their weaknesses can be addressed. These plans then have to be submitted to the district office in order that the Department should provide INSET. In all the years I have been appraised, there doesn't seem to be a system in place that supports the teachers to address their weaknesses based on their PGPs. It becomes the responsibility of the teacher to develop themselves professionally through their studies, and unfortunately not every teacher gets an opportunity to study. Why then go through the IQMS process if teacher training run by the Department is not tailored to teacher needs?

Du Toit and Sguazzin (2000a) explain that previous studies show that the 'cascade model' of transferring curriculum reform in preparing teachers to implement a new curriculum is inadequate to meet the demands of a changing curriculum. They further note that teachers were then expected to be able to implement curriculum reform after attending the once-off workshops (Du Toit & Sguazzin, 2000b).

This is disconcerting considering that Darling-Hammond & Ball (1999, cited in Fullan, 2007) concluded that teachers who have received intensive and extensive training are more effective than those with less.

Bertram (2011) notes that there has been little improvement in the quality of education in South African schools, although a lot of money and effort has been invested in teacher development. Hargreaves (1995) acknowledges that the development and training of teachers is essential to educational reform but observes that literature on professional development criticises the once-off in-service workshops that characterise many teacher training initiatives on the grounds that they expose teachers to the new curriculum changes without further meaningful support and training, hence they have minimal impact on improving teachers' current practices.

According to Moon (2001) there is no point in attending a course, training or workshop if it will not have an impact on one's practice, as the aim of a course, training or workshop is supposed to improve or change previous practice. After teachers have attended in-service training, the skills and/or knowledge gained should be applicable in their practice (teaching). This means that in-service training courses for teachers should have a more direct and positive effect on their teaching, enabling them to do something new i.e. put learning into action when they return to school. This expectation puts pressure on the development of resources and their effective use and the facilitation of learning as learning should have an impact on practice. This has implications for the design of professional development programmes. Janse van Rensburg & Mhoney (2000) noted the need for on-going support and development when teachers are back on site after receiving training at workshops. One of the teachers in the pilot was keen to have on-site support from facilitators of the Fundisa for Change programme (see section 4.9.5).

Teacher development should develop teachers' competence to 'organise systematic learning', which is more than the transmission of bits of information (Morrow, 2000 cited in Bertram, 2011). Bertram (*ibid*) notes that teachers might attend professional development workshops but that does not necessarily translate into learning new knowledge and changing teaching practice. She believes this happens because the workshops do not purposefully develop teachers to organise systematic learning through discipline-specific pedagogical content knowledge.

Another reason for the failure to improve the quality of education is the nature of the workshops that are offered to teachers. When teachers are to implement a new curriculum, it has been discovered that they are relegated to 'once-off', 'one size fits all' workshops that focus on how teachers should follow the official requirements in implementing the new policy (Bantwini, 2009). Moreover, Ball and Cohen (1999) add that these types of workshops fail to engage teachers in conceptual issues like the pedagogy and knowledge that underpins the curriculum reform and new assessment requirements.

Smyth (1995b) on the other hand claims that the bureaucracy attached to teachers' work, limits what teachers can do in their classrooms. He points out the imposition on teachers of prescribed curriculum frameworks and assessment tasks, adherence to policy guidelines, time that needs to be spent on content that needs to be taught and recommended assessment tasks to be covered. He (*ibid*) asserts that these issues need to be considered as well, as they become constraints on what teachers can do and that there can be no talk of professional development without these issues being addressed and challenged. Smyth (*ibid*) further notes the bureaucracy is of little value if teachers are not taken into account, as teachers not only implement a curriculum but also interpret it. Hence working with teachers and understanding teaching should be a key agenda in education research.

Correspondingly, Chadderton & Torrance (2011) note that policies impinge on teachers' practices as they cannot just decide what to teach and how to teach it but rather teach within a context determined by curriculum and assessment requirements.

A new orientation to a curriculum means there should be a new approach to professional development. A new curriculum policy brings with it new demands and expectations on teachers, therefore they need professional support that will enable them to make sense of the new curriculum requirements.

Du Toit and Sguazzin (2000b) suggest that professional development should involve the following:

- Focus on building skills, competences and attitudes, not just on information
- Take the principles of the new policy for education and training into account

- Be guided by policy and by teachers' self-determined professional development goals
- Provide opportunities and space for teachers to grow according to their needs and at their own pace
- Build on prior learning experience
- Take into account the contextual realities within which teachers and learners live and work
- Enable teachers to build up increasingly sophisticated understandings of their work and context

In light of what has been indicated above, in South Africa the new policy on teacher education and training, as stipulated in the Policy on Minimum Requirements for Teacher Education Qualifications, (South Africa. Department of Higher Education and Training [DHET], 2011), teaching is seen to be comprised of the acquisition, integration and application of different types of knowledge practices, which then makes it a complex activity. It explicitly foregrounds knowledge, reflection, connection, synthesis and research, paying close attention to what is to be learned, and how. According to the policy, the various types of knowledge which underpin teachers' practice are: Disciplinary Learning, Pedagogical Learning, Practical Learning, Fundamental Learning, and Situational Learning.

Disciplinary Learning refers to disciplinary or subject matter knowledge (in the context of this study, this would be environment and sustainability content in the Life Sciences), which involves the study of education and its foundations, history of education; and the study of specific specialised subject matter that underpins teaching subjects or specialisations. *Pedagogical Learning* includes general pedagogical knowledge, which involves knowledge of learners, learning, curriculum, teaching methods and assessment practices and specialised pedagogical content knowledge, which includes knowing how to represent the concepts, methods and rules of a discipline in order to create appropriate learning opportunities for diverse learners, and how to evaluate their progress. It also includes Inclusive Education. *Practical Learning* involves learning in-and-from practice. Learning from practice includes the study of practice, being a reflexive practitioner to form a basis for learning in practice and learning from other's practices, Work Integrated Learning. Practical learning is an

important condition for the development of tacit knowledge, an essential component of learning to teach. *Fundamental Learning* in the South African context refers to learning to converse competently in a second official language, the ability to competently use Information and Communications Technologies, and the acquisition of academic literacies which lay the foundations for effective learning in higher education contexts. *Situational Learning* refers to knowledge of the varied learning situations, contexts and environments of education (classrooms, schools, communities, districts, regions, countries and the globe) as well as prevailing policy, political and organisational contexts. It involves learning both *in* context and *about* context. This involves understanding the complex and differentiated nature of South African society and learning to work in nuanced ways with the diverse challenges faced by children in schools and the communities that they serve, for example, promoting inclusivity, and environmental sustainability (*ibid*).

This therefore suggests that any teacher training or professional development should take cognisance of these knowledge types which should underpin teachers' practice.

2.9 Curriculum policy implementation

The interpretation of curriculum policy and development in South Africa has followed two approaches, a focus on curriculum as policy which involves conflicts between curriculum theory and practice and a focus on curriculum as knowledge, looking at how knowledge is constructed and the role played by the school in teaching and learning, (Chisholm, 2005).

According to Bennie and Newstead (1999), a new curriculum brings with it underlying assumptions, aims, content, teaching and assessment methods which tend to challenge the teachers who are expected to implement it. They also note that the discrepancy between the teachers' ideologies and the principles underlying a new curriculum, together with lack of clarity as regards curriculum changes, teachers' lack of skills and knowledge and the lack of appropriate teaching and learning support materials are obstacles to the implementation of a new curriculum.

Eisner (1985, cited in Jansen & Hoadley, 2009), argues that a school curriculum should provide teaching strategies that will lead to learners developing the ability to infer, speculate, locate, solve problems, remember and visualise. He believes that these abilities are important in enabling learners to cope with problems and issues they will encounter in the future.

Orr (1992) argues that education is a vehicle for producing people who will be ecologically literate so they can address environmental issues. Ecological literacy he defines as knowing how the world works and how people relate to each other and to the natural environment. Orr (*ibid*) argues that much education on offer today contributes to the environmental crisis rather than addressing it.

Jansen (1998) contends that the development of a curriculum is not only about reorganizing the subject content but also involves the revision of textbooks, in-service training, and a process of eliciting support from all the stakeholders to embrace proposed changes to the curriculum. This differs from Orr (1992), who suggests that curriculum reform should question the fundamental nature and purpose of education and its role in society.

CAPS is very specific on the content that teachers should teach as well as on the methods teachers should employ in the transmission of that content. The Department of Education also evaluates, approves and catalogues textbooks that teachers need to use to teach subject content. This does not in any way hinder teachers from choosing other teaching and learning support materials in their mission to extend and develop the subject curriculum.

Summers, Kruger and Childs,(2001) hold the view that teachers need wider and deeper knowledge than that required by learners, arguing that this is important for diagnosing learners' learning difficulties, responding to learner needs, dealing with unforeseen questions, devising appropriate learning experiences in science and understanding what counts as knowledge progression. The Fundisa for Change programme (2011, see section 4.4.3.1, p. 79), suggests that such deeper knowledge is also needed so that teachers can evaluate the validity and purpose of knowledge included in the curriculum, and also identify knowledge exclusions in wider societal contexts.

Teachers, as essential resources of the education system, need teacher education programmes that will develop their competences but also provide them with a deeper understanding of some field of knowledge, which in this study is environment and sustainability content knowledge, that is deeper than the current school curriculum (CAPS) because any school curriculum changes over time (HSRC, 2005).

2.10 From Biology to Life Sciences

In South Africa, three different curricula have been used for Life Sciences in the Further Education and Training (FET) phase. Prior to 1994, National Assembly Training & Education Department (NATED) 550 was the curriculum used, a curriculum that was conceptually demanding compared to NCS. During the period 1995–2006 the Interim Curriculum (IC), a curriculum that followed a highly academic approach was used; and in 2006 the National Curriculum Statement (NCS) for Grades 10–12 was implemented and the name changed from Biology to Life Sciences. The NCS focused on the development of skills, construction of knowledge and the relationship between science, society and the environment. Dissatisfaction with the under-specification of the content to be taught in NCS led to its rewriting just three years later in 2009 for implementation in 2010, as the New Content Framework (NCF), which provided far more detail of the content to be covered (Johnson, Dempster, & Hugo, 2011). Each curriculum change meant changes in the content to be taught, methods of teaching and assessment practices.

In 2012 the Curriculum and Assessment Policy Statement (CAPS), a content and assessment referenced curriculum, was implemented in grade 10 for the first time. This created a significant content knowledge gap between the knowledge teachers received during their own schooling and teacher training and the content knowledge they have to teach in their classrooms.

Past efforts by the Education Ministry to orientate teachers into a new curriculum have proved to be far from adequate as workshops rarely cover the content that has to be taught.

According to Mayr (2005, cited in Johnson, Dempster, & Hugo, 2011), how a subject is recontextualised is influenced by the goals of the subject as these inform the selection and prioritising of content material. The goals for a school science education curriculum like Life Sciences are determined by historical, political, economic and sociological contexts, the agents responsible for drawing up the curriculum, and any stakeholders or interest groups – none of which is static.

Schmidt, Wang and McKnight (2005, cited in Johnson, Dempster, & Hugo, 2011) propose that for learners to understand a discipline, they need to be taught a curriculum that is coherent. A coherent curriculum according to them is experienced when the subject content knowledge shows progression, both within and across grades, from simple to complex. New topics are not introduced before the prerequisite foundational knowledge has been covered, nor is content simply repeated from grade to grade.

Le Grange (2008) outlines the history of biology education in South Africa, using Rosenthal and Bybee (1987) in contrasting a view of the biology curriculum in terms of a “science of life” and a “science of living”. He notes that all curricula in South Africa prior to 1994, and the interim curriculum, followed a “science of life” approach.

In South Africa ecology was first introduced in schools in the 1970s as part of the grade twelve biology syllabus as a response to the realization that humans are exploiting the finite resources we have on Earth (Le Grange, 2002). In light of Le Grange’s argument above, its inclusion in the curriculum would have followed the “science of life” approach.

Le Grange (2008) also mentions that prior to the implementation of the NCS three papers (Doidge, 1996; Watson, 1990; Schreuder, 1991) were published proposing that social and environmental problems facing the country should be addressed, in part through the biology curriculum.

Le Grange (2008) considered the NCS to resemble a “science of living” approach. He also argued for the integration of both approaches so that the subject can have social aspects that are more relevant to learners but at the same time not lose the foundational knowledge of Biology. The inclusion of socially relevant content in the Life Sciences curriculum was no guarantee that teachers would consider them in their teaching. Hence Fullan (1991, cited in Le Grange, 2008) argues that educational change depends on what teachers do and think and not simply on what is declared in policy. Therefore much still depended on how teachers were going to respond to the curriculum policy.

Le Grange (*ibid*) also states that much also depended on what would be included in or excluded from the textbooks, since these are still the primary source of content used by teachers. Past experience showed that the kind of teacher in-service training provided by provincial education departments had proved to be inadequate for successful implementation in classrooms. Le Grange (*ibid*) proposes a sustained programme of teacher professional development in which teachers are participants with policy-makers/departmental officials in determining what knowledge is most worth including in learning/teaching programmes.

It is apparent that the challenge therefore in any curriculum reform is how best to provide teachers with the required support and education so that they can effectively facilitate learning. The same challenge is true for the implementation of CAPS curriculum.

This challenge is exacerbated by the fact that CAPS places emphasis on content while the NCS was more concerned with the attainment of assessment standards, as shown by this extract from Life Sciences NCS curriculum:

“Content and contexts are provided to support the attainment of the Assessment Standards. The content indicated needs to be dealt with in such a way as to assist learners to progress towards the achievement of the Learning Outcomes. Content must serve the Learning Outcomes and not be an end in itself. The Assessment Standards and not the knowledge areas determine the depth or level. The criteria used to select core knowledge and concepts were derived from the Learning Outcomes and Assessment Standards, as well as the principles underpinning the NCS” (South Africa. DoE, 2003, p. 32-33).

2.11 Life Sciences CAPS curriculum

'Life Sciences' is the scientific study of living things and their interactions with one another and their environments. 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:

- *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;*** (my emphasis)
- *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.* (South Africa. DoBE, 2011, p. 8-9).

These expectations clearly indicate a heavy environmental discourse within the Life Sciences (as shown by the emphasis above), particularly when one considers the knowledge areas in Life Sciences highlighted below.

The Life Sciences content framework is organised according to four knowledge areas called strands (South Africa. DoBE, 2011, p. 9-10). Knowledge strands are expected to be developed progressively over the three years of 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;**
- **Knowledge Strand 4: Diversity, Change and Continuity.** (My emphasis)

The Knowledge Strands do not need to be taught in the same sequence each year, nor do all four Knowledge Strands have to be covered in each year. This categorisation is simply a tool for organising the subject content and they are also not weighted equally.

When teaching Life Sciences, it is very important to help learners to recognise the links between related topics so that they acquire a thorough understanding of the nature and interconnectedness of life. These links must also be made across grades. Educators have the freedom to expand concepts and to design and organise learning experiences according to their local circumstances, including the availability of resources.

The purpose of studying Life Sciences is to develop scientific knowledge and understanding, science process skills and understanding of Science's roles in society (South Africa. DoBE, 2011).

There are **three** broad subject-specific aims in Life Sciences which relate to the purposes of learning science. These are:

1. Specific Aim 1, which relates to knowing the subject content ('theory');
2. Specific Aim 2, which relates to doing science or practical work and investigations; and
3. Specific Aim 3, which 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.

“Teachers of Life Sciences should be aware that they are also engaged in teaching language across the curriculum. This is particularly important for learners for whom the Language of Learning and Teaching (LoLT) is not their home language. It is important to provide learners with opportunities to develop and improve their language skills in the context of learning Life Sciences. It will therefore be critical to afford learners opportunities to read scientific texts and to write reports, paragraphs and short essays as part of the assessment, especially in

(but not limited to) the informal assessments for learning.” (South Africa. Department of Basic Education [DoBE], 2011, p. 19).

The resources needed for teaching Life Sciences are listed next to each topic in the CAPS document in order to assist teachers with planning and preparation. Teachers must be qualified to teach the subject and must familiarise themselves with the equipment and how it is used.

The cognitive demands in assessment should be appropriate for the age and developmental level of the learners in the grade (South Africa. DoBE, 2011). Assessment must cater for a range of cognitive levels and abilities of learners. Tasks should be carefully designed to cover the content of the subject as well as the range of skills and the cognitive levels that have been identified in the specific aims. The specific aims, topics, content and range of skills in the subject should be used to inform the planning and development of assessments.

Table 2.1 Weighting of Cognitive Demands for the Assessment of content in Grades 10, 11 and 12. (South Africa. DoBE, 2011, p. 67)

Knowing Science	Understanding Science	Applying scientific knowledge	Evaluating, analysing and Synthesising scientific knowledge
40%	25%	20%	15%

The purpose of providing the weighting is to ensure that all topics are covered according to approximately the correct weighting (*ibid*).

In light of the CAPS curriculum expectations, the above need to be taken into consideration when teachers work with environment and sustainability content knowledge, and professional development designed for teachers should enable teachers to work with this content in achieving the aims of the curriculum.

2.12 Conclusion

This chapter provided an overview of the emergence of the environmental discourse in the South African curriculum, as well as dynamics of teacher professional development, particularly in South Africa. The recontextualisation framework by Bernstein has been outlined as a suitable tool for providing insight into the recontextualisation process.

In the next chapter I explain the research methodology and methods used in this study. The teaching of CAPS and teacher development has also been dealt with in the chapter.

CHAPTER 3: RESEARCH METHODOLOGY

The essence of qualitative enquiry is paying attention, being open to what the world has to show us, and thinking about what it means (Patton, 2002, p. 205).

3.1 Introduction

This chapter provides an outline of the research design decisions made to guide an investigation of how grade 10 Life Sciences teachers can be supported to understand and work with environment and sustainability content knowledge in the teaching of Life Sciences in CAPS. It also gives an explanation of the process used to generate the data and the effectiveness of the tools used to gather the data to answer the research question and the goals of the study. The chapter also looks at how the data were analysed, discusses ethical issues and trustworthiness of the findings.

3.2 Research methodology

3.2.1 Qualitative study

This study is designed as a naturalistic qualitative case study inquiry, underlaboured by critical realist philosophy. A qualitative study is naturalistic when it occurs in a real world setting with the researcher not manipulating the phenomenon under study. The researcher in this kind of study is open to what emerges as the phenomenon unfolds naturally (Patton 2002). Guba (1981, cited in Patton, 2002) defines a naturalistic inquiry as a discovery approach to research as the researcher enters a study setting with no preconceived notions of what the results of the research will be. Qualitative inquiry requires that the researcher be in close proximity with the people and the phenomenon being studied in order to capture what is occurring as the phenomenon unfolds.

Naturalistic qualitative enquiries enable researchers to provide descriptive insights as they are in close proximity with the participants and the phenomenon under study during fieldwork (*ibid*). In a naturalistic inquiry people are interviewed with open-ended questions under conditions that are comfortable for and familiar to them. This approach was

appropriate for this study as the phenomenon under study was a teacher training programme where as a researcher I observed how teachers were being supported without controlling or manipulating the nature of the support. I went into the field to observe how the process was unfolding.

In a qualitative study, the researcher must get close enough to the participants and the context to personally understand in depth the details of what is happening and capture what actually takes place and what participants say (Lofland, 1971 cited in Patton, 2002).

Qualitative methods facilitate the study of issues in depth and detail and as such produce a wealth of detailed information about a much smaller number of people and cases (Patton, 2002), rather than expansive populations.

3.2.2 Case study approach

Case study as an approach enables a researcher to describe an event before explaining it. This means that it places emphasis on first describing what is happening in an event before explaining the mechanisms that have led to its occurrence. It also rests on the assumption that there are underlying mechanisms to what is observed and this consequently demands an in-depth enquiry of the empirical (Chadderton & Torrance, 2011). Flyvberg (2011) further argues that it is an intensive approach that is characterised by detail and richness. A criticism of case study is that a single case study cannot be used to make generalisations for the population under study, an issue that to some extent is dealt with by critical realism.

This study is based on a single case study, a Fundisa for Change pilot programme that was implemented in May 2012 with fifteen Life Sciences teachers in Mooi River, KwaZulu Natal. This case study in part seeks to understand events that have occurred and the mechanisms that have contributed to those events occurring, and also to contribute insights into how giving attention to mechanisms can lead to possible occurring of desired events (see section 5.3).

Although 15 teachers had attended the initial workshop (see section 1.5), most of the data generated and analysed are from six teachers who attended all three workshops that were run in the pilot. Nine of the teachers who had attended the first session did not return for the next two sessions.

3.2.3 Research orientation

Critical realism is the philosophical orientation used to underlabour this case study research. Critical realism posits that reality exists independent of human consciousness. It suggests that causal mechanisms influence events and empirical experiences in an open system framework. It also has an emancipatory aspect that enables the identification of options for absencing causal factors constraining action (Bhaskar, 1993; Danermark, Ekstrom, Jacobsen & Karlsson, 2002).

This study aims to reveal the structures and mechanisms that might enable teachers to work effectively with environment and sustainability content knowledge in their teaching of Life Sciences.

Collier (1994) suggests that in open systems "...a multiplicity of mechanisms is operating, conjointly bringing about a series of events, which would not have been brought about by any proper subset of those mechanisms" (p. 43-44). He argues that there may be a variety of outcomes in an open system due to the multiplicity of the mechanisms and interacting processes involved.

In light of the argument above, in an open system like the Education and Training system, there are multiple generative mechanisms constantly operating leading to different outcomes. Moreover, Cohen, Manion and Morrison (2007) claim that "the social and educational world is a messy place, full of contradictions, richness, complexity, connectedness, conjunctions and disjunctions. It is multi-layered..." (p. 167).

Collier (*ibid*) states that objects have powers that are not exercised and if exercised may not be realised and if realised, may either be observed or not observed. He adds that generative mechanisms only operate when they have been triggered. He further argues that in open systems, triggered mechanisms operate in conjunction with other mechanisms resulting in complex outcomes.

Similarly, Sayer (1992), states that the outcomes of generative mechanisms in open systems depend on contingent conditions and as such cannot be predicted. This study aims to explore what mechanisms can be activated in order that teachers' powers of understanding and working effectively with environment and sustainability knowledge can be exercised, realised

and ultimately observed in teacher- learning interactions and learner achievement.

Reality, according to Danermark et al. (2002), consists of observable events produced by mechanisms that are often not directly visible. To acquire knowledge thus requires that focus should be on the underlying mechanisms that produce the observable events.

Critical Realism was therefore used in this study, which distinguishes three domains of reality: the real, actual and empirical (represented in Table 3.1).

Table 3.1 Stratified ontology

	Domain of real	Domain of actual	Domain of empirical
Mechanisms	√		
Events	√	√	
Experiences	√	√	√

Bhaskar (1998, p. 41)

According to Danermark et al. (2002), the empirical is made of people’s direct or indirect experiences, the actual is comprised of the events that are either experienced or not, and the real is where the mechanisms are found that produce events in the world. Mechanisms exist irrespective of whether they produce an event or not, when they do produce an event, the event comes under the domain of actual, whether it is observed or not. When such an event is experienced, it becomes an empirical fact and comes under the domain of empirical.

My initial focus during this study was on the teachers’ existing knowledge in relation to the environment and sustainability content knowledge in CAPS. Critical realism tools enabled an illumination of the events that have led to teachers’ existing knowledge. I then investigated the mechanisms and structures that have led to the events. Critical realism allows for generalised interpretations at the level of mechanisms useful in this study as it aims to inform a larger network of practice.

The nature of the study is an applied research and as such seeks to illuminate an important social concern in the education system in an effort to identify potential solutions, based on an understanding that social problems emerge within particular time periods (Patton, 2002).

3.3 Sample and site

The population of study was six Life Sciences teachers in Mooi River in KwaZulu Natal, South Africa who were expected to implement the CAPS curriculum for the first time in 2012 (see Section 3.2.2). The six teachers comprised of three male teachers and three female teachers from different schools (see section 4.5, table 4.2). Two of the male teachers came from the same school and the other male teacher changed schools during the course of the pilot. The venue for the workshop was one of the private schools in KZN. The dates of the sessions were during state school's term times; this consequentially meant that for the teachers to attend the sessions, they had to take time out of their classrooms.

An attendance register at the venue was signed for all the sessions so that at the end of each contact session they would be given an attendance certificate to show to the school management and/or department officials as proof that they were indeed attending the sessions. The pilot consisted of three contact sessions with the teachers. The first contact sessions ran over two days in May, the second also took two days in July and the last one was a day session in October.

The focus of the pilot programme was an introduction of teachers to the topic of biodiversity, an environment and sustainability theme, which is also one of the topics that teachers have to teach in the third term in the grade 10 Life Sciences CAPS curriculum.

3.4 Data generation methods

According to Patton (2002), a qualitative inquiry is best answered through in-depth, open-ended interviews, direct field observation and document analysis. He argues that these methods capture and provide insight into what happened and report the experiences of the participants. Interviews provide information about people's experiences and knowledge, observations enable the researcher to give detailed descriptions of people's activities, and

the documents that could be analysed are official publications, responses to questionnaires, programme records etc. The choice of data generation tools to use was informed by the study's research goals and included:

- Document analysis
- Questionnaires
- Observations
- Interviews (individual and focus group)

3.4.1 Document analysis

According to Bailey (1994, as cited in Cohen, Manion & Morrison, 2007), document analysis allows the researcher to get insights from inaccessible persons or subjects and historical stories. It is also useful in longitudinal analysis as it may highlight how situations have changed over time.

Documents are primary sources that are useful in qualitative research because of the nature of the data they contain (Yin, 2011). According to Cohen and Manion (2004), primary sources are original objects that are related directly to the events being investigated. Document analysis involves examining and interpreting data to gain insight, and as such it needs to be systematic (Corbin & Strauss 1990, cited in Bowen, 2009).

Many documents in the public domain may have been written by skilled professionals and may contain valuable information and insights about phenomena (Bailey, 1994, cited in Cohen et al., 2007). However, Bailey (*ibid*), argues that documents have a tendency to be highly biased and selective, as they were not intended to be regarded as research data but were written for a different purpose, audience and context. They, themselves, may be interpretations of events rather than objective accounts. This makes it important to use more than one tool for gathering data about the same subject.

For this study the following documents were analysed:

- Grade 10-12 Life Sciences Curriculum and Assessment Policy Statement (LSD)
- Fundisa for Change core text (FfCCT)

- Fundisa for Change content unit (FfCCU)
- Fundisa for Change teaching unit (FfCTU)
- Fundisa for Change assessment unit (FfCAU)
- Teachers' assignment tasks (TAT1-4)

A Life Sciences teacher myself, the Life Sciences CAPS document was accessible to me. In this study, the analysis of the curriculum document was important given that I was interested in how the environmental discourse was recontextualised in the official pedagogic text, particularly focusing on the scope and nature of the environment and sustainability content knowledge that teachers were expected to teach, how they were expected to teach it and how they should assess it.

The Fundisa for Change materials were analysed to get insight into how the pilot programme was conceptualised and how the official pedagogic text had been recontextualised in the training manuals resource materials. I was given a file that had the core text and the first set of units on the first day of the May contact session when they were also being issued to the teachers who attended the session. A third unit was issued at the second contact session (July).

3.4.2 Questionnaires

Patton (2002) views written responses to questionnaires as a form of document that requires examination. He argues that the data in questionnaires record and provide context. Questionnaires can have both open-ended and closed-ended questions with predetermined response categories.

According to Cohen et al., (2007), having categories in a questionnaire indicates sequence and coherence and assists respondents in navigating through the questionnaire. Open-ended questions provide respondents with an opportunity to communicate vital information and to give personal comments that could be lost with closed questions.

I used open-ended questions in my questionnaires. An open-ended question invites an honest, personal comment from respondents. It is the open-ended responses that might

contain the vital information that otherwise might have been lost in the questionnaire. Furthermore, it gives the respondents a form of ownership of the data.

Two questionnaires were completed by the teachers, both having open and closed standardised questions. The questions were framed according to themes that would enable easier analysis, and for coherence in the write up of the responses.

The first questionnaire (appendix A) was aimed at determining the teachers' context, their teaching experiences, their qualifications, their teaching practices and their existing content knowledge regards environment and sustainability concepts. The questionnaire was given at the start of the first contact session, after teachers had been given an orientation to the training programme. All 15 questionnaires were collected and analysed. The second questionnaire (appendix B) was completed at the end of the last contact session to consolidate teachers' experiences and learning during the period of the pilot, and six were received and analysed. Teachers also completed two evaluation questionnaires at the end of the first and the second contact sessions so they would share their experiences of the sessions (appendix C & D). Fourteen questionnaires were collected and analysed at the end of the first contact session and six were collected and analysed in the second session (see section 3.2.2).

3.4.3 Observations

Croll (1986) states that an observation is an attempt to describe a process that is on-going at a particular point in time. Observations entail being present in a situation and recording impressions of what takes place then interpreting the meaning of the observed behaviour (Somekh, 2011).

When researchers observe during fieldwork, they are in contact with the setting and the people they are observing. Direct observation enables researchers to have first-hand direct experience and thus enable them to generate detailed descriptions of the setting, the activities, interactions and participants' experiences. This kind of observation also allows the researcher to compare what is written in official programmes to what actually takes place. First-hand experience on-site is important as it allows the researcher to get insights that could be missed if reliance was on other's descriptions of the setting (Patton, 2002).

Observations take place in real-world settings, where programmes are subject to change and redirection. Good inquiry documents what is actually happening and the impacts of a process, programme or intervention over a period of time (see section 3.2.1 above). The researcher sets out to understand, accept and document complexities of a changing situation, including what emerges as important to understanding what participants are experiencing (*ibid*).

Yin (2011) views observation as “a form of *primary data*”, because the researchers use their senses to generate data instead of relying on what has been reported or written by someone else (p. 143, [emphasis in original]). Similarly, Cohen, Manion and Morrison, (2007, p. 396), note that observation “offers a researcher the opportunity to gather ‘live’ data from naturally occurring social situations”, i.e. looking directly at what is happening instead of relying on second-hand accounts. They point out that observation has the potential to produce more valid or authentic data than reading a written account by someone else. Likewise, the strength of observations is that it gives direct access to social interaction. Observation data enriches and supplements data gathered by other techniques and thus enables triangulation (Simpson & Tuson, 2003).

This is reinforced by Wirth (1949, cited in Patton, 2002), who notes that insight is gained through participating in the phenomenon that is being investigated.

I started my observation on the first day of the first contact session. I wanted to be there when teachers were orientated to the workshop. I observed all the sessions and when I could not be there at the start of a session I made plans to have one of the facilitator’s audio record what was happening and another to make some notes. Field notes (see appendix E for an example of the field notes) and an audio tape recorder were used to capture the teaching and learning processes. Initially I was a passive observer, just taking in what was happening and not participating in the activities, then later I became a participant observer although I did not actively take part in all of the activities that teachers did, and just listened in on the group discussions. Participating in the activities enabled me to be part of the group and to build trust and rapport with the teachers. It was easy for me to participate in the activities as I was also a Life Sciences teacher implementing the same curriculum the teachers were being supported to implement.

Observational data is often combined with information from conversations, interviews and documents to provide an in-depth picture of the perspectives (Foster, 1996).

I had drawn up an observation schedule (appendix F) although I did not use it during observation and instead wrote field notes. The schedule was used when I was organising the transcribed observation data and the field notes.

3.4.4 Focus group interview

I had not planned to have a focus group interview. It was initiated by one of the participants who had felt uncomfortable with an individual interview. Secondly, time constraints did not allow me to have individual interviews with all the participants. A focus group is composed of people who share common experiences and views (Yin, 2011). This worked well in this particular study because the three teachers who made up the focus group interview had attended the same workshop about which I wanted clarity in (appendix G).

Patton (2002) further says the group needs to have similar backgrounds and participate in a group interview to discuss a common concern. Group interviews can be used to assist participants to recall an experience that they had shared together (Fontana & Frey, 2011).

According to Patton (2002), a focus group interview encourages respondents to give additional information as they listen to others' responses. This means that respondents share their perceptions in relation to those of others.

The aim of the interview was to get more insight about things that came out from the responses given in the first questionnaire. The questions were open-ended and semi-structured and I had an audio recorder during the interview. It was a short interview during tea time as there was never a convenient time to have interviews. I did not take any notes during the interview as I did not want to disrupt the flow of the discussions. The interview was transcribed for analysis.

3.4.5 Individual interview

I decided on the interview guide approach outlined by Patton (1980, cited in Cohen et al., 2007). In this type of interview, topics and issues to be covered are specified in advance, in outline form; the interviewer decides the sequence he/she will follow in asking the questions during the interview. The advantage of outlining the form of the interview is that it increases the comprehensiveness of the data and makes data collection systematic for each respondent. Gaps in data can be anticipated and closed. Interviews remain fairly conversational and situational. This type of interview though, may result in important topics being omitted.

According to Cohen et al., (2007), an interview is a flexible tool for generating data. Kvale (1996, cited in Cohen et al., 2007) sees an interview as a tool that recognises people as resources of knowledge generation through exchange of ideas on topics of mutual interest in conversation.

Qualitative interviews are characterised by open-ended questions where the researcher is not bound by a routinized way of interviewing i.e. scripted plan. They have the framework of the questions to ask but respond to the context and setting of the interview (Yin, 2011, p. 134).

Open-ended questions in interviews enable the researcher to get insight into what participants perceive about a phenomenon being investigated (Patton, 2002). Barbour and Schostak (2011) propose that semi-structured interviews with open-ended questions can lead to unexpected issues and information to be discussed. Correspondingly, Cohen et al. (2007), state that open-ended questions can result in unanticipated answers.

I used open-ended questions in my interviews so that I would be able to rephrase, explain and add to my questions during the course of the interview. Open-ended questions are flexible; they enable the interviewer to dig deep so that she may get more insight if she chooses, or to clear up any misunderstandings. They also enable the interviewer to ascertain the extent of the respondent's knowledge; they encourage cooperation and help establish rapport; and they allow the interviewer to gain a clearer understanding of what the respondent believes (Cohen et al., 2007).

I interviewed one of the participants (appendix H) and used more or less the same questions I had asked during the focus group interview to also get more clarity on the responses the respondent had given in the questionnaire. I also used a face-to-face individual interview to interview one of the Fundisa for Change biodiversity module developers (appendix I) to determine the factors that have influenced the recontextualisation of the official pedagogic text into a mediating tool during the pilot. I audio recorded both interviews and had also taken fieldnotes when I interviewed the exemplar developer. Both interviews were transcribed for analysis.

3.5 Data generation and management

Data generation consisted of three phases:

- Phase one: content analysis of the Life Sciences CAPS curriculum document together with Fundisa for Change training materials (FcCT and FfCU's) in order to see how the environment and sustainability content knowledge, skills and values in Life Sciences (see section 4.3.1) have been delocated from the CAPS and relocated in the Fundisa for Change training materials (appendix J), that is, transformation and selective appropriation of the environmental discourse influenced by the expertise and interests of the developers of the training materials (Bernstein, 1996).
- Phase two: contextual profiling of teachers using a questionnaire (appendix A), to determine their starting points in terms of environment and sustainability content knowledge and their classroom practices. This phase also involved observing the Green Teaching teacher-support process and getting feedback from teachers about their experiences of that support process through interviews and evaluation questionnaires (appendix C & D).
- Phase three: analysis of teachers' assignment tasks, which was the contextualisation of their learning during the pilot. Teachers' completion points, at the end of the pilot, were also determined using a questionnaire (appendix B). This was done to compare the teachers' starting points to their completion points, to trace teachers' opinions on the impact of the pilot on their professional development.

All the interviews and observations were transcribed, colour-coded and recorded in computer files. One of the observations had to be translated from isiZulu into English. In one of the group activities that teachers did, one of the groups was made up of isiZulu first language speakers and they mixed English and isiZulu in their discussions. According to Polkinghorne (2005), a primary access to people’s perceptions and experiences is language, and rich data are generated when participants use the language they master. Polkinghorne cautions that meaning may be distorted when gathered data are translated from one language to another. A Xhosa speaker myself and isiZulu not very different from it, I was able to do the translation on my own.

A filing system was created to store teachers’ written responses (questionnaires) and assignment tasks. Separate files were used for questionnaires, session evaluation questionnaires and assignment tasks.

Table 3.2 Inventory of all the data sources used in this study, and how they were coded for easy access and reference. Summary of codes used and their explanations

Index code	Explanation	Appendix
Q1 & 2	Questionnaire 1 and 2 (contextual profiling & completion points)	A & B
EQ 1 & 2	Session evaluation questionnaire	C & D
OS	Observation schedule	F
FG (T2, 4 & 6)	Focus group	G
IT (T1)	Teacher interview	H
ID	Interview with FfCU developer	I
T1-T6	Teacher 1 - 6	
LSD	CAPS Life Sciences policy document	
FfCCT	Fundisa for Change Core Text	
FfCCU	Fundisa for Change Content Unit	
FfCTU	Fundisa for Change Teaching Unit	
FfCAU	Fundisa for Change Assessment Unit	
F1-F5	Facilitator 1 - 5	

3.6 Data analysis

Qualitative data analysis involves organising, accounting for and explaining the data; in short, making sense of data in terms of participants' definitions of the situation, noting patterns, themes, categories and regularities. Further, it is heavy on interpretation (Cohen et al., 2007). According to O'Leary (2004), analysing is moving from raw data to meaningful understanding of the data.

Inductive, abductive and retroductive modes of inference were used to make sense of the data (appendix J).

In an inductive approach to research, the researcher develops categories and concepts from the generated data. Abduction involves a recontextualisation where the researcher redescribes the phenomenon under study to discover connections and relations that are not obvious. Retroduction is about finding out what has led to the events observed (Danermark et al., 2002).

An inductive mode of inference was used to establish the environmental discourse in the Life Sciences CAPS policy document. An abductive mode of inference was used to analyse the features of Bernstein's pedagogic model (see section 2.2) to describe modes of knowledge, pedagogy, discourse and assessment in CAPS. Abductive mode of inference was also used to analyse transcribed observations in terms of Bernstein's concepts of recognising and realization rules (appendix K). I also used colour coding to highlight themes that came through from a transcribed discussion between the facilitator and the participants (appendix L).

A retroductive mode of inference was used to make sense of the factors that either enabled or constrained teachers in working with environment and sustainability content knowledge. The first step was identifying that teachers were not confident to teach environment and sustainability content knowledge in their teaching of Life Sciences. The second step was distinguishing the different components that have led to this. The third step was providing explanations for the teachers' feelings of inadequacy. The fourth step involved the seeking of causal mechanisms related to how teachers were feeling. The final step involved

mechanisms and structures that produced this feeling of inadequacy in teachers. Answers to these questions were generated through questionnaires and interviews.

3.7 Ethics

According to Cohen et al., (2007), ethics concern right and wrong, good and bad, so one has to consider how the research proposals, contents, methods, reporting and outcomes conform to by ethical principles and practices.

On the first day of my observation at the sight, my role as a researcher was revealed to the participants and permission to record the process was granted. I also personally talked with individual participants to ask for their consent to use what they said or wrote during the course of the workshops. Diener (1978, cited in Cohen et al., 2007), states that informed consent is the procedure in which individuals choose whether to participate in an investigation after being informed of the facts that are likely to influence their decisions.

I gave the focus group participants an opportunity to listen to interview recordings and I asked their permission to use everything they said if I needed to.

At a broader level, the Fundisa for Change programme obtained permission to run the programme from the DoBE (district office) who were aware that evaluation research would be conducted as part of the pilot.

3.8 Validity/Trustworthiness

As noted by Cohen et al. (2007), validity is an important key to effective research. Winter (2000, cited in Cohen et al.,2007), argues that in qualitative data validity might be addressed through honesty, depth, richness, and scope of data achieved, the participants' approach, the extent of triangulation and the objectivity of the researcher.

I used triangulation to increase the validity of my data interpretations. I used field notes, transcribed observations and teachers' evaluation questionnaires to trace the recontextualisation process. Triangulation is the use of two or more methods of data collection in the study of some aspect of human behaviour, studying the richness and complexity of human behaviour from more than one standpoint (Cohen et al., 2007).

On the last day of the workshop, I shared the findings I had summarised from the previous sessions with all the participants and workshop facilitators (F1 & F3) in order to strengthen the validity of the claims made. I used the observation schedule (appendix F) template as a framework for summarizing what I shared with them (see Section 4.8 & 4.9). I also emailed a hard copy of the summary to one of the facilitators (F1) for a review and for her to act as a critical friend since she had been part of all the workshops. The sharing of findings with participants is what Kerfoot and Winberg (1997) call dialogic validity.

3.9 Limitations

I had initially wanted to observe teachers in their classrooms to see how they were recontextualising the professional development programme content and how they were applying the competencies they acquired in the course back into their classrooms. However, large amounts of data generated and collected through the professional development workshop process, time constraints and the scope of a half thesis study did not allow for that to happen. In discussion with my supervisor, we agreed that including such data, while interesting and important for a fuller picture, would exceed the scope of a half thesis, especially since I had generated detailed data in the field observations.

3.10 Conclusion

In this chapter I discussed the study design and data generation tools and why they were suitable in this study. I also gave a brief description of how data were managed, and the modes of inference used to analyse the data. Finally I talked about ethical and validity issues.

CHAPTER 4: RECONTEXTUALISATION

One of the grave dangers of educational reform is that teachers may be left with the responsibility for change, but without the means (Janse Van Rensburg & Mhoney, 2000, p. 65)

4.1 Introduction

This chapter presents the findings and describes how an Official Pedagogic Discourse is delocated and relocated from the Field of Production into the Field of Recontextualisation (Bernstein, 1996, see section 2.2). The chapter starts with identifying the environmental and pedagogical discourse in the ORF through analysis of the CAPS document for Life Sciences (see section 4.2). This is followed by an analysis of how the environmental pedagogic discourse in the OPD was transformed in the PRF through analysis of the teachers' experiences of the CAPS orientation training run by one of the teacher unions (see section 4.4.2). The chapter also describes how the environmental pedagogic discourse in the OPD was relocated in the Fundisa for Change training materials (see section 4.4.3). The chapter also provides a contextual profile of the teachers who attended the Fundisa for Change pilot. The chapter further describes the recontextualisation of the environmental discourse within the Fundisa for Change teacher training practices (see section 4.6). The chapter concludes with teachers' experiences of the Fundisa 4 Change pilot training, gathered through interviews and questionnaires (see section 4.7).

4.2 ORF: Life Sciences CAPS curriculum document

I started with analysing the CAPS curriculum document which is interpreted by teachers in their reproduction of the OPD at the school level. This analysis was important in establishing what the curriculum expectations were for teachers. Since the research interest was on how teachers can be supported to work with environment and sustainability content knowledge in the teaching of Life Sciences, examining the environmental and sustainability discourse in the Life Sciences curriculum document

assisted in establishing the content, nature and scope of environmental and sustainability discourse in the official curriculum document. This allowed for understanding the support teachers were provided in the Fundisa for Change programme and how recontextualising took place and if teachers' meaning making would assist in successfully implementing the CAPS curriculum.

The Department of Basic Education (DoBE) is responsible for distributing the curriculum documents to schools and teachers are expected to understand these documents, and to recontextualise them in their classrooms (see section 2.6).

4.2.1 Environmental and sustainability discourse

The CAPS curriculum supports an environmental and sustainability discourse through its infusion of the principles and practices of social and environmental justice and human rights as one of the principles that underpin the curriculum, as evidenced by the following quote:

“The National Curriculum Statement Grades R-12 is based on the following principles... Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades R-12 is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors...” (South Africa. DoBE, 2011, p. 5).

The curriculum also aims to produce learners that will be able to *“use science and technology effectively and critically showing responsibility towards the environment and the health of others”* (South Africa. DoBE, 2011, p. 5). This provides evidence of the environmental and sustainability discourse in the OPD. Further evidence is found in the knowledge, skills and values learners are expected to develop when they study and learn Life Sciences (see section 2.11).

The curriculum, in articulating the purpose of developing scientific knowledge and understanding in the Life Sciences, aims to promote sustainable use of environmental resources as defined in the Constitution (see section 2.3.2). It also aims to develop an understanding of Science's roles in society to help learners understand the contribution of science to social justice and societal development as well as the need for using scientific

knowledge responsibly in the interest of people, society and the environment (South Africa. DoBE, 2011, p. 12).

The expectation is that teachers will be knowledgeable and thus be able to provide high knowledge and skills for learners; expand concepts and use methods that will lead to critical and creative skills (see sections 2.11 & 4.3.3.2).

All these expectations are contained in the CAPS curriculum document to guide teachers in their recontextualising of the OPD. It was therefore quite disturbing to discover that in May, four months into the implementation of the CAPS curriculum some of the teachers who attended the Fundisa 4 Change pilot workshop had still not received the CAPS curriculum document. This was brought to light in a questionnaire response from one of the teachers, *“I did not use the CAPS document because we did not have them but now that you have given us we will use them”* (T7, Q1). This raises questions on how teachers are expected to successfully implement a new curriculum without an OPD in their possession, as a point of reference. Or does this mean the DoBE has confidence in how textbook writers have recontextualised the OPD in their materials and that teachers can solely depend on them in implementing the curriculum? ³

For an effective recontextualisation of CAPS, teachers need to know the curriculum requirements as stipulated in the curriculum document therefore it is imperative that they have access to the document. Although these documents are found on the internet, it does not seem as if this is communicated to teachers by the DoBE officials so that those who have access may get the documents. When teachers were asked by one of the facilitators about internet use during the pilot, of the fifteen teachers who were there, only six said they used it for research, three said they used it only for social networking and six did not use internet at all.

³ If that was the case, the DoE would ensure that teachers get textbooks on time, experiences such as the textbook debacle that made headlines in Limpopo in 2012, where teachers had to teach a new curriculum without textbooks for the first six months of the year, would not happen.

4.3 Using Bernstein to analyse CAPS

The analysis of the curriculum that follows indicates that the CAPS LSD grade 10-12 (OPD) favours the performance pedagogic model as described by Bernstein (see section 2.2). The following features were used in the analysis to reach that conclusion:

- Discourse
- Space
- Time
- Pedagogic text
- Autonomy

The analysis will be presented using the broad categories of knowledge, pedagogy, discourses and competences, and assessment.

4.3.1 Knowledge

Life Sciences is a specialized subject which focuses on biological studies. In the discussion on what Life Sciences is, it is stated how knowledge in the Life Sciences is produced and mention is made about the debates and arguments that occur during knowledge production as evidence by this extract:

*Knowledge production in science is an on-going 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. 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. Scientific investigations are mostly about things that are poorly understood or not understood at all. Scientists are frequently involved in debates and disagreements. As more people take on such investigations, they tend to reach consensus about the ways in which the world works. **The science theory that is taught in schools has been tested and is generally accepted.** A good teacher will inform learners of debates and arguments among the scientists who were the first to investigate a phenomenon (p. 8). (My emphasis)*

Science knowledge that is taught at school seems to focus on what is known as evidenced by the emphasis made above. This is contrary to environmental knowledge which is characterised by knowledge that is uncertain, complex and contested (see section 4.4.3.1).

Bernstein (1999) perceives the sciences as a vertical discourse since it takes the form of a “coherent, explicit, and systematically principled structure, hierarchically organised...with specialised modes of interrogation and specialised criteria for production and circulation of text.” This quote indicates that, that perception has not changed in the 21st century (see section 2.11, p. 37).

As mentioned in chapter 1, this study focused only on grades 10-12, hence the analysis below is suited to these grades.

Table 4.1 Outline of environment and sustainability content knowledge in the Life Sciences CAPS curriculum for grade 10-12, in two of the four knowledge strands in Life Sciences as well as the skills and values learners are expected to acquire during the teaching and learning of Life Sciences (LSD, p. 33-57).

Grade	Knowledge	Skills	Values
10	<p><u>Environmental studies:</u></p> <p>Biosphere</p> <ul style="list-style-type: none"> • The concept of the biosphere. • The inter-connectedness with and components of the global ecosystem: the hydrosphere, lithosphere and atmosphere (<i>Links to Grade 8</i>). <p>Biomes</p> <ul style="list-style-type: none"> • Terrestrial and aquatic biomes of southern Africa and how climate, soils and vegetation influence the organisms found in each. • The location of the different biomes in South Africa. <p>Environment</p> <p>The concept of environment in terms of human activities in and interactions with the natural environment. Abiotic and biotic factors: effects on the community.</p> <p>Ecosystems</p> <p>The concept of ecosystem, structure and ecosystem functioning:</p> <ul style="list-style-type: none"> • Abiotic factors: <ul style="list-style-type: none"> - physiographic factors (aspect, slope, and altitude) - soil (pH, humus content, texture, water retention capacity and air content) - light (day length and seasonal changes) 	<p><u>Cognitive skills</u></p> <p>Skills that all learners should develop by working through the curriculum :</p> <ul style="list-style-type: none"> • Acquire Knowledge • Understand and make connections between ideas and concepts to make meaning of Life Sciences • Apply knowledge on Life Sciences in new and unfamiliar contexts • Analyse, evaluate and synthesise scientific knowledge, concepts and ideas <p><u>Investigation skills</u></p> <p>The following range of skills relates to doing</p>	<p><u>Appreciating and understanding the history, importance and applications of Life Sciences in society</u></p> <ul style="list-style-type: none"> • Understanding the history and relevance of some scientific discoveries • The Relationship Between Indigenous knowledge and Life Sciences • The value and application of Life Sciences knowledge in the industry in respect of career opportunities and in everyday life

	<ul style="list-style-type: none"> - temperature (effect of day/night and seasons) - water (water cycle and the importance of wetlands) - atmospheric gases (<i>link to pollution-Grade 12</i>); <i>and</i> - wind (<i>link to transpiration</i>). - Biotic factors, which include: (<i>Links to Grade 8</i>) - producers - consumers - decomposers. • Energy flow through ecosystems and relationship to trophic structure (food pyramids): - Trophic levels: producers, consumers (herbivores and carnivores and omnivores , decomposers (<i>link with Grade 9 and nutrition in Grade 11</i>); - Flow charts of the following: nutrients water, oxygen, carbon and nitrogen cycles (Names, e.g., nitrates are required but no detail of chemistry is necessary) • Ecotourism: <ul style="list-style-type: none"> - economics - ethics - opportunities <p><u>Diversity, change and continuity:</u></p> <p>Biodiversity Enormous biodiversity on Earth (large variety of species, different ecosystems and genetic differences) with an emphasis on the extent of biodiversity and endemism in southern Africa: indigenous and endemic species.</p> <ul style="list-style-type: none"> • Classification Schemes Classification schemes are a way of organising biodiversity • Brief history of classification: Scientists attempt to classify organisms based on shared features. As information increases classification changes. One of the currently accepted classification systems is the five-kingdom system: Animalia, Plantae, Fungi, Protista and Monera (Bacteria). • The naming of things in science: species concept and binomial system. Focus on Linnaeus (Carl von Linne) and his role in classification systems: Why do we use Latin? • Differences between prokaryotes and eukaryotes (<i>link to cell structure</i>). • The main groupings of living organisms, diagnostic features of each: <ul style="list-style-type: none"> - Bacteria - Protista - Fungi - Plants - Animals 	practical work in Life Sciences: <ul style="list-style-type: none"> • Follow instructions • Handle equipment or apparatus • Make observations • Record information or data • Measure • Interpret • Design or plan investigations or experiments 	
11	<p><u>Environmental studies:</u></p> <ul style="list-style-type: none"> • Population Size 	*Same as above	

	<p>Immigration, emigration, mortality, births. Fluctuations. Limiting factors and carrying capacity. Logistic and geometric growth curves with phases.</p> <ul style="list-style-type: none"> • Interactions in the Environment <ul style="list-style-type: none"> - predation: two South African examples of predator-prey relationships: graphs; - competition: <ul style="list-style-type: none"> interspecific: for light, space, water, shelter and food; intraspecific: for food, access to mates, water, space, and shelter; survival is determined by access to the above, ecological niches; - specialisation: competitive exclusion and resource partitioning; discuss one example of coexistence in animals and one example in plants; - parasitism: two examples from South Africa; one species benefits - mutualism: two examples from South Africa; both species benefit; - commensalism: two examples from South Africa. • Social Organisation: The benefits of herds/flocks (avoidance); packs (hunting); dominance; and the division of tasks (castes) (mention only). • Community change over time: Succession Primary and secondary succession and possible endpoints depending on environmental fluctuations (mention only). • Human Population <ul style="list-style-type: none"> Reasons for exponential growth: <ul style="list-style-type: none"> - age and gender distributions for different countries, including South Africa; - forecast of South Africa's population growth over the next twenty years and predict possible consequences for the environment. <p>Causes and consequences of the following (relate to conditions and circumstances in South Africa):</p> <ul style="list-style-type: none"> • The atmosphere and climate change <ul style="list-style-type: none"> - carbon dioxide emissions; - concept of 'carbon footprint' and the need to reduce the carbon footprint; - deforestation; - greenhouse effect and global warming: desertification, drought and floods; - methane emissions; - ozone depletion. • Water <ul style="list-style-type: none"> • Availability: <ul style="list-style-type: none"> - Construction of dams - Destruction of wetlands - Poor farming practices - Droughts and floods - Exotic plantations and depletion of water table - Boreholes and effects on aquifers 		
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	<ul style="list-style-type: none"> - Wastage - Cost of water • Quality: <ul style="list-style-type: none"> - Water for domestic use, industry, agriculture and mining: pollution, diseases, eutrophication and algal bloom. - The effect of mining on quality of water - Thermal pollution - The need for water purification and recycling - Alien plants, e.g., <i>Eichornia</i> • Food Security (<i>link with population ecology dynamics</i>) <ul style="list-style-type: none"> - human exponential population growth; - droughts and floods (climate change); - poor farming practices: monoculture; pest control, loss of topsoil and the need for fertilisers; - alien plants and reduction of agricultural land; - the loss of wild varieties: impact on gene pools; - genetically engineered foods; - wastage. • Loss of Biodiversity (the sixth extinction) <ul style="list-style-type: none"> - habitat destruction: farming methods, e.g., overgrazing and monoculture, golf estates, mining, urbanisation, deforestation; loss of wetlands and grasslands; - poaching, e.g., for rhino horn, ivory and ‘bush meat’; - alien plant invasions: control using mechanical, chemical and biological methods; and - indigenous knowledge systems and the sustainable use of the environment e.g., devils’ claw, rooibos, fynbos, the African potato (<i>Hypoxis</i>) and <i>Hoodia</i>. • Solid Waste Disposal <ul style="list-style-type: none"> - managing dumpsites for rehabilitation and prevention of soil and water pollution; - the need for recycling; - using methane from dumpsites for domestic use: heating and lighting; and - safe disposal of nuclear waste. <p><u>Diversity, change and continuity:</u></p> <p>Biodiversity</p> <ul style="list-style-type: none"> • Microorganisms: basic structure and general characteristics of the following groups (<i>links with Grade 9 and 10</i>): <ul style="list-style-type: none"> - viruses - bacteria - protista - fungi. <p>(Macroscopic organisms in the protista and fungi should only be mentioned - not studied in any detail)</p> <ul style="list-style-type: none"> • Mention of the roles that these groups play in maintaining balance in the environment and web of life. 		
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<ul style="list-style-type: none"> • Symbiotic relationships, including, nitrogen fixing bacteria in plants and <i>E.Coli</i> in the human intestine (<i>link with Grade 10</i>). • The effect and management of one disease from each of the four groups: <ul style="list-style-type: none"> - viruses (rabies, HIV/AIDS, influenza) - bacteria (blight, cholera, tuberculosis, anthrax) - protists (malaria) - fungi (rusts, thrush, ringworm, athlete's foot). • Immunity, including plants and animals' immune responses of against the infecting microorganism Vaccinations (briefly). • The use of drugs, e.g., antibiotics; effect on microorganisms • The use of microorganisms to produce medicines (e.g., insulin and antibiotics). • Traditional technology to produce, e.g., beer, wine and cheese. • Grouping of bryophytes, pteridophytes, gymnosperms and angiosperms according to the presence/absence of: <ul style="list-style-type: none"> - vascular tissue (xylem and phloem) - true leaves and roots - seeds or spores - fruit. Decreasing dependence on water for reproduction from Bryophytes to Angiosperms • Asexual and sexual reproduction, name advantages and disadvantages of each. • Flowers as reproductive structures Adaptations for pollination through (different pollinators) wind, insects and birds (South African examples only) differences and similarities. • The Significance of Seeds <ul style="list-style-type: none"> - seed banks; - seeds as a food source; and - endemic species in South Africa. • The relationship between the body plan and grouping of animals in phyla. The concept of a phylum. • Six phyla (out of about 30 in the animal kingdom): <ul style="list-style-type: none"> - Porifera - Cnidaria - Platyhelminthes - Annelida - Arthropoda - Chordata. • Key features in respect of body plans: <ul style="list-style-type: none"> - symmetry and cephalisation; - the number of tissue layers developed from embryo; 		
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	<ul style="list-style-type: none"> - the number of openings in the gut; - coelom and blood systems. • The relationship between body plans and modes of living for each of the six phyla; similarities and differences. • The role of invertebrates in agriculture and ecosystems (e.g., pollination, decomposition, soil aeration etc.) 		
12	<p>Environmental studies: (Human Impact on the Environment must be completed in Grade 11, but this topic will be examined in both Grade 11 and in the National Senior Certificate at the end of Grade 12. In this knowledge strand, it is important to emphasise the interrelatedness and interdependence of the human impacts and the environment)_</p> <p>Diversity, change and continuity: (In order to understand species, speciation, biodiversity and change, it is essential to understand how DNA and chromosomes enable continuity and change)</p> <ul style="list-style-type: none"> • Genes: Dominant and recessive genes and alleles Mention of Mendel, father of genetics • Inheritance and variation <ul style="list-style-type: none"> - Monohybrid crosses: phenotype and genotype, homozygous and heterozygous (pure bred and hybrid); examples of complete, incomplete/partial dominance and codominance; - Dihybrid crosses: phenotypes and genotypes. • Sex chromosomes Sex-linked alleles; sex-linked diseases • Mutations <ul style="list-style-type: none"> - harmless and harmful mutations: examples of diseases, disorders; gene mutations and chromosomal aberrations; and - useful mutations, link with natural selection • Genetic engineering: Stem cell research, genetically modified organisms, biotechnology and cloning. • Mention mitochondrial DNA and the tracing of genetic links • Paternity testing and DNA finger printing (forensics) 	*Same as above	

* The skills must be assessed at **the appropriate grade level** (South Africa. DoBE, 2011, p. 13 & 15) [Emphasis in original].

There are opportunities to make environment and sustainability links in the other two strands but these two (Environmental studies & Diversity, change and continuity) explicitly

deal with environment and sustainability content knowledge, hence the study focused mainly on these. The Fundisa 4 Change pilot programme focused mainly on Biodiversity and classification for grade 10 teachers.

4.3.2 Pedagogy

Bernstein (1975) defines pedagogy as valid transmission of knowledge. The way CAPS has been presented in the policy document demonstrates that it is a highly structured curriculum. Learners have less control over selection, sequence, and pace which makes the curriculum strongly framed, the teacher has some control over the selection, sequencing, pacing and criteria of the knowledge to be acquired (see section 2.2). CAPS specifies what teachers should teach, when they should teach it and how long they should take to teach it (see section 2.11).

The Life Sciences specific aims and the cognitive weighting linked to assessment in Life Sciences (see section 2.11) give an indication of the teaching methods that are required in the teaching of Life Sciences, as well as a guide to activities that learners could do to achieve the specific aims.

Life Sciences should be taught for four hours per week (South Africa. DoBE, 2011, p. 7). The prescription of the content knowledge, the teaching methods implied through the specific aims and the pacing makes CAPS a strongly framed curriculum. Specific pedagogic practices in the teaching and learning of Life Sciences are explicit and teachers' autonomy with regard to teaching practices is regulated by the expected knowledge, skills and values to be achieved by learners. In Bernstein's terms, there is less autonomy for teachers because of external regulations informed by the expected future performance of learners (1996).

The curriculum does give teachers the autonomy to choose which strand to start with but the sequence is then prescribed. If they choose to start with strand 3 then strand 4 should follow and if they start with strand 1 then that should be followed with strand 2. This means that if a teacher in grade 10 decides to start with environmental studies at the start of term one, then diversity, change and continuity should be the next strand to be taught.

*“The rationale for this order In **Grade 10** is that some areas of South Africa are best suited for an environmental study during early spring and also because seasonal comparisons in a chosen ecosystem are required where possible. Some teachers may elect to deal with the Environmental Study at the beginning of the year. However it is important to retain the sequence of Knowledge Strand 1 **before** Knowledge Strand 2 and Knowledge Strand 3 before Knowledge Strand 4. Decisions regarding the sequence (starting the year with Knowledge Strands 1 and 2 or starting the year with Knowledge Strands 3 and 4) must be made by teachers.” (South Africa. DoBE, 2011, p. 11) (emphasis in original)*

Currently the planning in the CAPS document is that environmental studies and diversity, change and continuity are taught in the third and fourth terms respectively. In grade 11 diversity, change and continuity is to be taught in the first term, progressing from diversity, change and continuity that would have been taught to the grade 10 learners in the fourth term. This would work well in terms of conceptual progression from grade 10 – 11. From this it is possible to see that the curriculum also gives attention to progression and development of the vertical knowledge structure of Life Sciences. The table below shows a progression map for biodiversity and environmental studies from Foundation Phase up to General Education and Training Phase (grade R – 9). It shows the prior knowledge that learners should be coming with from the lower grades in preparation for the Further Education and Training phase (Grade 10- 12).

Table 4.2 Environment and sustainability content knowledge from foundation phase to senior phase (CAPS, 2011)

Grade	Strand	Content Knowledge
R	Beginning Knowledge and Personal and Social Well-being (Life Skills)	<p>Topic: Birds</p> <ul style="list-style-type: none"> • Different types of birds • General characteristics of a bird - feathers, two legs, beak, lays eggs • Birds that cannot fly - ostrich, penguin • Nests <p>Topic: Reptiles</p> <ul style="list-style-type: none"> • Different reptiles - e.g. crocodile, snake, lizard • Characteristics of reptiles - cold-blooded, scaly body, lays eggs • Find out more about at least one reptile <p>Topic: Healthy environment</p> <ul style="list-style-type: none"> • The importance of a clean environment • Ways in which people pollute the environment • The importance of recycling
1	Beginning Knowledge and Personal and Social Well-being (Life Skills)	<p>Plants and seeds</p> <ul style="list-style-type: none"> • Why we need plants - include food, shade, shelter for animals

		<ul style="list-style-type: none"> • What plants look like - roots, stem, leaves, flowers • Different plants - similarities and differences (classification) [my emphasis] • Seeds and where they come from • What plants need to grow • Growing a plant from a seed - such as a bean or a lentil
2	Beginning Knowledge and Personal and Social Well-being (Life Skills)	<p>Topic: Soil</p> <ul style="list-style-type: none"> • Different soils - colours and textures • Creatures that live in the soil - such as earthworms, moles • Soil for the growth of plants; the value of growing vegetables <p>Animals and creatures that live in water (aquatic biomes)</p> <ul style="list-style-type: none"> • Fresh water <ul style="list-style-type: none"> - River - e.g. fish, crocodile - Ponds and dams - e.g. frog, dragonfly • Salt water <ul style="list-style-type: none"> - Sea - e.g. shark, crayfish - Rock pools - e.g. starfish, crab
3	Beginning Knowledge and Personal and Social Well-being (Life Skills)	<p>Rights and responsibilities of others</p> <ul style="list-style-type: none"> - At home - At school - In our community - In the environment <p>Topic: Insects</p> <ul style="list-style-type: none"> • Characteristics of an insect • Different insects - such as fly, mosquito, ant, beetle • Observing and drawing an insect • How insects help us • How some insects harm us
4	Life and Living (Natural Sciences & Technology)	<p>Different habitats</p> <ul style="list-style-type: none"> • a habitat is the place where a plant or animal lives • there are different kinds of habitats such as grassland, forest, river, sea <p>Need for a habitat</p> <ul style="list-style-type: none"> • animals need a habitat for food, water, a place to shelter, have babies and escape from dangers
	Life Skills Health and environmental responsibility	<ul style="list-style-type: none"> • Healthy environment and personal health: home, school and community • Examples of environments that are unhealthy: pollution (air, water and land) including illegal dumping sites • Dangers of unhealthy environments to personal health • Strategies to keep environments healthy: conservation of environment • Celebrating Arbour day

5	Life and Living (Natural Sciences & Technology)	<p>(* Plants and animals, and their habitats make up the total biodiversity of the Earth)</p> <p>Many different plants and animals</p> <ul style="list-style-type: none"> • there are many different plants and animals living in different habitats on Earth* (South Africa has a wide variety of indigenous plants and animals and their habitats) <p>Inter-dependence</p> <ul style="list-style-type: none"> • plants and animals depend on each other • they also depend on the resources available (such as air, water, soil, food, and places to hide) in their own habitats <p>Animal types</p> <ul style="list-style-type: none"> • there are many different kinds of animals, <ul style="list-style-type: none"> -- some do not have bones, and some have hard outer 'skins' or shells (invertebrates) -- some have bones (vertebrates) <p>Food and feeding</p> <ul style="list-style-type: none"> • green plants make their own food** and build their branches and stems using water and carbon dioxide from the air, and energy from sunlight. Plants use carbon dioxide from the air and release oxygen into the air • animals need food to carry out their life processes (to move, feed, grow, sense the environment, excrete, breathe and reproduce) • all animals depend on plants as their primary source of food (herbivores, carnivores and omnivores) • a food chain describes the feeding relationships between plants and animals. • a food chain <ul style="list-style-type: none"> -- starts with a plant, (produces foods) -- then follows with an animal that eats the plant -- after that with an animal that eats that animal -- includes the transfer of energy which flows from the plant through to the last animal in the chain
	Life Skills Health and environmental responsibility	Water as an important basic need: Importance of water Different ways of saving water Different ways of protecting the quality of water
6	Life and Living (Natural Sciences & Technology)	<p>Different ecosystems</p> <ul style="list-style-type: none"> • an ecosystem is an area where living and non-living things depend on each other in many different ways • there are many different ecosystems such as rivers, mountains, sea, rocky shore, ponds, wetlands, grasslands, forests and deserts, which support different kinds of living things <p>Living and non-living things in ecosystems</p> <ul style="list-style-type: none"> • in an ecosystem there are certain relationships between living things (plants, animals/people, microorganisms), and non-living things (air, water, sunlight, soil) in a particular area* <p>Food webs</p> <ul style="list-style-type: none"> • in an ecosystem plants and animals are connected by their feeding relationships. This is called a food web • a food web consists of: <ul style="list-style-type: none"> -- plants (producers) which produce food for themselves

		and animals -- animals (consumers) which are herbivores, carnivores, omnivores -- microorganisms (decomposers) that break down dead plant and animal matter and return nutrients to the soil
7	Life and Living (Natural Sciences)	<ul style="list-style-type: none"> • The biosphere -- The concept of the biosphere -- Requirements for sustaining life` • Biodiversity -- Classification of living things -- Diversity of animals -- Diversity of plants • Variation -- Variations exists within a Species
8	Life and Living (Natural Sciences)	<ul style="list-style-type: none"> • Interactions and interdependence within the environment -- Introduction to ecology -- Ecosystems -- Feeding relationships -- Energy flow: Food chains and food webs -- Balance in an ecosystem -- Adaptations -- Conservation of the ecosystem
9	Life and Living (Natural Sciences)	No links

4.3.3 Discourses and competences

Bernstein (1990) distinguishes between instructional discourse and regulative discourse (see section 2.2). Specific instructional discourse refers to the content knowledge to be taught, cognitive skills to be acquired and the assessment of the knowledge and skills during teaching and learning interactions. General regulative discourse refers to the aims of the state for its citizens.

4.3.3.1 General Regulative Discourse

“Education and the curriculum have an important role to play in realising the aims of the Constitution.” Minister of Basic Education, Angie Motshekga, 2011 (South Africa. DoBE, 2011, foreword).

The South African curriculum is underpinned by the values in the Constitution. The curriculum is explicit in wanting to promote democratic values, social justice and human rights; one of the rights is for South African citizens to enjoy a healthy environment, hence

environmental education was integrated in the school curriculum (see section 2.3.2). The curriculum is seen as a vehicle that will bring social transformation, improve quality of life of all South African citizens and free the potential of every South African (South Africa. DoBE, 2011, foreword).

The curriculum requires that teachers foreground the Constitutional values in their teaching. One of the principles in the curriculum is value-oriented. It encourages the infusion of the principles and practices of social and environmental justice and human rights (LSD, p. 5).

This suggests that this principle should be embedded during teaching and learning interactions.

The issue of knowledge is explicit in the curriculum. It constitutes one of the principles that underpin the curriculum. It is stated that knowledge should be high and that the content and context should progress from simple to complex in each grade. Only the minimum standards of knowledge are specified therefore “educators have the freedom to expand concepts and to design and organise learning experiences according to their local circumstances, including the availability of resources.” (LSD, p. 10). This encourages teachers to recontextualise the curriculum as they extend and work with the prescribed content knowledge.

CAPS also encourages the valuing of indigenous knowledge systems to recognize the rich history and heritage in an effort to reflect and nurture the Constitutional values (LDS, p. 5). The curriculum is also specific on the skills it wants developed in learners. The CAPS aims to produce learners that are able to:

- *identify and solve problems and make decisions using critical and creative thinking;*
- *work effectively as individuals and with others as members of a team;*
- *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.* (LSD, p. 5)

The curriculum encourages an *“active and critical approach to learning instead of rote learning which does not create opportunities for critiquing of given truths”* (South Africa. DoBE, 2011, p. 4). This suggests that learners should be given opportunities to critique and evaluate knowledge given to them. This is particularly important when working with environmental and sustainability content knowledge as it is contested (see section 4.4.3.1). The curriculum also expects that there should be progression from simple to complex in terms of content and context both within and across the grades as mentioned above.

CAPS curriculum also aims to *“ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives”* (LSD, p. 4).

It also calls for inclusivity in the teaching process.

The curriculum asserts that inclusivity should be *“central in the organization, planning and teaching”* in schools (LSD, p. 5). To achieve this, teachers must be able to recognize and address barriers to learning. Teachers are also expected to pay particular attention to developing learners’ language skills through reading and writing (see section 2.11).

4.3.3.2 Specific Instructional Discourse

Rules of instructional discourse are explicitly stated in the curriculum as indicated above (see section 4.3.2). Pedagogical practices are thus visible, making the curriculum strongly framed. *“When teaching Life Sciences, it is very important to help learners to recognise the links between related topics so that they acquire a thorough understanding of the nature and interconnectedness of life. These links must also be made across grades”*, (South Africa. DoBE, 2011, p. 10). This shows the regulation of knowledge progression when topics are taught. It also says something about topic interconnections within and across the grades (see section 4.3.1). This indicates intra-disciplinary classification between various topics within the Life Sciences (Bertram, 2008).

Teachers are also expected to ensure that learners are familiar with rules regarding the safe use of equipment and chemicals. This is a skill learners have to acquire when investigating phenomena in Life Sciences as they will be assessed on how they handle equipment and apparatus. In assessing learners, a range of skills and cognitive levels should be employed in the assessment of subject content knowledge (see section 2.11 & 4.3.4 below). The knowledge, skills and values learners should develop in the teaching and learning of Life Sciences form part of the specific instructional discourse (see table 3.2 in section 4.3.1).

4.3.4 Assessment

“Evaluation defines what counts as a valid realization of the knowledge on the part of the taught” (Bernstein, 1975, p. 85).

CAPS has a strong emphasis on assessment. Examining how knowledge is assessed also gives insight into how a curriculum document understands knowledge as well as which knowledge is valued (Bertram, 2008).

In assessing learners, teachers are required to design assessment tasks that will cover the content of the subject, the range of skills and the cognitive levels identified in the specific aims, at the same time catering for a range of cognitive levels and learner abilities. “The cognitive demands in assessment should be **appropriate for the age and development level** of the learners in the grade.” (LSD, p. 67, [emphasis in original]).

A seven-point scale is used to grade learner performance. Level 1 means the learner has not achieved as expected and level 7 denotes outstanding achievement.

It is clear that CAPS requires learners to work at various levels of cognitive engagement with the majority of assessment located in the categories of understanding and analyzing conceptual knowledge. It is clear that CAPS requires learners to develop *knowledge* and *understanding* as the majority of the weighting (65 %) focuses on the categories of *knowing* (40 %) and on *understanding* (25 %) conceptual knowledge. The *application of knowledge* is weighted at 20 % and the *analysis, synthesis* and *evaluation* make up the last 15 %. Teachers are given strongly externally regulated guidelines on how to design their tests for example. The cognitive levels above closely resemble Blooms taxonomy.

The acquisition of Life Sciences knowledge seems to dominate any other skills learners need to acquire in Life Sciences. Teachers will therefore have to master new sections of content which have not been taught, before particularly environment and sustainability content knowledge. These teachers might struggle to teach this knowledge considering that Life Sciences knowledge and environmental knowledge is changing, on-going and contested- especially for those teachers who still teach facts from prescribed books as if these were truths that cannot be critiqued.

Table 4.3 Time allocated to teaching the environment and sustainability content knowledge in Life Sciences and how these are weighted in terms of assessments in a 300 marks exam.

Grade	Topic	Time	Weighting	
			%	Marks
10	Biosphere to ecosystems	6 weeks	40	60
	Biodiversity & classification	1 week	7	10
Total		7 weeks	23	70
11	Population ecology	4 weeks	24	36
	Biodiversity and classification	3 weeks	20	30
	Biodiversity in plants and reproduction	3 weeks	20	30
	Biodiversity of animals	2 weeks	13	20
	Human impact on the environment: current crises	7 weeks	47	70
Total		19 weeks	62	186
12	Human impact (grade 11)	2.5 weeks	17	25
Total		2.5 weeks	8	25

The table shows that more time is spent on teaching environment and sustainability content knowledge in grade 11 than in grade 10 and 12, and that more than 50 % of what is assessed at the end of the year exams is on that content. In grade 12 the content is a revision of grade 11 (2.5 weeks), which means that teachers will have ample time to spend on it only in grade 11 (7 weeks).

The following section describes how the Life Sciences curriculum document has been recontextualised in the pedagogic recontextualising field (PRF). It starts off with a description of how teachers choose the resources they use for teaching. It then reports on teachers' (teachers in the case study) experiences of the professional support provided by one of the teacher unions in collaboration with the DoBE. It proceeds to give a description of the training modules and units that were developed by the Fundisa for Change programme for recontextualising the Official Pedagogic Discourse. Perspectives on the recontextualisation process by one of the training unit's developers are also shared.

4.4 Pedagogic Recontextualising Field (PRF)

The Department of Basic Education provides further recontextualisation support through orientation training for CAPS. A catalogue outlining the textbooks that have been approved by the DoE is also sent to schools so that teachers can choose the textbooks they will use to teach the content specified in the CAPS document.

4.4.1 PRF: Textbooks

Although a content analysis of CAPS textbooks approved by the DoBE was not part of this study, it was important to determine the factors that influenced teachers' choice of textbooks they use for teaching and learning. This is rather important, particularly in cases where teachers are not direct recontextualisers of the ORF but rely on textbook writers' interpretation of the ORF. This is evidenced by a statement made by one of the teachers at the workshop, "*...because when you look at work programmes now when you go to CAPS, so you just follow the textbook as it is, so it's a guideline. Textbook now is like a work schedule. You know now it's going to be this and this and this*" (T6, FG).

Teachers indicated that they used a variety of textbooks, with some using only one textbook. Other resources like charts, magazines and DVDs were also used by some although some depended only on textbooks. A variety of responses were given that shed light on how textbooks were chosen. Teachers chose a textbook that:

"follows assessment guidelines", (T1, Q1)

"almost covers everything that I need in my teaching" (T2, Q1)

“is easy to use and contains more information”(T3, Q1)

These responses seem to suggest that teachers in the case study make informed choices based on the curriculum requirements. Other responses though suggest that teachers just use what is available. Teachers use *“what is given in the school”* (T5, Q1).

What also emerged is that teachers were given the DoBE catalogue to choose a textbook before they even knew what they had to teach. A remark made by one of the teachers indicates that they are not always well informed when they choose a textbook, *“what usually I did, I just order any book so I will just teach and just ordering any book you are using the school’s funds. Sometimes you will find that when the book is here, ‘haai’ [no] this one is not good as ours but you can’t take it back.”* (T3)

4.4.2 PRF: Teacher training

When a new curriculum is introduced, the Department of Basic Education runs workshops to orientate teachers to the new curriculum. Most of the teachers in the study had attended a two-hour, one-day grade 10 CAPS training workshop organized and run by one of the teacher unions. The teachers felt that the workshop was *“scanty and not more informative”, “it was not a fully equipping training as it only covered the basic/introduction part of the content, very short and lasted for only two hours”* (T1, Q1). Teachers also felt that the time was not enough (FG).

Teachers in a focus group interview said that the CAPS orientation training was inadequate as it was more generic and not subject specific, as shown by these comments:

T6: It was just about unpacking the CAPS document, it was just about that. They were just going through the CAPS document, it was like that.

T2: Actually I think they were just trying to shine, they were not having the information as such...That’s what I can say, because they were not competent...They were just together going through this document.

T2: I’m thinking of one other thing. Do you remember that union workshop? It was general it was not specific to each subject, isn’t it? So I think it’s better if they do it like this. And say, this is a Life Sciences CAPS workshop; this is a Physical Sciences CAPS workshop. I think it would be much better, so that it would be easier to use the examples you see. Let us say the workshop is run by a person who is doing

economics, I would be confused because I am a Life Sciences educator. So that's what I think (FG).

The same sentiments were shared by one of the teachers in an individual interview, who had also attended a union-run workshop.

T1: To be honest in that workshop I did not gain anything, the lady was also...She did not know what she was going to do. She only talked about the CAPS document and she was only telling us that you have to turn to page this and read as it is. There was no clarification about the curriculum yet we are expecting a lot because that was a new curriculum that was expected to roll out to the learners so we came blank (IT).

Another issue that came out was that teachers preferred the workshops to be run by Departmental officials as opposed to union members who are ordinary classroom teachers.

T6: I think more workshops must be run by the Department itself, maybe subject advisers, it should be like that. (FG)

T1: They have to bring out, the subject advisors especially, the Department needs to make sure that these workshops about the new curriculum are run and conducted by people who actually know the curriculum. Because what I've also noticed now, these information some of even these subject advisors also they don't know much about this curriculum that is why they are just talking. This year I was surprised to find that now, instead of the Department...I was expecting the Department of Education to be the one that now work shopped educators about this curriculum now it became a surprise to find now it was the union and I just...and the people who conducted the workshop these were teachers who were conducting the workshops its teachers, the ones who also don't know about the curriculum. It was like the blind leading the blind. I think what needs to be done now, even these subject advisors they should be work shopped also on how to roll out this new curriculum to the educators... The educators need to be work shopped thoroughly. This workshop [referring to the Fundisa for Change pilot programme] now has taken us step by step, but the Department has given us one day. How can you do the assessment the methods of teaching and the planning of a lesson and drafting of a work schedule in one day? That is impossible! (IT)

In the next section I describe the recontextualisation of the OPD by the Fundisa for Change pilot programme. I start by analysing the contents of the Fundisa 4 Change training module core text and the units that were used for training the teachers. I then share insights gained from interview with one of the core writers of the exemplar module. In my analysis I examined the environmental and sustainability discourse, and the pedagogic discourse. The interview was particularly important in shedding light on the factors that influenced the development of the exemplar.

4.4.3 PRF: Training module used in the CAPS Life Sciences pilot

A content analysis of the Fundisa for Change training manuals helped me to clarify and identify the environmental discourse within the manuals in order to guide interpretation in the rest of the study. The aim was to trace how the official message is changed or elaborated in these recontextualising processes in the training manuals and in training workshops.

4.4.3.1 Fundisa for Change Core text (FfCCT)

Teachers in the pilot were given the Fundisa for Change training manuals. According to the core text, the aim of the course is to introduce teachers to knowledge, methods and assessment practices for teaching successfully with the CAPS through focusing on the environment, science, society and sustainability. Moreover, it seeks to support teachers in teaching what is often 'new' content knowledge. It aims to do this through *scaffolding, expanding and extending* the environment and sustainability content, methods and assessment practices suggested as a 'minimum' in the CAPS, [emphasis in original] (FfCCT, 2011, p. 1). This will therefore enable teachers to exercise the 'freedom to expand concepts' given to them as stated in the CAPS curriculum document, (South Africa. DoBE, 2011, p. 10).

The core text states that it is important for teachers to know their subjects and particularly the environmental content embedded as much as it is important to know how to extend and expand the environmental content in the subjects they teach.

The course is structured around three units:

- Know your Subject
- Improve your Practice
- Improve your Assessment Practice

It is stated in the core text that the units can be approached interchangeably (i.e. any unit can be used first) but all three units together make up the whole (FfCCT, p 1).

In having the 'Know your Subject' unit, the course aims to highlight that, although each subject in CAPS has an environmental focus, it is different in the different subjects because

subjects have their own knowledge structures and ways of generating knowledge.

A key feature of this course is to provide an understanding of the particular form which environment and sustainability knowledge takes in each subject, and why it is that way.

According to the core text, research in environmental education indicates that most teachers do not fully understand the environment and sustainability content that is required in the curriculum as it is considered 'new knowledge'. It is believed that it is because this knowledge is rapidly changing and transforming as scientists work to generate new and better understandings of environmental issues and possible solutions and alternative practices. This closely resembles the on-going nature of knowledge production in the sciences (see section 4.2.1).

The core text argues that teachers have the triple challenge of a) inducting learners into available knowledge / content and concepts (i.e. what is known), b) teaching learners that knowledge is contested, and that knowledge can change (i.e. that what is known can be questioned and changed); and c) teaching learners that not everything is known about an issue (i.e. that not everything can be known about anything). It stands to reason that science teachers would be challenged to teach knowledge that is characterised by uncertainty since *"science knowledge that is taught in schools has been tested and is generally accepted."* (see section 4.3.1).

Environment and sustainability knowledge similarly to sciences knowledge, is contested and in many cases we remain uncertain about the full scope, extent and implications of environmental issues. Not everything is known, and both teachers and learners need to work with knowledge that is contested, as well as knowledge that is incomplete. Failing to expose learners to such an understanding of knowledge is to offer them an incomplete education (FfCCT, p. 8).

The core text also states that, in knowing your subject, the focus should be on **core concepts** and **core processes** that provide teachers with the foundational knowledge necessary to understand a range of environmental issues and alternative solutions. For example,

- An understanding of the Earth as a system
- An understanding of key life-supporting processes
- An understanding of how ecosystems function to support the diversity of life

- Diversity; and especially biodiversity and its role in supporting life (FfCCT, p. 8)

The examples of concepts and processes given above are what constitute the Life Sciences curriculum and what learners are hoped will develop as they study Life Sciences (see sections 2.11 & 4.4.3.1 above).

The text (*ibid*) further explains that research also shows that many teachers are ‘under-teaching’ learners by not giving enough attention to progression and appropriate levels of content knowledge required at different phases and grades at the different levels of the education system, reflecting a similar interest in progression as shown in the CAPS (OPD) (see sections 4.3.2 & 4.3.3.2)

In the ‘know your subject’ unit, the starting point is on the identification of the environmental knowledge and concepts teachers are *meant* to teach in particular curriculum subjects. Then it focuses on investigating what is known i.e. what content knowledge is available on the topic, and what key concepts underlie or underpin the content requirements in the curriculum for environmental learning. And then investigate what is *not known*, and how teachers teach about things that are not known (FfCCT, p. 9)

The ‘improve your teaching practice’ unit is included because of the belief that quality education results from good teaching and that each subject favours a particular teaching methodology in creating knowledge. This will then influence how environmental content is mediated and assessed in a particular subject. The core text prioritizes three methods in addition to subject-specific methods that are generic to all subjects; listening with intent, reading and writing and using mathematical concepts and numbers to learn (*ibid*).

Listening with intent is seen as an important method for learning as it leads to adequate vocabulary development that enables learners to understand what is being said. In reading and writing, learners manipulate language as they engage in meaning-making processes. Learning more about the world is also promoted through use of calculations, numbers and mathematics concepts (FfCCT, p. 11). This is in line with the one of the aims of the curriculum, which is to produce learners that will be able to “*communicate effectively using visual, symbolic and/or language skills in various modes.*” (LDS, p. 5).

The FfCCT notes that the teaching of environmental content in the CAPS requires learners to engage actively (“active and critical learning’, LSD, p. 4) with complex local and global social-ecological issues and risks (“knowledge in local contexts, while being sensitive to global imperatives”, LSD, p. 4) in order to develop action competence (see section 4.3.3.1) and for learners to engage critically with environmental issues in developing solutions to address them. The FfCCT also notes that the 1995 White Paper posits that active approaches to learning should be used in environmental education (FfCCT, p. 12, see also section 2.3.2). This idea has been conceptualized as one of the principles underpinning the CAPS curriculum, active and critical learning (LDS, p. 5, see also 4.3.3.1). Teachers therefore are required to develop capacity for designing teaching and learning interactions that enable learners to explore and investigate the local, while also developing an understanding of the global, as well as interactions that encourage critical thinking and critical analysis of topics at different scales and contexts. The text also emphasizes that teaching methods chosen should appropriately align with and extend the content focus of a subject.

The following are perceived as methods that can substantively strengthen environmental learning in the different subjects, experiential, investigative, learning by doing and deliberative methods. Teaching methods, when used in combination, have the potential to lead to transformative learning and can expand learners’ opportunities for learning (FfCCT, p. 14).

The core text also includes a unit on ‘improve your assessment practice’. This states that there is a need to focus on improving assessment practice in the context of a subject, and its environmental topics and content. The text clearly indicates that a critical analysis of the assessment requirements for CAPS were done. This was confirmed by one of the developers of the unit who mentioned in an interview that in doing research in preparation for writing the unit he consulted the CAPS curriculum document, *“I was researching to the curriculum itself because biodiversity is a topic that spans across the curriculum from grade 10-12 in the FET band”* (ID).

Further evidence of this is the fact that mention is made of how CAPS has clearly defined assessment practices that guide teachers. Extracts have been taken from CAPS documents (FfCCT, p. 17-18). The unit therefore seeks to support teachers in developing the insight and

skills for effective assessment of learners. It is also mentioned that good teaching can be extended and improved through good assessment practices. Moreover, learners receive good feedback on their progress when good quality assessment has been used. Opportunities are also created for teachers to 'get to know' learners and to identify the kind of support learners need to progress in their learning, (FfCCT, 2011).

According to the FfCCT, environmental learning requires more active, or action-centred, critical, creative and situated approaches to learning and focus on the kind of feedback that is most useful to give in an environmental learning process (p. 22).

The central focus of the course is to strengthen environmental learning in the curriculum through engaging with the three units. Units for different subjects and phase levels, focusing on specific content, pedagogy and assessment practice are then developed drawing on this conceptual framework. In the case of the LSD, the focus was on biodiversity.

4.4.3.2 Know your subject unit (Biodiversity content knowledge)

An analysis of the exemplar indicated the following aspects of biodiversity:

- Biodiversity
- Roles of biodiversity
- Environmental issues
- Responses to environmental issues

In an interview with one of the key writers of the exemplar, in explaining why these particular aspects were chosen in looking at biodiversity, he mentioned that his experience as a practitioner guided him.

"I am a Biologist and biodiversity is one of those topics I would have a natural inclination to biodiversity. It's something I have been working with for more than 10 or 15 years, so it comes as a natural thing which is the reason why I wanted to actually have that frame of the way I would look at it. As a practitioner and as an environmentalist, what would be the way I would naturally look at biodiversity, bring out the environmental aspects of biodiversity in a way that is actually understandable to people, teachers and ordinary learner on the ground" (ID).

Aspects of biodiversity in the unit covered subthemes and the content within each theme. Curriculum links for each aspect, subtheme and content are also explicitly stated and reference is made to where they appear in the CAPS curriculum document.

The bulk of the content covers grades 10 & 11 topics, as the extract from the unit below indicates.

The biodiversity exemplar is drawn from the CAPS FET phase Life Sciences from grade 10-12...The exemplar is based on the framework below that attempts to draw together biodiversity aspects in the curriculum in an attempt to develop a progressive understanding of the topic. The bulk of the content falls under grade 10 (term 3&4) and some under grade 11 (term 1&2). (FCCU, p. 1)

These are discussed in more detail below.

4.4.3.2.1 Biodiversity discourse

The theme of biodiversity covers definitions of key concepts (variety of life and life systems, species, population, genus, community, habitat, ecological niche, ecosystem, trophic levels and biomes), it also focuses on levels of biodiversity (genetic, species and ecological diversity), and it looks at ecosystems (aquatic and terrestrial South African biomes) and taxonomy (classification of living organisms and using identification instruments or tools). This content resembles the content knowledge that teachers have to teach (see table 4.2 in section 4.3.1)

An activity under this theme uses three case studies: Irish potato famine, cultivating coffee & disease control. These need to be read and discussed, and require identification of what level of biodiversity is significant in each case, and giving an explanation of how the situation might have been different with a greater biodiversity. It has been highlighted that studying South African biomes creates opportunities to teach and learn about biodiversity, starting within the school yard and extending to global biomes. A second activity requires researching a plant and animal species endemic to one's province, and in South Africa, and then using a South African map which shows distribution of biomes to find out in which biomes the endemic plant or animal resides.

4.4.3.2.2 Roles of biodiversity

This theme constitutes ecosystem services & human wellbeing (life support systems and processes, biodiversity resources and livelihood sustenance). One of the activities requires a

reading of a case study in which a particular biome regulates climate, and providing an explanation in the form of a poster. The second activity is accompanied by a case study on the interdependence of biological and cultural diversity amongst the AmaXhosa and Mfengu people. It requires each person to tell a story about one's own culture and about a plant or landscape that is significant to that culture. This reflects the curriculum's commitment to indigenous knowledge (see section 4.3.3.1). A third activity requires drawing a mind map illustrating the different services provided by wetlands, using a factsheet on wetlands. The unit has not provided any curriculum links to this aspect of biodiversity, which suggests that this aspect is not explicitly stated in the curriculum. But analysis of the curriculum document shows that this aspect is covered in the curriculum. The curriculum expects teachers to discuss with learners the importance of wetlands when teaching about water as an abiotic factor (LSD, p. 33, see also table 4.2 in section 4.3.1).

Links could also be made when teachers teach about trophic levels (food chains and food webs). Further links could also be made to what teachers teach in the first term on the chemistry of life, discussions on minerals and vitamins in different foods (LSD, p. 23). There are links that could be made with applications of indigenous knowledge systems and biotechnology which is to be taught in term three as this section focuses on different plants are used in traditional medicines and in vaccines (LSD, p. 28). An indication of the connections between topics within a grade would indicate the intra-disciplinarity discourse in Life Sciences (see sections 2.2 and 4.3.3.2).

4.4.3.2.3 Environmental issues

This theme focuses on impacts of human activities on biodiversity (biodiversity loss due to pollution, overexploitation, extinction, invasive alien species, habitat change and climate change). The curriculum covers human impacts on the environment when grade 10 learners do fieldwork in term 3. The table below shows opportunities where learners could discuss the negative impacts of humans on the environment (my emphasis). It also shows that progression of the content from grade 10 fieldwork to the content they will cover in grade 11 (my emphasis).

Table 4.4 Investigations in grade 10 (LSD, p. 33-34)

<p>Strand 3: Environmental Studies</p>	<p>Fieldwork</p> <p>Choose ONE ecosystem (close to the school) within a local biome for special study. The study must:</p> <ul style="list-style-type: none"> • deal with abiotic and biotic factors and the interactions between them; • the trophic relationships in an ecosystem; • record and describe seasonal changes over two terms either Terms 1 and 2 or Terms 3 and 4 • biodiversity within the ecosystem using field guides and keys • positive and/or negative human impact on the ecosystem <p>Different groups should investigate different factors.</p> <p>Each group must plan, collect, record and present, analyse and evaluate data.</p> <p>(This serves as an introduction/link to human influences on the environment in Grade 11.)</p>
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Further links to the curriculum could also be made with the sixth extinction, mentioned in grade 10 under diversity, change and continuity strand and expanded in grade 11 on the topic of human impacts on the environment (LSD, p. 36 and 51), (see table 4.2 in section 4.3.1)

4.4.3.2.4 Responses to environmental issues

The focus is on biodiversity conservation (environmental education & education for sustainable development, collaborative management and community-based natural resource management, traditional and western protected areas, conservation of key and threatened species, non-consumptive use of biodiversity, private game reserves, invasive alien control, policy and legislation and low carbon and green economy). No mention is made on the FfCCU to indicate how this dimension appears in the curriculum.

Although no curriculum links were made explicit in the FfC, these could be explored by learners when they focus on the positive impacts of humans on the ecosystem (see table 4.3 above). The FfCCU has elaborated and extended the OPD in the recontextualisation process as indicated above.

4.4.3.3 Improve your teaching unit

This unit, like the previous one, was drawn from the CAPS. It provides possible pedagogical approaches or teaching methods that can be used in the teaching and learning of biodiversity. The methods have been categorized as being relevant for teaching **in** the environment, learning **about** biodiversity and those that can be implemented **for** the environment, with some of them teacher-centred, e.g. Information transfer methods and some learner-centred e.g. Investigative methods. Several activities and methods have been provided, that can be used to teach the different aspects of biodiversity.

An activity in this unit exemplar required that teachers look at the Life Sciences curriculum and write the skills associated with the three specific aims (see section 2.11) then to choose one of the activities provided and list all the skills that could be developed in that activity, giving a description of how the activity develops each skill. Teachers also needed to consider some of the challenges they had in supporting the development of each skill, e.g. lack of resources or teachers and/or learners' prior knowledge. Finally teachers had to reflect on the strengths and weaknesses of the teaching method used in the activity, using a handbook titled 'Environmental Education Methods' (Rosenberg, O' Donoghue & Olivitt, 2008). This activity was not done by teachers due to time constraints.

4.4.3.4 Improve your assessment unit

This unit focuses on relevant assessment approaches that can be employed in the teaching of biodiversity. It covers the purpose of assessment, key principles of assessment, assessment approaches, assessment methods and tools, assessment of cognitive skills using Bloom's Taxonomy, CAPS Life Sciences assessment focus (links between content knowledge and assessment processes) and assessment examples linked to biodiversity content knowledge unit (linking specific aims to assessment activities).

What the unit developer emphasized in the interview was the strong link between teaching methods and assessment. *"You can use assessment to actually teach. It's one of the things I think came through quite strongly. You try to build your teaching activities and your methods around the way you are going to assess".* (ID)

A reference list was provided for all the units, together with appendices required for the activities. A four-part, practice-based assignment also forms part of the training manual. The assignment is designed in a way that allows for subject specific application and for work context. The four parts of the assignment are: know your learners, know your subject, improve your teaching practice and improve your assessment practice. Appendices are also provided to facilitate completion of the assignment.

From the analysis of both the CAPS and Fundisa for Change training materials, parallels were seen indicative of the Biodiversity units developers having worked closely with CAPS in the development of their materials (AM 1).

4.5 Teacher contextual profiling

A contextual profiling questionnaire was given to teachers to complete prior to the start of the workshop. Teachers' responses are tabled below.

Table 4.5 Teacher profile

Teacher	Qualifications	Teaching experience	Experience in teaching Life Sciences
T1	BEd[Hons]	20 years	15 years
T2	STD & FDE	16 years	16 years
T3	BEd[Hons]	14 years	14 years
T4	SPTD & ACE (FET:M1)	17 year	1 year
T5	BSc Physiology & PGCE (2011)	1 year	1 year
T6	Electrical engineering	7 years	2 years

The results below are for all the teachers who attended the first workshop

Table 4.6 Teachers' rating of their understanding of environment and sustainability concepts

Concepts:	Strong, completely adequate	Not bad, but needs improvement	Weak, needs strengthening
Ecosystems	1 (T1)	5 (T2-T6)	
Please comment on your rating:	Personal interest and enjoyment of environment (T5)		
Biodiversity		6 (T1-T6)	
Please comment on your rating:	Very little experience, self-taught (T5)		
Nature & People		6 (T1-T6)	
Please comment on your rating:	Little teaching experience (T5)		
Taxonomy		3 (T2, T4 & T6)	3 (T1, T3 & T5)
Please comment on your rating:	There is room for improvement (T4)...little teaching experience (T5)		

The results above indicate that teachers have more confidence in teaching certain topics in the curriculum than others. Previous Biology syllabuses, prior to 1994, show that teaching of ecosystems was part of the syllabus hence three of the teachers would feel confident to teach it considering their experience of teaching Life Sciences as indicated in table 4.5 above. Taxonomy and biodiversity are new content knowledge which teachers had never been taught in their high school education, or when they trained to be teachers.

Most of the teachers have never attended a workshop that focuses on environmental topics. One of them (T1) has been exposed to environmental themes through her involvement with eco-schools. One of the teachers (T6) has received exposure to environmental issues through film shows and talks, wilderness trails and hikes.

The teachers chose to participate in the pilot because they wanted to improve understanding of some of the concepts so they can teach effectively and with confidence (T1). They wanted to improve and develop their teaching (T6). Some said that they wanted to equip themselves with better knowledge so they can teach with passion (T3). They wanted to gain more insight (T4), to enrich themselves with current knowledge and stay updated (T2), be energized so as to enthuse learners as well as to network (T6). Mention was also made of wanting to learn more strategies to teach learners about biodiversity and sustainability, and make content more practical for learners.

Table 4.7: Teacher constraints and enablers in working with environment and sustainability content knowledge in the teaching of Life Sciences.

Critical realism concepts	Constraints	Enablers
Event	1. Lack of confidence in working with environment and sustainability content knowledge	1. Confidence in working with environment and sustainability content knowledge
Mechanisms	1. Content referenced curriculum after having taught an outcomes based curriculum 2. Inadequate teacher training 3. Inadequate orientation to new curriculum 4. Constant curriculum change since 1996	1. Training that develops content knowledge, pedagogical skills and academic competence
Structures	1. Department of Basic Education 2. Institutions of higher education	National Teacher development Network (Fundisa for Change)

Events are what can be observed as they happen. Critical realists pay attention to those accounts that produce or reproduce the sequence of events. They also inquire about non- occurrence of events when they are expected to occur in order to get insight into what could have been the hindrances (Easton, 2010).

In this study, teachers lacked confidence in working with the environmental discourse in the Life Sciences, although the discourse is explicit in the curriculum. Teachers in the pilot have never been offered or attended a workshop addressing environmental concepts. Environmental knowledge is knowledge they never engaged with when they themselves were still learners and when they were training to be teachers. The orientation workshops they have attended as each curriculum was revised have always been generic and not subject specific, therefore no content knowledge has been covered in any depth. Nsubunga (2009) found in her study that a subject advisor who had run Life Sciences workshops for teachers had no environmental education background or experience in running environmental training workshops. The focus of the workshops was to meet the regulatory requirements of the curriculum, rather than to promote environmental education.

Some teacher education programmes also do not offer modules in environmental education. One of the teachers who completed her PGCE in 2011 also had not received any environmental education from the institution where she did her study. These factors have constrained teachers' ability to work with environmental discourse in teaching Life Sciences.

4.6 PRF: Pedagogic discourse (presentations)

Three workshops were run, totalling five days of observations. The first workshop ran over two days, on the 21st - 22nd of May 2012, the second was conducted on the 19th – 20th of July 2012 and the third and last a day workshop on the 12th of October 2012. I attended all the workshops to get insights into the recontextualising process and activities in the teacher development programme. I describe these in detail in this section.

Table 4.8 Fundisa for Change training programme

21 – 22 May 2012	19 – 20 July 2012	12 October 2012
<p>Day-one programme activities introduced teachers to:</p> <ul style="list-style-type: none"> •programme, its objectives; •contextual evaluation questionnaire; •programmes' its focus on the environment, science, society & sustainability; •the nature of scientific, environmental and sustainability knowledge (knowledge generation in the sciences, complexity and contestability and uncertainty of environmental and sustainability knowledge); • teaching methods and processes that support change-oriented learning; • assessment practices as per requirement of the CAPS and how they relate to the specific aims of Life Sciences; • introducing teachers to biodiversity key concepts (biomes & taxonomy) they need to teach across grade 10-12 in the CAPS and how to teach them; and • fieldwork. 	<p>Day-one programme activities:</p> <ul style="list-style-type: none"> •teachers give feedback on part 1-2 of assignment task •Teachers are introduced to exemplar on assessment 	<p>Programme activities:</p> <ul style="list-style-type: none"> •Overview of the two previous sessions •Review of assessment practices •Review of assignment part 1 & 2 •Discussion of assignment part 3 & 4 •Workshop overview & evaluation
<p>Day-two programme activities introduced teachers to:</p> <ul style="list-style-type: none"> • role of biodiversity and how to teach it; • human impacts on biodiversity and how to teach them; • emerging responses for biodiversity impacts and how to teach them; • assignment tasks • evaluation questionnaire of the two-day workshop 	<p>Day-two programme activities:</p> <ul style="list-style-type: none"> •Teachers revising teaching methods •Continuation on assessment •Teachers introduced to resources they can use for teaching •Discussion of part 3-4 of assignment task •Teachers complete evaluation questionnaire 	

A background has already been provided about the site (see section 1.5). Fifteen teachers were in attendance and three workshop facilitators. Introductions were made, each teacher giving their name and why they were attending the workshop. The facilitators were introduced and I was introduced as a researcher, a master's student and a Life Sciences teacher.

During the welcoming and orientation by one of the facilitators it was made clear to the teachers that the workshop was creating an opportunity for both the teachers and the facilitators to learn from each other and that the teachers' input would be appreciated,

"So you are the first people within South Africa who are running the course. Now that gives you some opportunities to tell us where we are going wrong... It is what I want you to remember today and tomorrow, that it is not us training you; it is a bit of us training each other. So bear that in mind so that at any stage if you have anything to add please do so and if at any stage would like to give just a little bit of insight do so. We would, we are here to learn as well". (F1)

The objectives of the course were given to teachers, which were to help teachers to become more competent and confident so they could teach better. A brief overview of the units and their significance for teachers was explained, and teachers were informed that they were expected to complete an assignment. Teachers were invited to share their workshop objectives (F1).

A second facilitator (F2) gave a detailed overview of the course. The presentation started with giving the context/framework that would be used to explore the concept of biodiversity in the wider context of environment, science, society and sustainability, which is the broad focus of the Fundisa for Change programme (appendix M).

4.6.1 Know your subject

This presentation began by highlighting to teachers that the subject they were teaching was Life Sciences, which meant that they had to think about it in the context of science, and that they should not lose sight of that when dealing with biodiversity content knowledge. It was also emphasized that one of the objectives of the course was for teachers to know and understand that biodiversity is in the curriculum that they are expected to teach, and for them to recognize that the course, besides being a competency-rich course,

was also content-rich so that teachers could deepen their understanding of what they were teaching (F2).

Reference was also made to the concerns about South Africa's poor performance in international tests on literacy and numeracy, which is linked to the quality of teaching and learning in the country's education system. The facilitator referred back to the triple challenge that teachers are facing (see section 4.3.3.1), adding that knowledge is contested particularly when people have to make judgments on how to use resources. People cannot be told what to do as there are not necessarily definite answers into our practices. People therefore need to adapt accordingly, drawing on scientific knowledge (F 2).

The issue of environmental knowledge and its characteristic of being uncertain, changing and complex was discussed (see sections 4.3.1 & 4.4.3.1), noting that the knowledge people need is not all found in textbooks. It was said that nobody knows everything there is to know and that some information is misleading, hence research and scientific understanding is important in order to be aware of and understand problematic solutions that science tries to bring. A case study is cited of a bigger problem created in solving an existing problem (F2).

One of the teachers (T4) brought up rhino poaching as a theme that is prominent in the media and how there was a feeling that rhino horns should be legally harvested. Teachers were encouraged to be researchers and to teach learners to be researchers as well, particularly when addressing ethical and controversial societal issues like rhino poaching as these questions and issues are complex and are not necessarily addressed in textbooks (F2).

Teachers were also informed that they need to be aware of what biodiversity content knowledge is covered in grades 10 – 12 to ensure knowledge progression and the interconnectedness of concepts. It was seen as important to build a conceptual foundation between grades, identifying the links in order to prepare the lower grades well for the next grade in a quest to improve quality and depth of knowledge (F2).

The next activity teachers were asked to do, under the theme of knowing your content knowledge, was to match terms to definitions. They worked in groups and reported back, answers were written on a flipchart (F1).

The next activity was called '30 seconds' and the teachers went to the facilitator (F1) at the back of the room and looked at a South African map for 30 seconds and then had to draw what they saw on a flipchart in front of the room. This particular activity did not go as planned. The map that teachers were looking at showed colour coded biomes found in South Africa. The teachers spent a lot of time drawing the outline of the map without drawing the biomes. The facilitator (F2) acknowledged that her instructions might not have been clear enough for the teachers. She then told the teachers what she had expected them to do. This created an opportunity to discuss reasons why learners sometimes do not perform as expected when they are given tasks. The discussion emphasised the importance of giving clear instructions. The atmosphere that had been created from the onset allowed for the facilitators and teachers to be in a safe space to openly share their ideas.

4.6.1.1 Definitions of key concepts

This presentation introduced the *biomes*, which is a key concept relevant for understanding biodiversity. The facilitator (F1) started by giving the names of the biomes in South Africa and asked teachers to indicate something they knew as special about any particular biome. Teachers participated actively and gave responses that were correct. They were then asked to use a South African map with all the biomes on it, to identify the biome in which they lived and worked. They were able to identify that they were in a grassland biome. The facilitator (F1) said she would not dwell much on the definitions of the different biomes as that information could be found in textbooks. This was an indication to teachers that textbooks were a resource they can use to find information. She invited teachers to ask questions they were concerned about regarding biomes. Teachers did not ask any questions.

4.6.1.2 Taxonomy

Teachers were given 5 minutes to find the section on taxonomy from the CAPS document. The facilitator (F3) encouraged teachers to become familiar with the CAPS document, remarking that when they know what the requirements are, they are in a better position to elaborate what is in it. She proceeded to define what taxonomy is and asked teachers to tell her how it is defined in the CAPS document. She then asked teachers to trace progression in the concept of taxonomy from grade 10 – 12. She reflected that understanding taxonomy

taught in grade 10 will enable learners to make comparisons between aquatic and terrestrial organism required in grade 11, thus emphasizing the importance of progression across the grades (intra-disciplinarity). She then referred teachers to the taxonomy section in the Fundisa for Change to explain the taxonomic ranks but admitted that she herself did not know much about the rank domain. She linked the genus name *Homo* with the teaching of the history of life on Earth, a topic teachers will teach in the fourth term (intra-disciplinarity), and gave the historical taxonomic classification.

She then introduced teachers to identification guides that are used to identify species. Each group of teachers was given a field guide and they were asked to look for any species and share the information given about it and to find other species in the guide that share similar characteristics with that species. The teachers were able to identify from the identification guides which species came from the same family but differed in terms of genus.

4.6.1.3 Role of biodiversity

The facilitator (F3) started the presentation by asking teachers what types of plants are found in biomes, particularly the grassland biome. The discussion proceeded to the use of the plants. The facilitator made the comment that without grasses none of us would have had breakfast. This links with the teaching of 'Molecules for Life' in term one in CAPS Grade 10 (see sections 4.3.1 & 4.4.3.2.2). She then asked each of the teachers what they had had for breakfast, then traced all the meals to grasses directly or indirectly. Then she asked if they had known that they were grass eaters. The discussion was to emphasise the importance of grasses and the services that biodiversity rendered to human beings. This was useful for the recontextualisation of knowledge, particularly for teachers who worked and lived in the grassland biome.

A brief discussion on biomes and ecosystems followed, and it was noted that many ecosystems can be found in a biome. Clarity was established between the definition of a biome and an ecosystem. This clarity arose from a question that was asked by one of the facilitators (F1), asking the difference between an ecosystem and a biome. One of the teachers (T1) responded that biomes consisted of ecosystems. This was further developed when the facilitator (F1) asked if the same ecosystem could be found in different biomes.

This brought silence for some time from the teachers and only the facilitators (F1-F3) tried to bring a distinction between the two concepts. F3 explained that a wetland could be found both in a forest biome and in a grassland biome but that to be sure which biome that is, one had to identify the major type of vegetation, climate and animal life that is found in that biome. F1 mentioned that knowledge is always contested and that even experts debated amongst themselves.

4.6.1.4 Human impacts on biodiversity

The facilitator (F2) referred teachers to the Fundisa for Change materials on biodiversity section in the text on factors that were drivers in environmental concerns. She invited teachers to mention things that they think impact on biodiversity. There was silence for some time. F2 talked about the changing landscape and asked how a changed landscape affects the services that biodiversity provides. Teachers were then able to recognize that habitat change impacts on biodiversity and the services it renders. One of the facilitators (F3) mentioned that natural vegetation provides more services than a changed landscape. Discussion then ensued on what people do to change the land e.g. agriculture, industry, pollution etc. Teachers were actively involved in the discussions. The facilitator (F2) then linked habitat change to overconsumption and overpopulation. She said that overconsumption is linked to the issue of needs and wants but she also highlighted that impacts are complex issues as they affect people's livelihood and that issues are not simple. She encouraged teachers to explore all sides of an issue they were inquiring about. When asked what resources people overconsume, one teacher (T6) mentioned that water is over consumed through cooking and washing. The facilitator explained that overconsumption deals with unreasonable use of resources without denying people the possibility of making a living e.g. eating endangered animals. One of the facilitators (F1) in clarifying the point of overconsumption defined overconsumption as when people take more than they require, *"people require x but take x and y."*

Teachers then did an activity where they read South African case studies which were appendices in the FfCCU, and tried to identify what the issues were and how they impacted on biodiversity. Teachers worked in groups and gave feedback.

4.6.1.5 Emerging responses to environmental issues

The facilitator (F4) started off by giving teachers pieces of paper that had the factors that impacted on biodiversity. She made links with the previous presentation and built on it. Teachers in groups had to take one of the factors they had discussed in the previous presentation on impacts (see section 4.6.1.4). She then used a power point presentation and pointed out that it had been taken directly from the Fundisa for Change biodiversity content unit, and asked teachers to think about how the impact of education can be measured i.e. its effect on controlling biodiversity loss. She also emphasised that people need to be aware of what is under threat in order to make appropriate legislation and that people also need to balance biodiversity concerns with economic development. She also made mention of the importance of skills development in municipalities so that biodiversity challenges can be properly addressed. The facilitator encouraged teachers to recognize that responses are not beyond people's capabilities. This presentation elaborated what is in the curriculum as the responses she talked about (see section 4.4.3.2.4) are not made explicit in CAPS, in terms of the positive impacts people have on the ecosystem.

4.6.2 Improve your teaching

Another facilitator (F1) started this off by asking teachers to identify the teaching methods used by the previous facilitator who had covered 'knowing your subject'. The discussion centred on the rationale for using a variety of teaching methods. The main factor discussed was learners' different learning styles and use of diversity of methods allowing for a variety of educational purposes and outcomes to be addressed. The facilitator referred teachers to the FfCCT materials and the three main teaching methods it advocates (see section 4.3.3.1). She then proceeded to ask teachers if they used those methods in their teaching Life Sciences and how often they used them and how they used them. One of the teachers reflected that she used numbers when learners work with interpreting graphs. The facilitator also encouraged teachers to read, as that makes a difference to their own abilities.

Each teacher was given a 'Methods and processes to support change-oriented learning' resource book (Rosenberg, O' Donoghue & Olvitt, 2008) that provides a variety of teaching

methods teachers may use in teaching environment and sustainability content knowledge. This was accompanied by a power point presentation summarizing what is in the book to provide orientation to, and clarity on the methods. The facilitator first asked teachers to share what they thought was meant by each method and then explained some of the teaching methods that teachers find less familiar e.g. deliberative methods, and elaborated on the activities that go with each of the methods. Teachers in groups were then asked to choose a method from the methods book and to report on how they used it and to provide advantages and disadvantages of the method. Teachers reported back and the facilitator invited teachers in other groups to give input, after which she summarized and added further input. She also informed teachers that teaching practices would be linked to content knowledge in the subsequent sessions.

4.6.2.1 Teaching practices for biodiversity concepts

The facilitator (F1) asked teachers how confident they were in teaching biomes. This was met with silence. One of the teachers (T1) finally said her learners got confused with the details about the different biomes because they had no prior knowledge about them and as such it was difficult to teach biomes. The facilitator repeated that the workshop was to ensure that teachers could be confident in teaching biomes, and asked teachers how they had taught it in the past. None of the teachers were willing to share, but instead another teacher also said she had problems teaching it.

One of the facilitators (F2) said she would start by asking where they were and in which biome that was, then ask if they recognized natural vegetation that could give clues to the biome in which they live, or bring a species to school or take a photograph using their phones then use that to identify the biome in which it is found. After this the teachers could extend from the local to other biomes, pointing out what is special about each biome - e.g. mentioning that the national flower is found in the *fynbos* biome.

The facilitator (F1) leading the session explained to teachers that it is not always possible to take learners to things they do not know or to find pictures for those things but that teachers need to find ways of teaching something that learners have never seen. "*We do not need to have gone to Cape Town to teach about fynbos.*" She rather advised teachers to ask

themselves what they *do* teach instead of being stuck in the concept. She said the requirement from the curriculum was on what a biome is, not just talk about fynbos. She asked teachers to look at exam papers to see how biomes are assessed. Another facilitator (F3) said teachers could look at the biotic and abiotic factors that characterize a particular biome i.e. conditions that have resulted in these distinct biomes.

The lead facilitator (F1) for the session criticized the curriculum for its strong framing (see sections 2.2 & 4.3.2) for specifying what should be taught and when, as this is limiting, *“that’s why sometimes I have a concern when CAPS says you will learn this at this week I’m concerned that we cannot actually do this progression too easily and I’m worried if we make it too complex we might get lost in the process”*.

Another facilitator (F2) wanted to know from the teachers why there was a need to understand biomes and subsequently biodiversity. Teachers kept quiet for some seconds thinking about it and some suggestions were to understand why other things are found in some areas but not in others and so environmental impacts could be understood. The facilitator (F2) then added that there is a need to understand how biomes contribute to human well-being and by understanding how special they are, a sense of ownership is built when it is realized that biomes have cultural and spiritual links for people. When this is captured in learners the idea of biomes will make sense to them.

The lead facilitator (F1) for the session encouraged teachers to speak up when they had concerns, as the discussion on how to teach biomes had also helped her to get new ideas of teaching biomes.

4.6.2.2 Teaching taxonomy

The facilitator (F3) gave teachers an extract from the FfCCU (p. 20) and asked them to draw a diagrammatic representation indicating the taxonomic rankings. She then introduced teachers to dichotomous keys used to identify species, provided teachers with the activity sheet below and asked them to match the shape numbers to the appropriate names in the flow diagram. She did the first one with the teachers.

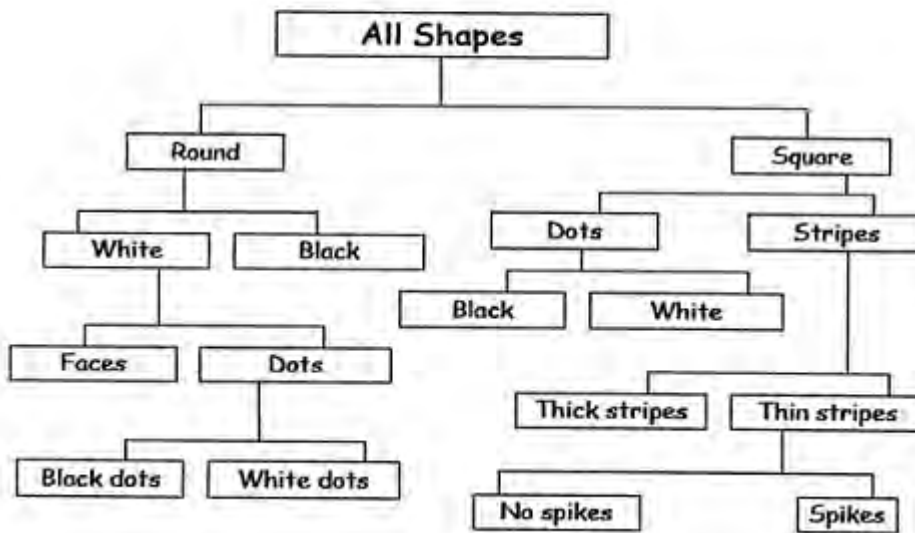
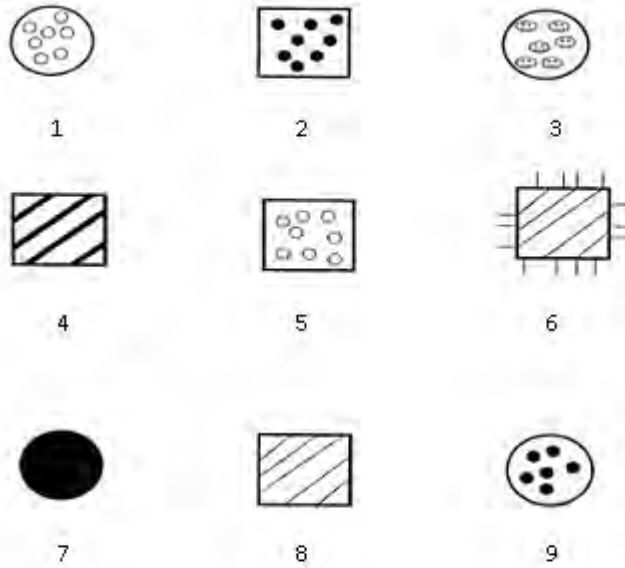


Figure 1: Taxonomy activity sheet

The narration below explains how this was used with the teachers

Facilitator: Do you understand the instructions, should I repeat? Let me do the first one as an example. Is it round or square?

Teachers: Round

Facilitator: Therefore look at round and forget the square. Does it have white or black dots?

Teachers: White

Facilitator: Forget the black part. If it's white does it have faces or dots on it?

Teachers: Dots

Facilitator: Therefore ignore the faces. Does it have black or white dots?

Teachers: White

Facilitator: So we know it's round with white dots. Then classify the others as a practice in classification, do the same for the other shapes.

Feedback was done collectively. Teachers asked for a hard copy of the activity sheet as this activity was done as a power point presentation.

Teachers were each given a leaf by one of the facilitators (F2), who then asked them to indicate by raising their hands if they recognised it. Only one of the teachers raised his (T2) hand. The facilitator (F2) then used a field guide to trees of Southern Africa (Van Wyk & Van Wyk, 1997) with a dichotomous key to facilitate its identification. Teachers were uncertain about some of the concepts used in the classification e.g. differentiating between a simple and a compound leaf. The facilitator then explained the concepts she was using to classify as she went along until the leaf was successfully identified.

Teachers were encouraged to use the same kind of activities to teach taxonomy. Teachers were then taken on a fieldtrip within the sites' grounds and were asked to carry the grassland field guide from Share-Net in case they wanted to identify something. The site was at the side of the road and one of the facilitators (F1) pointed that out, adding that a fieldtrip could be as simple as going to the side of the road.

Teachers were asked to collect as many different types of grasses as they could find, and to think about how grasses can be classified. They were asked to give attention to what differentiates them from each other in terms of the species, and to use the field guide to identify the grasses. They were also asked to think about the importance of the biome in which the fieldtrip was located (grasslands), its relationship to people, and why it should be managed and conserved. Teachers were also asked to think about what other Life Sciences concepts could be taught in an integrated way by just visiting one place. A report back was scheduled to be done the next day. Teachers then went off in groups to collect the grasses, commenting that they were concerned about snakes.

An overview of the previous day's activities was done before the feedback discussions on the fieldtrip. Teachers kept silent when asked how they were able to decide whether what they had collected was a grass species or not. The facilitator (F3) told the teachers the characteristics used to identify grasses. Some of the teachers had collected any plants they had seen in the field: not all were grasses. She then showed teachers how they could have used the field guide to identify different species of grasses.

4.6.2.3 Teaching roles of biodiversity

The facilitator (F3) then referred teachers to a case study that was in the FfCCU (p. 23) which was about different food farming practices. She asked teachers to read it and to share how they would use it in their teaching, what topics they would use it for and the teaching methods they would use in working with the extract. She also asked them how knowledge could be expanded from the extract. Teachers were able to make links with topics in the curriculum and to give relevant teaching methods and how the text could be expanded. One of the teachers (T3) said she would use it to teach about nutrition and a balanced diet. Another (T1) mentioned that she would use it as a case study but did not elaborate. The facilitator (F3) mentioned that as a case study it could be used to develop vocabulary, teach learners to read and write for comprehension and to teach language. It was important to mention that it would teach language as the curriculum requires that all teachers should be language teachers (see section 2.11). This comment from the facilitator indicated that she is aware of the curriculum requirements, although she did not make it explicit to the teachers that her comment was informed by the curriculum. The facilitator (F3) also mentioned that the case study could be given to a language teacher for integration. The teacher (T1), who is an eco-school coordinator, shared how she uses the vegetable garden and the school grounds to teach biodiversity. The facilitator (F3) then encouraged teachers to use local case studies to teach. T3 added that in extending the knowledge she would teach about deficiency diseases linked to lack of variety in diet. The discussion touched on indigenous knowledge systems when the facilitator mentioned that learners could investigate farming methods used in the community. This linked well with the principle of valuing indigenous knowledge systems as a principle in CAPS (see section 4.3.3.1).

The facilitator mentioned that no monetary value had been put on the value of the services our ecosystems provide, as each biome has something to provide, and noted that allocating monetary value to ecosystem services could encourage proper management of the ecosystems. She discussed all the services (see section 4.4.3.2.2) provided by biodiversity, using examples from everyday life and indigenous knowledge systems - e.g. she mentioned that the forest biome provided antibiotics like penicillin that some traditional medicines are harvested from forests, and that grass is also used for thatching.

Teachers were given an activity to do, where they had to read a fact sheet on wetlands, an appendix in the FfCTU (p. 53) and then drew a mind map illustrating the different services provided by wetlands. Teachers were also given a booklet on ecosystem services (Share-Net Resource). Teachers were encouraged to add information about a specific wetland in their area.

4.6.2.4 Teaching impacts on biodiversity

One of the facilitators (F2) asked teachers if they do teach about loss of biodiversity, in which grade and how they taught it. Only one teacher (T1) admitted to teaching it and explained that she used case studies from magazines. Some then also mentioned they used textbooks in teaching it. The facilitator (F2) encouraged teachers to use case studies to have variety, mentioning that different case studies tend to have different opinions about the same issues. This highlighted the notion of knowledge being contested. Discussion arose again about teaching something learners have never seen, and the facilitator advised that teachers use a habitat accessible to learners and make reference to other habitats but to do something within the realm of learners' experience.

"It is fantastic to be able to touch, feel and see. What's important is to choose another habitat that is accessible to them, e.g. a wetland in your school...do next best thing and find a similar case study. I have given you a variety of case studies and you can find one that you can relate to, so look for different case studies and bring in pictures." (F2)

One teacher reinforced the importance of using learners' local environment, as learners know what is in their environments and how to work out solutions for local issues. This highlights the difference between vertical and horizontal knowledge (see sections 2.2 & also section 5.2) and how horizontal knowledge, which is concrete, enables the contextualisation

of the abstract vertical knowledge. The curriculum encourages teachers to contextualise (see section 4.3.3.1).

“There are some issues in their [learners’] community, you [a teacher] must move into their [learners’] community because when we [teachers] talk about sustainability or destruction of biodiversity, they [learners] will say things like, ‘we have a forest near our house, we use wood and we use electricity, what do you say? Are you saying we must take one log and burn it?’ I was quite interested yesterday when you [facilitator 2] said, it was discussed that it’s them as a community to decide how can they use what is available maybe for next year than to dictate to them.” (T7)

The facilitator then shared a Malawian case study, where community members decided to plant wood lots in the community as they felt they walked long distances to find firewood. The community then monitored the plantation and only small branches were cut off from the plant. This reinforced the idea that communities can come up with solutions to their environmental issues.

4.6.2.5 Teaching responses to biodiversity impacts

The facilitator (F4) started the session with an activity. Teachers in groups were given a piece of paper that had one of the factors that impacted on biodiversity. She used the previous presentation on the impacts on biodiversity as a starting point and built on it. This was important in showing progression from one lesson to the next. Teachers were asked to discuss ways in which responses could be made for each of the factors (see section 4.4.3.2.3). Teachers were encouraged to draw on what they could have heard or read. They could also talk about initiatives they might have introduced or could do in their own schools or local communities as a response to addressing the impacts.

“Biodiversity is not only about doom and gloom, this is the gloom, there is a brighter future. You are aware of the responses to pollution. How have people tried to overcome the issue or deal with the challenge? Let’s not talk from hearing only, let’s talk from real examples that we know of. What have you seen happening in your community, what have you done in your community?” (F4)

The facilitator wanted to emphasise that teaching biodiversity is not only about the problem but also about how to resolve such problems.

One of the facilitators (F2) gave them a hint to think about scientific responses (good or bad) to environmental issues that were discussed the previous day. Teachers reported giving different examples e.g. pollution is addressed through clean up campaigns, use of unleaded petrol, posters or community protests against polluting industries, selling of plastics or using recycled bags etc. All the groups presented and responses were written on a flip chart. The facilitator (F4) summarized ideas after every report back.

Another group mentioned that population increase has a negative impact on natural resources as there are child-headed homes (loss of nuclear family) who rely on social grants. They also raised issues of HIV/AIDS and learners dropping out from school because they can't afford school. But the teachers did not explain how these social issues impacted the natural environment. This was pointed out by the facilitator (F4).

"Think about the long impacts of these social issues and how they find expression in biodiversity impact in the long run or not. Will there ever be a link between these two? That is something to package and think about" (F4)

The facilitator (F4) also advised teachers not to be alarmed by statistics linked to population explosion; a term which she said was used by environmental alarmists, but instead to think about its impact on biodiversity. *"As Life Sciences teachers think about, what are the impacts of the 9th billion person being born? What does it mean for our natural support system as we know it?"* (F4)

4.6.3 Improve your assessment practice

In preparation for this presentation, the facilitator (F3) brought CAPS curriculum documents for teachers. In introducing this unit she asked teachers to open both the FfCCT and the curriculum document at the assessment section. This was to highlight that the assessment component of the FfCCT was extracted from CAPS.

In her introduction she asked teachers how they felt about assessment and why assessment was an important component. One of the teachers (T4) reflected that he used assessment as a yardstick to measure his learners' performance, and as measurement of how well he transferred knowledge to his learners. The facilitator advised teachers to constantly be

thinking about assessment and to familiarize themselves with the CAPS document in order to know what the requirements are for assessment. She also mentioned that assessment enables the teacher to identify challenges learners are facing so that teachers can adjust their teaching and look at different strategies to enhance the teaching and learning process. She also emphasised that assessment helps to build learners' conceptual understanding as through assessment teachers can see conceptual progression.

She then gave a power point presentation based on information taken from the CAPS document. She gave page numbers from CAPS document, emphasizing that *"sometimes we are very critical of the Department of Education but CAPS is very very thorough"* in guiding teachers on how to assess. She then asked teachers to work in pairs and discuss assessment tasks they had given to learners and to decide whether those tasks belonged to the category of assessment 'of' learning or assessment 'for' learning. During the reporting back she asked teachers who had not said anything to give input. She asked questions throughout as teachers were reporting back, e.g. how did you decide that the task is assessment 'of' learning or assessment 'for' learning? She informed teachers that when a test is evaluated for remedial purposes, if it leads to a teacher changing their teaching method it can be classified an assessment 'for' learning task. She shared that tasks fall under assessment 'for' learning tend to be informal and on-going and she gave a detailed analysis of the difference between the two forms of assessment.

She encouraged teachers to *"reflect on your own practice, think about what you are currently doing"* She proceeded to read from the CAPS to familiarize teachers with the programme of formal assessment. Then she explained the specific aims of Life Sciences (see section 2.11) and drew parallels with the three units of the course. She emphasised that it is Life Sciences because what is taught and learned in Life Sciences needs to be applied in life. *"As Life Sciences teachers you need to be aware of the aims of Life Sciences and know why you teach, i.e. the aim of what you are doing, where you are trying to get to with everything you are doing"*.(F3)

She also drew the teachers' attention to the weighting in terms of marks allocated to assessing particular topics. She informed teachers that it provided guidance on the amount of time they need to spend teaching a particular topic. She gave teachers a take-away task

to look at terms 3 & 4 in grade 10-12, and to look at the assessment for achieving specific aim 1 & 3, focusing on the cognitive skills required by referring to the CAPS document. The activity was taken from the FfCTU (p. 8). Teachers were not asked to report on what they had done, therefore no feedback was given for this activity. This activity could have been valuable for teachers. It could have allowed them to think about how they assess and how assessment should be integral as they plan their lessons.

In the second session (July) the facilitator (F3) gave an overview of the discussions pointed to in the first session (May) and used the same power point presentation to refresh teachers' memories. She then gave teachers an activity in which she wanted them to choose a topic they could teach, provide teaching methods they would use, the activities they would give to learners and the assessment they would use. She gave them a template (shown below) on which to write their planning.

Topic

Content	Methods of teaching	Activities	Assessment

She also suggested that they use the CAPS to investigate assessment requirements. There were two groups, each with three teachers. Teachers reported back and the facilitators (F1 & F3) identified gaps in their presentations and suggested that a revision of the teaching methods the next day was necessary. This is evidenced by the following comment from the facilitator (F3),

“Keep what you have written now to reflect, extend and improve it after tomorrow’s session. You have written some teaching methods now and have written a lot on activities, you have not written activities but ideas. We need to unpack what we mean by activities and methods and activities within the methods...the activity is not speaking to the method.”

Another facilitator (F1) added to the discussion,

“I think there is a confusion between methods, methodology and activities. For an example, there are investigative methods then you need to know what activities that could be conducted as being investigative. It’s important to know why you are doing that, that is, using a particular method or activity. We are going to touch on this again tomorrow.”

Teachers were then given the FfC assessment unit (see section 4.4.3.4) which the facilitator (F1) went through with them, giving a quick overview of what was in the unit.

The next day started with a recap of teaching methods and assessment, revisiting what was done in the first session (May). The facilitator (F1) informed teachers that it was important to recap as it would affect the teachers’ assignment (see section 4.4.3.1). She proceeded to inform teachers that they needed to know why they were choosing a particular teaching method and to know what they were trying to achieve with it.

“The CAPS says ‘fieldwork’ but what does that mean? It’s very easy to say we need to do fieldwork. Does it mean I walk outside and I have done fieldwork? What actual activities are we doing in that fieldwork?...we need to know why we are going out and that process is this..., e.g. it could be a water quality test.”

The discussion then was on the difference between assessment methods and assessment tools. Using a table in Fundisa for Change assessment unit (FfCAU, p. 4), the facilitator (F1) talked about assessment methods and asked teachers how they would use each type in their lessons. Teachers participated actively and gave practical examples, e.g. when asked how they would use questionnaires, one of the teachers (T1) said she would ask learners to draw a questionnaire they would use to ask for indigenous knowledge. The facilitator added that a teacher could use the questionnaire drawn by learners to assess their ability to write questions as learners would have to think of the wording [in asking questions], adding that learners would be learning an important research skill. This links with teachers’ responsibility of teaching language as they teach Life Sciences. *“We are challenging you to learn new teaching systems than what you have previously learned, i.e. to rethink it [teaching strategies].”*(F1)

The facilitator (F1) then made links between CAPS’s weighting of cognitive demands for assessment with Bloom’s taxonomy (Bloom, 1956). The links between CAPS and Bloom’s

taxonomy are made explicit in the FfCAU (p. 6) (see sections 2.11 & 4.3.4). The facilitator pointed out that CAPS has weighted remembering at 40 %, adding it meant remembering is still an important part in teaching and learning. She also said there were different teaching techniques that could help with remembering and building vocabulary. One of the teachers (T2) noted that Bloom’s taxonomy is a hierarchical pyramid starting with ‘remembering’ at the bottom and finishing with ‘creating’ at the top, and commented that it seemed that there was more to remember than to create.

Another facilitator (F3) mentioned that some learners can’t work in an abstract way (see sections 2.2 & 4.3.1) but may remember. Teachers (T2 & T3) agreed and one added that learners need to remember to create, *“You cannot create and write without remembering.”*(T2)

The facilitator (F1) reminded teachers that remembering is what learners have to do first but it is not the only thing they need to do. *“To write a good essay you need to remember some of the words but you are not going to write a very good essay if you only remember, so you need to be able to put more.”*

Teachers then had to take any biodiversity concept and decide on key assessment skills to use to work with the concept. They had the CAPS document and the FfCAU for reference to complete the activity since the FfCAU had made direct links between the concepts, methods and assessment requirements of CAPS. Example shown below:

Table 4.9: Linking Content Knowledge to Assessment Processes

Content Knowledge Section	Section Summary	Assessment Activity Examples from the Methods Section	Key assessment skills (verbs)
Definition of key biodiversity concepts	The concept of biodiversity is based upon the principle of hierarchies and the basic building block is the species. Understanding the levels of biodiversity and the associated terminologies. South African biomes.	1. Review of selected texts on biodiversity to identify key terms and concepts. (Grade 10, 11) 2. Investigation of a local natural ecosystem (Grade 10) [Practical activity]	Define, describe, list, name, observe, recall, illustrate, measure, record (draw)

(FfCAU, p. 7)

The table above shows the content (levels of biodiversity, biomes) that learners need to acquire and the teaching method and activity (Investigation) and skills that could be assessed (LSD, p. 13).

Table 4.10: Linking Life Sciences specific aim 3 to assessment activities

Specific Aim 3	Cognitive skills	Assessment Focus	Examples of Assessment Activities
Appreciating and Understanding the History, Importance and Applications of Life Sciences (Biodiversity) in Society	Understanding the history and relevance of biodiversity discoveries	Learners' ability to identify significant historical events and personalities in biodiversity science	<ul style="list-style-type: none"> Discuss the significance (influence) of the Linnaean classification system in modern taxonomic classification systems
	The Relationship Between Indigenous knowledge and Life Sciences	Learners' ability to demonstrate the relationship between indigenous knowledge and modern biodiversity practices	<ul style="list-style-type: none"> Discuss how indigenous communities classified living organisms in their area and how this has resulted in modern taxonomic/ classification systems Discuss indigenous peoples' biodiversity conservation approaches and compare them with modern conservation practices
	The Value and Application of Biodiversity Knowledge in the Industry in Respect of Career Opportunities and in Everyday Life	Learners' ability to recognise the application of biodiversity knowledge in agriculture, horticulture, genetic engineering, natural resources management, etc.	<ul style="list-style-type: none"> Discuss the roles of biodiversity to ecosystem and human well being Discuss how human activities have negatively impacted on biodiversity Discuss the different human responses to biodiversity issues Critically analyse the causes and implication of elephant crisis in South Africa

(FfCAU, p. 12)

The table above shows how specific aim 3 of Life Sciences can be assessed.

Listening in on one of the discussions on an activity teachers did in the pilot, I found that teachers were able to take a concept and design relevant activities and a method around it (appendix N). After teachers had completed the task, the facilitator (F1) asked the presenters to come to the front and write their plans on a flip chart. She also asked other teachers to give input to the presentations, adding that the activity would feed into the teachers' assignments tasks. Teachers then reported on the activity. Input came from other teachers and the facilitators. Presenters were asked questions both by teachers and

facilitators and were asked to clarify and extend what was presented e.g. below which is also linked to the activity noted above:

T3: *"The content is grasslands. We skipped summary of grassland, we think it will need a textbook. First we decide on knowledge, then methods then assessment. We choose grassland. Learners when they go to fieldtrip, the skills they will develop. They will be able to describe as feedback to the class the type of grassland it is, list plants and animals they found, observe what is there. Knowledge is needed for recall. They can draw graphs from fieldwork information. Activity, investigate local grassland ecosystem."*

F1: *"Out of interest, remember here we are talking about assessment, where do you see the different teaching techniques and the different assessment techniques? Is it very different or very much the same? Does anyone have anything to add to that?"*

T6: *"Add tools for assessing e.g. peer-assessed questions."*

T2: *"Guiding questions."*

T1: *"What tools are learners going to use to identify those plant species...what will they use to compare them?"*

F1: *"How are we going to do this? Taxonomy. Okay now you are taking it one step further, you are saying we must do classification."*

F3: *"We need to be careful of what content knowledge we are meant to be covering in a grassland ecosystem. If you look at what the CAPS says you need to cover, it's not so much about grassland ecosystems, its core content that has to do with biome, biosphere."*

F1: *"So what is it that you actually teaching?"*

F3: *"So you have to be careful that you ground, although you are doing grassland ecosystem as your method and your investigation is based on a grassland ecosystem, it should ensure that you are covering the content that you are meant to be covering. And the content you are meant to be covering are all the other sub lists from the CAPS document".*

T2: *"Do we need to write it down?"*

F3: *"Yes, in your content knowledge you must have it there. You can write grassland but the content I need to cover in grassland is all those list of..."*

The third and last session (October) was conducted by a facilitator (F5) who was also assessing the teachers' assignment task. Teachers in pairs engaged in activities that required them to reflect on their assessment practices. In the first activity they had to write down three things they thought they were doing well. Then they had to write about what they

struggled with. They then had to choose one of the struggles and discuss how they thought they could overcome it.

The next activity required teachers to analyse the cognitive level of the questions they had set for learners, questions taken from an assignment task. Teachers really struggled to change a lower order question to a higher order question, which has implications for their ability to enable their learners to develop higher order thinking skills, especially considering that 15 % of assessment should develop learners' higher order thinking skills (see sections 2.11 & 4.3.4).

4.7 PRF: Pedagogic discourse (assignment task)

Teachers were informed from day one during the orientation to the course that they would be required to complete an assignment (see section 4.6). The assignment was in four parts, which had to be done in parts throughout the duration of the course (see section 4.4.3.5). On the second day of the first workshop, one of the facilitators (F2) explained the tasks teachers had to complete by the time of the second workshop. She explained what each part required of teachers. She also explained why each part was important in enhancing their classroom practice. She also explained that some of the tasks would be challenging for them, e.g. critically reviewing a resource to analyse how it reflects the incomplete and contested nature of environmental knowledge, but which would allow them to step beyond what they normally do, enabling them to think critically and understand complexity of knowledge. From the analysis of the teachers' work (appendix O) it was evident that they could produce text required in the assignment task.

They were told that they would also be doing things that they normally did in their lesson preparation, e.g. planning a lesson.

The meanings of certain words such as explicit and implicit had to be explained to teachers. The phrasing of the assignment was a bit confusing for some of the teachers and clarification was needed. Examples were also provided to demonstrate how they could do certain tasks. They were also advised that they could have a cluster meeting to discuss the assignment or consult a facilitator closest to them between course sessions.

On day one of the second workshop session, the discussion was on the challenges they had in completing the assignment tasks. It was a very valuable discussion because the facilitator (F1) leading the session asked teachers to give reasons why they thought each task formed part of the assignment and why its inclusion was important, as well as how having done each task positively influenced their practice. In the end this allowed teachers to view the completion of the assignment task as a developmental process (appendix L). One of the teachers (T5) reflected that it had helped her with her lessons. *“Part 3 and 4 [of the assignment] was not a waste of time as I did all the lessons. It’s just that my planning was more than it would have been.”*

Teachers reflected that although the assignment was challenging they had learned a lot from it (see section 4.8.1 and appendix L). The facilitator (F1) encouraged them, *“Assignments are an important component to show your learning, but the most important component to me is that at the end of your time with us you have grown your academic and teaching abilities.”*

On the last workshop, teachers received feedback from the assessor (F5) on the assignment tasks they had completed. She gave them a marking rubric that was used to assess the assignments (Appendix P). The rubric had the DELTA environmental centre logo as they were organizing accreditation for teachers for attending the workshop and completing the assignment. Teachers had not been given this assessment rubric when they were given the assignment brief. This made the evaluation somewhat invisible to teachers, but the assignment brief did give clues on what they had to do but was not as explicit as the assessment rubric. Looking at how each question was weighted could have given teachers an indication of where they had to put emphasis in their responses.

General feedback was given to teachers but they were told that they were free to have individual discussions with the assessor. The assessor/facilitator (F5) went through each part of the assignment task, giving specific feedback on what was done well or poorly and going through exactly what her expectations were in each section of the assignment.

Teachers were also told that what had been assessed thus far was a draft and if they wanted to, they could improve their assignment by using the feedback and adding to what they had already written but they still had to submit what had been assessed and the additions they

had made. This would enable teachers to see how they had developed through the programme. I observed only one teacher writing the feedback, the others were simply listening.

In assessing the assignments, the facilitator had written questions and comments at the end of the teachers' responses which were not part of the assignment, but which she said would prompt them to reflect on what they had written in response to their classroom practices,

"That question is not saying you need to answer it but I just put it there for you to think about, 'what does it mean for me and my own practice'? If I know children don't have access to a library and I'm setting them a research assignment, what does that mean for me as a teacher?" (F5)

She emphasized that being aware of what learners were struggling with would help teachers teach in ways that would scaffold learners to achieve the requirements of the curriculum. She wanted teachers to reflect on what the implications were for them in their role as teachers i.e. to **recognise** and **realize** through scaffolding learners well for achievement of curriculum aims. She had also brought in two portfolios from the Geography Fundisa for Change programme pilot so teachers could see how they could present their assignment portfolios and see how other teachers had responded to assignment tasks. Teachers flipped through the portfolios.

In the next section I discuss the positives and the negatives of the assignment task.

4.7.1 Positive emergences

One of the teachers (T5) said, having worked through the assignment, that a lot of the new concepts she needed to teach had been explained. She added that she had learned more about conceptual progression and connections within and across the grades. Another (T1) said that having looked at progression had allowed her to understand the knowledge required in each grade. This sentiment was shared by T2, *"I have learned about the correlation between concepts in the same and different grades."* Another teacher (T3) said she had learned the value of research, and finding resources for teaching instead of only relying on a textbook. T5 said searching for resources for part two of the assignment had made her realize that she needed to encourage learners to read. T6 reflected that the assignment had improved his teaching practices which would benefit the learners he taught.

The assignment encouraged T3 to work with the CAPS document. It helped T1 to have activity ideas she could use to engage with her learners. One of the teachers (T5) felt she had learned a lot through doing the assignment, especially with finding resources, but that she found the work interesting. T1 felt the work she did on the assignment would help her with her teaching. The assignment therefore stimulated them to do research, to work more with the CAPS document and prompted them to think of new activities they could do with their learners.

One of the teachers (T5) felt that what they did could be used in their lessons, although they had not expected so much output from their side. She added that she knew she was not wasting her time as what she did in the assignment was preparation for what she had to teach in term 3. She further said she actually made use of the tasks she had prepared for the assignment in her teaching. This was important that teachers realized that the course and the tasks they had to do formed part of their normal teaching practices and were not an added burden on their already overloaded schedules. T6 said looking for resources had enabled him to integrate knowledge across subjects.

In completing part one of the assessment tasks, one teacher (T1) reflected that she was able to identify gaps in the content that their learners brought into class from grade 9, which is important for them to know as it has implications for the content they need to teach in grade 10. Another (T2) added that it also enabled him to identify assessment activities his learners struggled with - e.g. scientific method (writing a hypothesis), another mentioned (T1) data analysis, which also has implications for the teaching methods they choose and the assessment activities in which they engage learners in order to enable them to acquire those skills. This helped teachers to understand the kind of learners they are dealing with.

T6 also felt that doing the assignment in parts and then reviewing what had been done in the next sessions prepared her well for the next tasks.

4.7.2 Challenges with assignment

One of the teachers (T3) felt assignment tasks should be reduced to one or two as she had a lot of work that she was doing in her school. Another teacher (T1) said she had struggled to find resources to do part two of the assignment tasks. She added that the assignment was

challenging, it required a lot of research and was stressful and that at one point she had considered quitting but decided against it as she felt the course was helping her with her teaching. Another (T5) felt anxious due to the time it took to complete the tasks. One teacher (T3) mentioned that she did not have enough time to complete the tasks because of many other pressures on her time.

4.8 Emerging issues

There are also some issues that emerged from the analysis of discussions with teachers and from their written responses to questionnaires and evaluations. As these influenced the recontextualisation process in the PRF, I provide an overview of them below.

4.8.1 Logistics and model of delivery

In the first workshop there were 15 teachers attending. In the second workshop that number had gone down to six. Some of the teachers stayed away because they had not done the assignment tasks. This was reported by their colleagues who were at the workshop. One had to attend a cluster meeting on day one of the second session but still stayed away on day two. In one school the DoBE wanted the teachers to stay at school and teach as they were identified as an underperforming school. One teacher was busy with grade 12 learners, and school administration. The rest disregarded efforts (emails and text messages) to contact them.

Being away from school to attend the workshops was a concern for one of the teachers (T5) as her learners were left unattended during her absence but there never seemed to be a perfect time for having the workshops. One of the teachers (T3) was required by the DoBE to teach on Saturdays because her school had been identified as underperforming. One teacher (T4) mentioned that the gap between contact sessions was too large and suggested small sessions in between the contact sessions to help with assignment tasks.

Only two teachers (T1 and T5) were ready to submit their assignment tasks at the second contact session, and two more (T3 and T6) managed to submit between the first and second session. By the third session only four had managed to have their assignments assessed and feedback given to them. One of the teachers (T2) had his first assignment tasks ready for

assessment. Only one teacher had still not completed the tasks given in the first workshop. By the end of the last contact session the same two teachers (T1 and T5) who had submitted their first tasks submitted the last tasks of the assignment. The rest were given a deadline for the 15th of November 2012 to submit.

Teachers got to see the assessment rubric used for assessing their assignments only after they had been assessed. It might have been worthwhile to have given this at the same time they received the assignment brief.

4.8.2 Resources

Besides the Fundisa for Change units provided (see section 4.4.3), use was also made of additional resources to extend teachers' competence and knowledge, e.g. they were given a book titled *Methods and processes to support change-oriented learning* (Rosenberg, O' Donoghue & Olvitt, 2008) to introduce them to different teaching strategies. Teachers also worked with field guides and materials from Share-Net (see section 4.6.2.2). Teachers were also given different issues of *Environment* magazine which they could use in their teaching.

Another resource used was a booklet titled *Perceiving and visualising ecosystem services* (Share-Net Resource) to strengthen the teachers' understanding of the role of biodiversity. What was most significant about the Fundisa for Change Biodiversity unit was that one of the teachers (T3) said they were advised by their district official (Subject Education Specialist, previously known as subject advisors for Life Sciences) to use the FfCCU as a reference when they order textbooks that they would use with their learners, as it was relevant and showed concept progression. Previously teachers just ordered any textbook which sometimes turned out not good enough (see section 4.4.1) but could not return it or buy another since the money to buy the books came from the school funds. From personal experience, teachers are expected to order textbooks before they have been orientated to a new curriculum. This makes it difficult to make an informed decision on the appropriateness of a textbook.

According to a report by DoE's LSM initiative in support of the provincial DoE (1999, quoted in Czerniewicz, Murray & Probyn, 2000), a wide range of books is available to teachers, but selection by teachers is a problem, because not enough time is given to teachers to make

informed decisions, teachers have not been trained to select materials and make appropriate choices. Teachers are expected to select from a list without actually having seen the books. In some instances teachers' order are ignored and are sent books they have not requested (p. iv).

Teachers reflected that they experienced difficulties in finding suitable resources to enrich their content knowledge (see section 4.7.2), as a response to which one of the facilitators (F3) brought resources from Share-Net. She explained all the resources she had and how they could be used. Some of the resources she was able to give away to the teachers (e.g. *Biodiversity is Wow*, *Windows on our world Wetlands*) and she gave the teachers the Share-Net order form so they could order more if they wanted.

All the teachers were happy with the good resource materials they received. They said the materials enabled an easier understanding of subject content (T1); it also allowed for exposure to more resources and helped with the understanding of CAPS as the Fundisa for Change units are aligned with the CAPS (T6).

What also was evident was that even with resources at their disposal, teachers were not sure how to use them, i.e. what to look for or how to understand, a critical analysis of the resources. The assignment gave them a framework (appendix Q) on how they could manage their resources.

4.8.3 Trainers

As described in section 4.6 above, facilitators presented different aspects of the course. However there was a lot of team (co-) teaching, which enriched the presentations as facilitators were able to draw on and complement each other's expertise. Facilitators used different teacher training skills and resources in supporting teachers' learning, guided by the Fundisa for Change core text and biodiversity units, and also used their own expertise and experience. Although they did not do all the activities that were in the units, their expertise came through as they did other activities they had prepared to work with the biodiversity units.

The trainers did not rigidly stick to the workshop programme but rather allowed teachers to raise their concerns and to deal with them, e.g. giving suggestions on how teachers can

teach biomes to their learners (see section 4.6.2.1). As a result some of the activities that should have been done were not done. When teachers were struggling with activities that integrated all three units, they included problematic units from the last sessions as explained in section 4.6.3. Even when time pressures were experienced they made time to address teachers' concerns.

All the facilitators kept emphasizing that environmental and sustainability knowledge is incomplete, uncertain and complex, therefore teachers should be good researchers (see section 4.6.2). They never assumed that teachers knew nothing, they asked for teacher input before every presentation. They created an atmosphere that enabled teachers to ask questions. One of the teachers in evaluation of (T4) the course said, *"Tutors were patient, humane and courteous to us and very approachable, that's encouraging to see"*.

Teachers felt the workshops helped them a lot due to the materials given and the competence of the trainers (T2). To help teachers with the challenges of the assignment they created opportunities for teachers to discuss their challenges. In trying to get teachers to understand what was required of them, they (F1) asked the teachers to give the rationale of each aspect of the assignment task and in answering these questions it opened up the task and made teachers confident that they could do the tasks.

Facilitators had different views on how the course should be run. One believes CAPS should not be the starting point as they are supposed to teach CAPS ++⁴, *"We are not here to teach CAPS but help teachers to be able to teach with CAPS...we didn't start this course by starting with CAPS, CAPS is not the focal point."*(F1)

A counter argument to this is that teachers have to teach CAPS, therefore CAPS should be a point of departure, *"Teachers need to be comfortable with CAPS first before doing CAPS ++...we are here to help the DoBE to strengthen teachers' knowledge content of the curriculum, so for me knowing how to work backwards and forwards in the CAPS is important."*(F3)

Both perspectives, however, use CAPS as a key referent, but emphasise rich subject knowledge (CAPS++)

⁴ CAPS++ is an approach which orientates teachers to a much wider knowledge scope than that expected by CAPS, but which *at the same time*, prepares teachers to teach CAPS successfully (Lotz-Sisitka, 2011).

4.8.4 Working with CAPS

Teachers (T1) noted that the workshops gave them an opportunity to study and analyse the curriculum document in-depth. It was their first time to get a clear understanding of the changes in the curriculum and to feel confident in implementing it (T1). *“It made me to be aware of the requirements of the curriculum. I have studied and analysed the curriculum in depth. I have gained confidence in rolling out the curriculum.”*(T1)

One teacher felt he could be one of the experts of the CAPS curriculum (T2). They gained confidence in working from the curriculum document to the textbook and back (T1). They said the workshop enabled them to go through the document and understand concepts and use the document as an important tool instead of working from a textbook only (T1). The teachers said that the workshop was focused; as a result their understanding of the curriculum improved a great deal (T5).

4.8.5 Support system

Teachers want to be supported, and appreciate the support from DoBE officials T1 and T3, from their school principals and School Management Team (T3) and colleagues (T4) for their professional development efforts, as the expectation is to uplift the school. District officials were in support of the content covered in the course and advised teachers (T1) that more was needed to be done in grade 10 and 11 as in grade 12 learners would be assessed on the biodiversity content taught in the lower grades.

The school Governing Body also supported the teachers as they saw that the course could uplift the school and take it out of the district category of under-performing (T3). Colleagues from the teachers' schools saw value in teachers wanting to develop themselves through attending the course (T4).

Further input required was requested to develop skills for conducting field trips (T1). One of the teachers (T2) also indicated that he would like to have the facilitators visit his classes to observe him as he taught so that his strengths and weaknesses could be identified.

4.8.6 Table 4.11: Teachers' finishing points

Concepts:	Strong, completely adequate	Better than before, but still needs improvement	Weak, needs strengthening
Ecosystems	4 (T1, T2, T4 & T5)	2 (T3-T6)	
Please comment on your rating:	I was having pre knowledge about it (T2)...because we learn every day (T3)...because the training added on the information I already had		
Biodiversity		6 (T1-T6)	
Please comment on your rating:	I was teaching it in NCS (T2)...environmental studies changes (T3)...this has been discussed in depth (T5)...because this is abroad topic so I think there is a need for improvement (T6)		
Nature & People		6 (T1-T6)	
Please comment on your rating:	I taught threats to biodiversity in NCS (T2)...this is also a broad topic with much more to learn (T6)		
Taxonomy		3 (T2, T4 & T6)	3 (T1, T3 & T5)
Please comment on your rating:	It was lacking in school curriculum (T2)...I am still not clear about some concepts (T6)		

Comparing teachers' starting points (see table 4.6 in section 4.5) and their finishing points (table above), with regard to their understanding of the concepts shows that teachers understanding has improved even though in some instances more was still required.

4.8.7 Other emerging issues

One teacher (T1) reported that her learners were more interested in environmental studies, and some were even considering careers in the environmental field. They understood environmental studies better and found that they were teaching each other when she was absent from school. The same learners have shared information they had gained in a wetland field study with the rest of the school and are encouraging others to conserve biodiversity. Learners have a better understanding of Life Sciences. Learners are engaged in outdoor investigations and enjoying them.

Two of the teachers (T2 and T6) conducted workshops in their school to empower other Life Sciences teachers who had not attended the workshops. One of the teachers (T4) has established an eco-committee in his school as part of the Eco school's project. One of the teachers (T6) started a recycling project with her learners and had organized a litter clean-up, and taken her learners on a field trip.

Teachers (T1 and T3) who attended these workshops together are now in contact outside the workshop sessions. The workshops created a space where teachers were comfortable to ask help from each other. This was not possible before, even though they were attending the same cluster meetings as in the past.

Teachers (T3) also shared the resources with colleagues in their schools and are transferring the knowledge learnt to other subjects (Geography) that they teach (T6).

One of the teachers (T3) was nominated at her school to lead the assessment committee since they learnt she had completed a unit on assessment. She will use what she has learned to develop the whole school.

4.9 Conclusion

The framework of the Fundisa for Change national environmental education teacher development network indicated that the support processes they used with teachers could potentially enable teachers, in their classrooms, to work with environmental and sustainability content knowledge in the teaching of Life Sciences. The feedback that teachers gave is that the objectives of the workshop: to gain knowledge, confidence and network and improve their practice, were achieved.

The next chapter will present a brief summary of the study and recommendations to address issues discussed in this chapter, and recommendations for further research.

CHAPTER 5: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Curriculum policy is seen as the key factor in setting direction for and providing coherence in teaching and learning. It guides teachers as they plan their daily classroom activities, it guides textbook writers about what materials they should provide to support teachers and learners and it informs those who construct assessment instruments for measuring what has been learnt (Taylor, 1999, p.107)

5.1 Introduction

The discussion in this chapter draws from the data that was presented in the previous chapter. This chapter provides insights into the factors that influenced the recontextualisation processes. Insights gained are discussed through analytical statements that relate to the aim of the study. This chapter also provides a summary of how an environmental discourse in a curriculum is recontextualised in teacher training. It is also a reflection on the findings which have influenced the recommendations suggested.

I will start by reminding the reader about my research question and goals, as they guide the discussion that follows.

Research question:

How can teachers be supported to understand and work with the environment and sustainability content knowledge in the CAPS grade 10 Life Sciences curriculum?

Goals:

1. Investigate the scope and nature of the environment and sustainability content knowledge in the CAPS Grade 10 Life Sciences curriculum, and how this is related to teachers' existing knowledge and knowledge recontextualisation (see sections 4.3.1, 4.5 & 4.6.2.1)

2. Investigate the nature of the support given to teachers to understand and work with this new knowledge focus in the Grade 10 Life Sciences (in the field of recontextualisation amongst teacher educators, see sections 4.6 & 4.7)
3. Investigate factors that enable/constrain teachers in understanding and working with the environment and sustainability content knowledge in the grade 10 Life Sciences CAPS and to absent absences that may be identified (see sections 4.5 & 4.6.2.1).

5.2 PRF: Teacher Education practice

In the following section I will use Bernstein's concept of framing (see section 2.2) to interpret observations made during the implementation of the Fundisa for Change programme.

Table 5.1 Framing of the Fundisa for Change programme presentation

Hierarchical	F--
Evaluative	F+/-
Selection	F++
Sequencing	F++
Pacing	F+/-

F: Framing

++ very strong framing

+/- strong/weak framing

-- very weak framing

Framing is about who is in control of the pedagogical relationship (Bernstein, 1996). In this particular study, it refers to the degree of control that the facilitators or the teachers had over the selection, sequencing, pacing and evaluation of the knowledge transmitted during the Fundisa for Change programme implementation.

Framing over hierarchical rules was weak; teachers were free to give input. This had been encouraged from day one, when they were informed that both teachers and facilitators would be learning from each other (see section 4.6). Teachers and facilitators were on first-

name bases. The evaluative criteria were mostly visible, which means the discourse was made explicit to teachers. A visible pedagogy (see section 2.2) was evident when teachers were giving report backs after activities. Feedback from facilitators on teachers' activities was strongly framed when they made it clear what was missing from what teachers reported (see section 4.6.3). Evaluation of teacher activities therefore favoured a more performance pedagogic model.

The recontextualisation was very strongly framed with regard to selection and sequencing. The facilitators had chosen what to include, which resources to use and the sequencing in relation to topics and themes shared with teachers and also in choosing the activities that teachers had to do and when. These were reflected in the first session's programme, and only weakened in the subsequent sessions as the workshop programme gave teachers more space to share what their workshop objectives were. The programme also weakened when facilitators saw the need to do something they felt teachers still needed input on (see section 4.6.3). The pacing was relatively weak as teachers made comments and asked questions although this seldom occurred. Some topics were revisited as the need arose. Time was allocated for the activities that needed to be done during the workshops and for the assignment tasks, teachers therefore had to work within those time frames but extensions were given for completion of the assignment tasks.

Most of the questions and comments from teachers were around teaching methods (see section 4.6.2.1); maybe they felt strongly about this component, as it affects them directly in the classroom and impacts on their classroom practice. An assumption was made about the teachers' knowledge during the classification activity using a field guide, but teachers were not familiar with some of the terms used to distinguish different characteristics (see section 4.6.2.2). Questions facilitators asked were to get teachers to think and reflect on their practices (see section 4.7).

During facilitator presentations recognising rules (see section 2.2) with regard to curriculum expectations and environmental discourse was made explicit to the teachers. It was emphasised that biodiversity content knowledge progressed from grade 10 -12 (see section 4.6.1). Facilitators in their presentations made recognising rules accessible to teachers. The first presentation (see section 4.6.1) indicated to the teachers that biodiversity was what

they were expected to teach, and that biodiversity should be understood within the framework of environment, science, society and sustainability. This introduction enabled teachers to acquire realization which allowed them to see the connections between the concepts mentioned above (see appendix M). Teachers in most cases, through texts and oral presentations, showed that they had acquired realization rules from recognising rules the facilitators made explicit in the recontextualisation process. In some cases, although recognising rules were made explicit to teachers, they did not acquire the required realization rules. For example, it was indicated to teachers that when they teach about biomes, they should not worry too much about teaching biomes that are unfamiliar to them or to their learners, but rather teach about the key content knowledge (e.g. biotic and abiotic factors) that need to be taught using a particular biome familiar to learners (see section 4.6.2). When teachers did an activity where they had to plan a lesson with teaching methods, activities and assessment, they still did not make the connection between key content knowledge to be taught when doing fieldwork with learners in a grassland biome (see section 4.6.3). Teachers also struggled to realize the links between teaching and assessing and preparing learners well for assessment (appendix R), although it was made explicit to them that they should recognise the relationship between the two.

The assignment tasks (see section 4.4.3.4 see also 4.7) also introduced teachers to recognising rules. The aim of part one of the assignment tasks was to enable teachers to see the importance of knowing what learners came with into their classroom so that when they planned their lessons they could take those insights into consideration to ensure learner achievement of curriculum requirements. Although teachers were able to identify what learners came with (appendix K), they did not think beyond that in terms of what that meant for their practice. In fact this was not made explicit in the assignment: it was only emphasised when teachers had discussions about the assignment task that it surfaced (see section 4.7).

Task two of the assignment aimed at indicating to teachers that there is a progression of concepts from grade 10 – 12 as well as interconnections of concepts both within and across the grades. This is emphasised in the aims of CAPS curriculum (see section 4.3.3). Noting this interconnectedness would allow teachers to prepare learners well for the next grade and to make links between knowledge areas as they teach Life Sciences. Teachers were able to

realize that and commented on it (see section 4.7.1). Teachers were able to see the connections between concepts, meaning they acquired realization rules to be able to do that (appendix S). Task two also gave teachers access to recognising that knowledge is contested and that they should be critical when they review resource materials. Teachers had access to realization rules to be able to comment critically on the uncertain nature of environmental knowledge found in knowledge resources (appendix O).

Task three of the assignment was aimed at emphasising to teachers that there are links between learner activities and the skills learners need to acquire with each specific aim in the Life Sciences. Unfortunately I was unable to get teachers' responses from the teachers' portfolio (teachers had to submit their assignment tasks as a portfolio). The assignment tasks was to enable the facilitators of the programme to see if teachers were able to use the recognising rules to produce text that would prove that they had access to realization rules in working with environment and sustainability content knowledge in the teaching of Life Sciences in the CAPS curriculum. In task four of the assignment, teachers had to show that they were able to differentiate between assessment 'of' and assessment 'for' learning through designing assessment tasks for learners. This was aimed at indicating to teachers that there are two types of assessments (recognising rule) and that they could work with both in supporting learners to develop the skills required in the specific aims of Life Sciences. I did not analyse the teachers' responses to see their acquisition of realization rules.

Morais, Neves and Afonso (2005) argue that teachers can only learn when there is strong framing at the level of selection and sequence. They add that teachers cannot select knowledge that they have not yet acquired and neither can they give it a proper sequence. It makes sense then that there was strong framing in terms of selection and sequencing in the Fundisa for Change course. Environment and sustainability content knowledge is fairly new knowledge to the teachers and it would not make much sense to give them too much freedom to choose the sequencing as they still needed to learn the different dimensions of looking at biodiversity and its progression within and across the grades. As shown above, there was a need to scaffold the learning of key concepts as well as pedagogical content knowledge associated with these (e.g. knowledge of biomes, but also how to teach biomes).

They also pointed out that only later can framing be weakened, after teachers have acquired

some recognition and realisation rules for a context where knowledge should be learned, skills developed and an efficient teaching-learning process should be implemented. But they maintain that a strong classification between a researcher and teachers should always go together with weak framing of the hierarchical rules. They add that weak framing of pacing and hierarchical rules allows all participants to control the pace of their learning and the opportunity to consider all contents selected during a training process (*ibid*). The Fundisa for Change programme reflects a similar process of strong framing with regard to selection, and sequencing and a strong and weak framing with regard to pacing and hierarchical rules.

Ensor (2004) points out that teacher education is perceived to be crucial in transforming classroom practice, and as such access to recognition and realisation rules should be the main educational agenda. She adds that in South Africa many factors have made both pre-service and in-service teacher education relatively ineffective in bringing about change in school classrooms. Two of the factors are: poor content knowledge on the part of teachers, and for a time, a curriculum which provided insufficient guidance to teachers on what they should teach.

5.3 Influence of Minimum requirements for Teacher Education Qualifications in the recontextualisation process

The Fundisa for Change programme was informed by the policy on the minimum requirements for Teacher Education Qualifications (Lotz-Sisitka, 2011).

The Fundisa for Change programme, in responding to the knowledge mixes which are the minimum requirements of the TEQF (see section 2.8) produced a content knowledge unit to help teachers with foundational knowledge to teach biodiversity a component within the subject of Life Sciences (***Disciplinary Learning***).

In their recontextualisation, part one of the assignment tasks (see section 4.) required that teachers know their learners. The programme also produced units that looked at teaching methods as well as assessment practices (see section 4.4.3.1). In the recontextualisation it also enabled teachers to work in-depth with the curriculum so they would know curriculum

expectations and what those meant for their practice. Through the recontextualisation process, the facilitators supported them in how to teach different aspects of diversity. The use of different teaching methods and assessment strategies would enable teachers to cater for diversity in the learning styles of their learners (***Pedagogical Learning***). This is also highlighted in the curriculum (see section 4.3.3.1)

The assignment task 3 and 4 (see section 4.4.3.4) as well as the questions posed to them during the last session (see section 4.7) created spaces for teachers to reflect on their practice and particularly to think of ways of improving their practice (***Practical Learning***).

The facilitators used PowerPoint presentations and a data projector. This inspired one of the teachers (T5), *"I have bought a projector to show visuals to aid teaching...YouTube clips are very interesting and enjoyable."* The assignment also required teachers to critically review their chosen knowledge resource in light of the nature of environmental knowledge which is 'new', contested and partially uncertain. They had to read in an informed and critical way (***Fundamental Learning***).

The nature of the content knowledge teachers were working with (biodiversity) allowed teachers to think about issues of environmental sustainability. Discussions on teaching biomes (see section 4.6.2.1), starting with where learners lived and the types of plants they saw, and using learners' experiences to respond to impacts to biodiversity, enabled teachers to think about how they could work with learners and what they bring into the classroom. Discussions on the importance of bringing indigenous knowledge systems into the curriculum also enabled teachers to think about the communities where learners came from and for them to consider that in their teaching (see section 4.6.2.4). This is also in the curriculum (see section 4.3.3.1) (***Situational Learning***).

Analytical statements were developed to present the main findings of the study. The analytical statements are categorized according to teachers' engagement with the OPD and the Fundisa for Change recontextualisation processes.

They are:

Teachers' engagement with OPD

- **Analytical statement 1:** Teachers developed confidence from an in-depth analysis of the CAPS curriculum.
- **Analytical statement 2:** Teachers have content gaps in environment and sustainability knowledge and these can be addressed through professional development that emphasises rich subject knowledge.
- **Analytical statement 3:** Teachers are not familiar with teaching methods that can be used to teach environmental and sustainability content knowledge.
- **Analytical statement 4:** Teachers struggle to see the relationship between teaching and assessing.

FfC recontextualisation processes

- **Analytical statement 5:** Teachers do not have enough and adequate resources for teaching and learning.
- **Analytical statement 6:** Training given to teachers should be interactive to enable them to recontextualise training received in their work places.
- **Analytical statement 7:** Teacher training should go beyond content knowledge that teachers have to teach, but should also consider how teachers can teach and assess that knowledge.
- **Analytical statement 8:** It is important to have a strong framing for selection and sequencing of content knowledge and a relatively weak framing for pacing and hierarchical rules in teacher training workshops.
- **Analytical statement 9:** Professional development has the potential to lead to whole school development.

5.4 ANALYTICAL STATEMENT 1: Teachers developed confidence from an in-depth analysis of the CAPS curriculum

When a new curriculum is introduced it comes with demands and expectations from teachers. For teachers to be able to do what is expected of them, and to meet the

requirements of a curriculum, they need to know what the curriculum requirements are. One of the obstacles to successful implementation of a curriculum is the disjuncture between what teachers believe and what the curriculum requires (see section 2.9).

As already discussed in chapter two (see section 2.6), curriculum is one of the most crucial components of a successful school performance as it delivers society's aims, and as argued by UNESCO (2004) teachers are one of the most crucial influencing factors in the attainment of quality (see section 2.7).

Carl (2009) asserts that teachers develop the curriculum requirements as they interpret it. This point is reiterated by Stables (2004), who argues that teachers are involved in an uncertain, continuous interpretation of curricula. This is an important process for teachers as substantiated by Smyth (1995a), who argues that the key to educational change is dependent on the teacher who has to develop, define and interpret the curriculum.

Carl (2009) believes that successful implementation of a curriculum depends on how well teachers have been informed and prepared for curriculum changes, as well as on their willingness to embrace the changes (see section 2.7). Day (1999) adds that INSET should prepare teachers to meet the demands of the education system.

As mentioned in chapter 4, the DoBE gives the curriculum documents to teachers, who then have to recontextualise them in their classrooms.

Every time a new curriculum is introduced, the DoBE gives teachers training to orientate teachers to the new curriculum. Findings from this study indicate that the training was inadequate, as evidenced from interviews conducted with teachers. *"It was just about unpacking the CAPS document... They were just going through the CAPS document..., they were not having the information as such... they were not competent"* (see section 4.4.2).

In another interview the same sentiment was reinforced, *"She only talked about the CAPS document and she was only telling us that you have to turn to page this and read as it is. There was no clarification about the curriculum yet we are expecting a lot because that was a new curriculum that was expected to roll out to the learners so we came blank"*. (see section 4.4.2)

During the presentations teachers received in the Fundisa for Change programme, all the facilitators worked with the CAPS document. They made reference to the curriculum, e.g. mentioning that biodiversity was in the curriculum and therefore teachers had to teach it (see 4.6.1). In the assessment activities teachers did, they were required to work with the curriculum (see 4.6.3), and the documents were provided for them by the facilitators.

In their reflections on being asked how the course had worked with the CAPS curriculum, the following responses indicate that they benefited from engaging with the document:

- *“I will refer to the document in conjunction with the textbook.” (T1)*
- *“I have the feeling that I will be one of the experts vis-à-vis CAPS.” (T2)*
- *“In a focused time like this, my understanding improved a great deal.”(T5)*
- *“It made me to be aware of the requirements of the curriculum. I have studied and analysed the curriculum in depth. I have gained confidence in rolling out the curriculum.”(T1)*
- *“I have investigated the document in more detail.” (T5)*
- *It is my first time to get clear and understanding the changes in the curriculum through this workshop (FfC), that is covered nicely” (T3)*

These responses indicate that teachers benefitted from working intensely with the document. Even the teachers who did not continue with the programme and only attended the first session in May benefited from engaging with the curriculum. In the workshop that teachers attended, the curriculum document was read to them and they reflected that they did not learn anything that would assist them to implement the new curriculum (see section 4.4.2). The same was done in the FfC programme, but the difference was that explanations were given to clarify what the text in the curriculum meant for teachers’ classroom practices, and they were given opportunities to interact with it and were supported in its interpretation. The curriculum was recontextualised within a content, pedagogy and assessment practice framework. This indicates an important extension of OPD recontextualisation offered by the ORF and PRF. Conde and Sanchez (2010), discussed in chapter two, (see section 2.6) note that teachers need to know what is in the curriculum to be able to work with it.

5.5 ANALYTICAL STATEMENT 2: Teachers have content gaps in environment and sustainability knowledge and these can be addressed through professional development that emphasises rich subject knowledge

Bertram (2011) asserts that teachers need deep conceptual disciplinary knowledge to be able to access new content knowledge on their own. Hence she argues for teacher training to be subject-specific instead of training teachers to implement a particular curriculum. Her argument is that a curriculum changes over time (see section 2.4).

Research places emphasis on teachers' subject content knowledge. It is believed that teachers can integrate content knowledge with other subject content knowledge if they are given rich subject knowledge (see 2.5). There are claims that teachers with good subject knowledge teach best (Summers, Kruger & Childs, 2000). Other studies reveal teachers tend to teach well what they know, and are not confident to teach content they are unfamiliar with (Grossman, 1995 cited in Cutter-Mackenzie & Smith, 2003). Although the focus of this study was not on asking teachers which environmental topics they taught well or poorly, they did reflect on which topics they were comfortable with and those in which they were not (see section 4.5).

Subject knowledge and teaching methods need to be updated as teaching occurs in a world that is predominantly complex, uncertain and dynamic, Day (1999).

One of the teachers reflected that biomes & biodiversity concepts were sufficiently covered, and confidence in teaching them had been gained (T1). Another mentioned that she had gained deeper insight into the content of the topic (biodiversity).

According to the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa. 2011-2025.:

“Universities that provide TE programmes supported by DHET have the responsibility for ensuring that their programmes are accessible to teachers and that they are responsive to national, provincial and individual teacher priorities and needs. Programmes should be of high quality and lead to meaningful development for teachers”, (Department of basic education and higher education and training, 2011, p.3.

The quote above strengthens the role that Teacher Education system should play in supporting teachers with their needs and curriculum priorities.

5.6 ANALYTICAL STATEMENT 3: Teachers are not familiar with teaching methods that can be used to teach environment and sustainability content knowledge within a school subject

When teaching methods were introduced to teachers using the Methods resource book, teachers were able to give input on only a few of the teaching methods in the book, the rest they did not know. The facilitator went through all of them and gave examples of when those particular methods could be used, as reported in section 4.6.2.

Parker and Adler (2005), citing Mattson and Harley (2003), state that teachers, when they lack teaching methods advocated by the curriculum, tend to imitate what they think is expected of them. They attribute this to teachers' lack of evaluative rules which enable the recognition and substantive realisation of the new practices.

Hirst (1974) believes that a subject should be taught in a way that will enable learner understanding and develop thinking processes characteristic of that subject. He points out that teaching methods should be determined by the nature of the subject and what needs to be taught (see section 2.6).

In the FfC programme, teachers were given a carefully designed biodiversity unit that gave them ideas of teaching methods they could use to teach a particular aspect of biodiversity (see appendix L).

The following reflections are an indication that teachers were exposed to methods they did not normally use. Some went as far as to say reading and writing to learn was a method they associated with language teachers (T1). CAPS does mention that every teacher should be a language teacher (see 2.11). Another method closely related to that which one teacher felt she would start using was case studies (T3). Reflecting about doing fieldwork with learners, this is what they had to say:

- *“I have been encouraged to make a ‘field trip’ even if it means just out of the school grounds.”(T5)*
- *“Fieldtrip was a first for this class, they enjoyed being outdoors and did investigations well.”(T5)*
- *“My learners enjoyed to go out as part of learning and we are doing it regularly.”(T3)*

Findings from both Ramsarup (2006) and Jenkins (2008) are that teachers need to be supported to implement new pedagogical strategies that support change in schools.

5.7 ANALYTICAL STATEMENT 4: Teachers struggled to see the relationship between teaching and assessing

As much as CAPS is content-referenced it is also assessment-referenced, hence its name Curriculum and Assessment Policy Statement. CAPS is explicit on how learners should be assessed and on what they should be assessed (see sections 2.11 & 4.3.4).

Hirst (1974) demonstrates that there is a link between teaching and assessment. He points out that activities clarify the teaching intention. When learners do activities, they should learn what was intended for them to learn, hence teaching should be aligned with what learners need to learn (see section 2.6).

Good teachers, according to Gewirtz and Cribb (2009), require technical and practical wisdom to be able to make decisions on the forms of assessment that are most valuable. Darling-Hammond and Ball (1999, cited in Fullan, 2007), argue that the way teachers assess their learners depends on their depth of subject content knowledge (see section 2.6).

How learners are assessed will influence learners’ ability to develop higher order thinking skills. Findings discussed in chapter 4 indicate that teachers struggle to differentiate between assessment activities and key concepts when they plan for lessons (see section 4.6.3).

In one of the activities that teachers did during the FfC programme, it became apparent that assessment is a challenge for teachers (see section 4.6.3). One of the teachers (T2) said he

was not confident with allocating marks for activities, another mentioned that he struggled to draw assessment rubrics (T6). One was worried that she would not be able to set tasks that had a correct balance (weighting) of the cognitive demands. Teachers struggle to ask higher order questions. One of the teachers (T3) mentioned that she was unable to set a task for learners unless she had taught the content first. One teacher said she struggled with asking learners questions requiring them to apply knowledge (T1). Teachers are able to identify what their learners are struggling with, i.e. types of questions but are unable to relate that to teaching (see appendix S).

5.8 ANALYTICAL STATEMENT 5: Teachers need adequate resources for teaching and learning.

In the contextual profiling, teachers said they used textbooks in their teaching. Some teachers use only one textbook while others use a variety of textbooks. In some cases no other materials are used besides the textbooks (Q1 & appendix A).

Teachers reflected that their choice of a resource is influenced by what is given to the school, content covered as per curriculum requirements, school's budget, information it contains and its user-friendliness (see section 4.4.1). Besides being given resources in the FfC programme, teachers were also assisted in how to analyse the appropriateness of a resource (see section 4.8.2). Gudmundsdottir (1990) states that resources that teachers use is influenced by their valuation of the subject they teach.

Shulman (2004) also claims that a textbook or syllabus initiates the teaching and learning process. The text in these teaching materials becomes a vehicle for the achievement of educational purposes. He further claims that with a text and educational purposes a teacher can start pedagogical reasoning and action (see section 2.7). On the contrary, Lotz-Sisitka (2004) asserts that teachers should not only be supported with more comprehensive resources but should also be supported to use the resources appropriately.

In the FfC programme teachers had not brought their textbooks. It was implied from their responses (see section 4.8.4) that they used textbooks to teach. The DoBE expects teachers to use the school fees to buy textbooks that they, as a Department, have screened and

approved (see section 4.4.1). CAPS maintains that all learners should have a textbook for learning, “Every learner must have his or her own textbook” (LSD, p. 19).

CAPS provides examples of the kind of resources teachers need for teaching Life Sciences. These are listed next to each topic in order to assist teachers with planning and preparation. The table below shows how this is presented in the curriculum document.

Table 5.2 Resources for conducting investigations

Topic	Content	Investigation	Resources
Biosphere to Ecosystems	<ul style="list-style-type: none"> •Biosphere •Biomes •Environment •Ecosystems •Abiotic factors: 	Fieldwork	<ul style="list-style-type: none"> •Textbooks • Identification guides and keys to groups of organisms • Access to an ecosystem • Map of South Africa • DVDs • The internet • Nature programmes on TV • Local information • Appropriate instruments for measuring abiotic factors.

(Adapted from LSD, p. 33)

Most schools do not have the money to buy more resources beyond a textbook, irrespective of how good or bad it is (see section 4.4.1), which means that the textbook they choose should be of good quality to compensate for lack of extra resources or funds to buy more.

The NEEP-GET (2005) pilot report identified that teachers select materials that are least challenging, and that do not require much reading or further research. The recommendation was that teachers require support to select and use materials.

The FfC programme aligned its materials with the curriculum. Teachers were provided with materials, and they were assisted with strategies to use the materials in lesson planning and in classroom practice (see section 4.8.2). Although teachers were not observed on how these were used in classrooms.

The FfC programme introduced teachers to the importance of doing research and using more than one knowledge resource for teaching, particularly when working with knowledge that is complex, uncertain and contested - like environmental knowledge (see section 4.7). The FfC units that were given to teachers also have a reference list to point teachers where

they could get more resources. The presentation by one of the facilitators (F3) also gave teachers ideas of where they could get more resources (see section 4.7.2). Teachers appreciated the resources they received from the FfC programme (see section 4.8.2) and departmental officials also saw them as valuable resources that could be used to critique the textbooks approved by the DoBE (see section 4.8.2). The programme was enriched by not having teachers use textbooks they normally use in their teaching. This is also evidenced by a response made by one of the teachers (T6), that searching for knowledge resources enabled him to find information he could use to teach Life Sciences in addition to other subjects (see section 4.7).

5.9 ANALYTICAL STATEMENT 6: Training given to teachers should be interactive to enable them to recontextualise training received in their work places

Teachers in the study learned from the pilot, because the recontextualisation process was interactive through activities that teachers had to do and the assignment tasks that enabled them to recontextualise their learning (see section 4.6.2, see also 4.7).

The Fundisa for Change programme created what the NEEP-GET report (2005) calls a 'learning space' (see section 5.2). This was created through:

- Giving time to reflect on own practice in a dialogue with colleagues.
- Opening up practice for discussion.
- Introduction to new ideas, looking at own practice, apply new competence
- Challenging the 'normal' way of doing things.
- Building relationships that give a trustful environment (to bring their practice into the learning space).(NEEP-GET, 2005, p. 51)

5.10 ANALYTICAL STATEMENT 7: Teacher training should go beyond content knowledge that teachers have to teach but should also consider how teachers can teach and assess that knowledge

The study revealed that teachers needed more than the content knowledge in the curriculum but also how to teach that content knowledge. They could read about biomes but they were not confident on how to teach the topic. Assessment is also an important

component of teaching, as the study indicated. There is a close link between teaching methods, activities and assessment (see sections 4.6.2.1 & 4.6.3).

Lotz-Sisitka and Olivier (2000) argue that professional development programmes should help teachers to:

- Gain deeper knowledge of the learning area
- Understand and implement associated pedagogical processes
- Understand and interpret those environmental education processes (content and skills) that are integral to particular learning areas (p. 89)

The FfC programme managed to provide teachers with deeper subject content knowledge of biodiversity, and pedagogical processes in the Life Sciences subject and the environmental education processes (content and skills) that are integral the teaching of Life Sciences (see sections 4.4.3.1 & 4.6.2).

5.11 ANALYTICAL STATEMENT 8: It is important to have a strong framing for selection and sequencing of content knowledge and a relatively weak framing for pacing and hierarchical rules in teacher training workshops

Learning occurred in the FfC recontextualisation processes because the FfC training controlled what was to be taught to teachers and how the concepts would be developed. It also allowed opportunities for teachers to develop at their own pace to build their confidence. The weakening of the hierarchical rules allowed for a safe space to be created for teachers to engage actively in the recontextualisation process (see sections 5.2 & 5.9).

In the 'Learning for Sustainability' pilot project, it was found that while some sessions could be built around teachers' report-backs and reflections, there was still a need for new information, exposure and resources. Hence the focus of the sessions had to be decided beforehand. The dilemma was to what extent teachers could be able to identify the need to explore unfamiliar terrain. The opportunity to develop that insight was dependent on their progress in understanding previously unexplored terrain (Janse van Rensburg, & Mhoney, 2000).

5.12 ANALYTICAL STATEMENT 9: Professional development has the potential to lead to whole school development.

One of the teachers (T3) commented on how the FfC programme had given her confidence to take leadership in curriculum activities at her school. *“Since I have attended this course for me it is now easier to apply different forms of assessment and also I am confident to talk to other teachers [about assessment] exactly because we have an exam committee in my school so now they want to choose me as a chairperson. I’m gaining confidence now”*.

Comments from other teachers also show that the whole school could benefit from professional development programmes that provide teachers with competency to do their job with confidence (see sections 4.8.5 & 4.8.7).

Bradley (1991) cited in Day (1999) argues that INSET focusing on staff development make teachers feel valued in the job they do, adding that teachers then do a good job to receive feedback. Teachers are encouraged when they get satisfaction from engaging in change and it makes them feel willing and competent to contribute constructively to the development of the school.

5.13 Summary of study

This study was of a Fundisa for Change programme pilot. It is a national case study of teacher professional development focusing on a pilot of a curriculum framework and resources for teacher education, with a specific focus on the inclusion of environment and sustainability in the South African teacher education system for successful implementation of the CAPS curriculum.

The study investigated how a small group of teachers can be supported to work with environment and sustainability content knowledge in the teaching of CAPS Life Sciences. Qualitative data-generating methods were used. The piloting was in the KwaZulu Natal province.

According to the nine analytical statements, findings in the study revealed that the Life Sciences teachers who attended the FfC pilot lacked confidence in teaching environment and sustainability content knowledge integrated in the Life Sciences curriculum.

Many factors have led to this, amongst them inadequate training teachers received when environmental education was integrated into the school curriculum, and other mechanisms identified through critical realism analysis (see section 4.5). Environmental content knowledge is new knowledge that teachers have not engaged with in initial and/or in-service teacher training.

Findings also showed that teachers in the study have not previously engaged in an in-depth analysis of the requirements of CAPS. They were also not familiar with teaching methods that can be used to successfully teach environment and sustainability content knowledge within a Life Sciences pedagogy. Teachers do not have enough, appropriate resources for teaching, and they also struggled with assessing learners.

The FfC programme recontextualisation processes showed that training given to teachers should be interactive to enable them to recontextualise training received in their work places. Teacher training should go beyond content knowledge that teachers have to teach and should also consider how teachers can teach and assess that knowledge. It is important to have a strong framing for selection and sequencing of content knowledge and a relatively weak framing for pacing and hierarchical rules in teacher training workshops. Professional development has the potential to lead to whole school development. It is not just about the *what* but also the *how* that matters (see section 2.2, p. 8).

In the next section recommendations are suggested.

5.14 Recommendations

Recommendations in supporting teachers to understand and work with environment and sustainability content knowledge in the teaching of grade 10 Life Science in CAPS are based on the findings of the study.

1: Recontextualisation should be grounded on interpreting the policy requirements

Curriculum is more than a plan or policy as it includes the interpretation and enactment of policy at various levels of the education system. An understanding of curriculum-as-practice focuses on how curriculum is shaped by context, resources and capacity (Czerniewicz, Murray & Probyn, 2000).

The CAPS curriculum, unlike previous curricula post 1994, provides sufficient guidance to teachers on what they should teach, how they should teach and assess learners. Therefore, teacher training should enable teachers to implement the curriculum.

Findings from the study showed that for almost half the year, some teachers were implementing a curriculum without the curriculum document guiding their practices. Those who had it admitted that they have never had such an in-depth look at a curriculum document. The orientation training teachers received for CAPS from the DoBE was inadequate as the document was read to teachers and not interpreted with them in relation to their practice. Expectations written in any document are not automatically translated into practice, hence an in-depth analysis accompanied by critically reflexive recontextualisation processes (e.g. professional development activities and assignments) of a curriculum is important for a successful implementation of that curriculum.

2: Teacher pre- and in-service training should focus on developing teachers' understanding of the foundational knowledge in the Life Sciences that can improve an understanding of environment and sustainability content knowledge.

Teacher development programmes that aim to support teachers with environmental education should therefore have the task of supporting teachers to develop knowledge *about* the environment, so that they are able to engage learners *in* the environment *for* the environment (Fien, 1993). Focusing only on environmental issues could lead to a superficial engagement with environmental issues.

According to the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa. 2011-2025 (2011), *"the development and the delivery of high quality, content-rich pedagogically sound continuous professional development courses for teachers should be strongly aligned to the content frameworks for a particular subject and phase"* (p. 6).

This suggests that teacher education programmes should support teachers to teach environment and sustainability content knowledge embedded in the subjects they teach. Links between Life Sciences pedagogy and environmental pedagogy should be made explicit.

An environmental focus is different in the different subjects because each subject has its own epistemological basis. Therefore a clear understanding of those differences will enhance an understanding of the teaching methods that can be used to teach environmental and sustainability content knowledge within a particular subject.

4: Good quality resources should be provided for teachers and they should be supported to use it appropriately.

Most teachers do not have the luxury of having more than one resource to use for the teaching and learning interactions. This means that teachers need a good quality resource that would support the implementation of the curriculum. Some teachers in the study, since they had not had access to a policy document, had used only textbooks to implement the new curriculum. It becomes important therefore that good quality resources are available for teachers. From this study, teachers appreciated good quality resources that have extended curriculum content knowledge specifications, and which could be used in conjunction with textbooks. Teachers need access to resources, according to Czerniewicz, Murray & Probyn (2000) this means access both to the physical resources and the intellectual capacities needed to utilize them. This argument also suggests that teachers need academic literacy to be able to interpret the policy documents and to critically analyse available resources. This expertise will enable them to support their learners in the development of higher order thinking skills.

5.15 Recommendations for further research

- There are limitations to the study. The scope was small as the research was of one pilot site with six teachers.
- Further studies should be conducted that would look at how teachers can be supported to work with environment and sustainability content knowledge within other subjects or other content areas of Life Sciences. This could provide some insights in terms of looking at the patterns, similarities or differences between different cases.

- It would be valuable to trace the teachers who participated in this pilot to observe how they recontextualise the training in their classroom practices. There is no point in attending a course or training if it will not impact one's practice. Some insights into classroom practices were gained through reflective interviews from the teachers who had taught the Biodiversity content, but this was not observed in practice.

5.16 Conclusion

This chapter has discussed in more depth the data presented in chapter 4. Analytical statements were used for the discussion. This discussion drew on literature and past studies to get the deeper understanding of recontextualisation needed to support teachers in their classroom practices.

This study contributes to the field of educational research, particularly focusing on teacher training that aims to impact classroom practice. There is an awareness that past Teacher Education training programmes have failed to develop deeper conceptual depth and understanding of environment and sustainability. Recommendations suggested could be used to influence future Teacher Education curriculum development and the expansion of Fundisa for Change programme to other subject focus areas.

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APPENDICES

Appendix A: Questionnaire 1 (Q1)

My School & Community

1. In which area is your school? E.g. township, rural, urban?
2. How many teachers do you have in your school?
3. How many learners do you have in your school?
4. What is the teacher: learner ratio in class?
5. What is the language of instruction in your school?
6. What is the first language of the majority of the learners in your school?
7. What is the first language of the majority of the teachers?
8. What subjects does your school offer in grade 10 - 12?
9. In which quintile is your school? (fee-paying/ no-fee school?)
10. Name some of the social factors you are facing in your school:
11. What support and partnerships do you draw on to strengthen teaching and learning in your school?

My Starting Points

1. How long have you been teaching?
2. For how many years have you taught Life Sciences?

3. Why are you teaching Life Sciences?
4. What are your qualifications?
5. What teaching methods do you tend to use in Life Sciences?
6. What assessment techniques and tools do you use in Life Sciences?
7. Which language(s) are you using in teaching Life Sciences?
8. Which TISM (text books, other materials) do you use for Life Sciences?
9. What factors influence your choice of TISM?
10. What challenges are you encountering in the teaching of Life Sciences?
11. What support is available to you, for example from the Department of Education and service providers?
12. Have you had training on CAPS? If yes, explain the nature of the training.

12. How would you rate your understanding of the following concepts?

Concepts:	Strong, completely adequate	Not bad, but needs improvement	Weak, needs strengthening
Ecosystems			
Please comment on your rating:			
Biodiversity			
Please comment on your rating:			
Nature & People			
Please comment on your rating:			
Taxonomy			
Please comment on your rating:			

14. Have you previously participated in workshops and/or courses that deal with environmental concepts? If yes, please list them.

15. Why did you choose to participate in this initiative?

Appendix B: Questionnaire 2 (Q2)

1. Please provide your name:

.....

2. The name of your school

.....

3. Please choose one or more of the options in the table to describe the extent to which you participated in this training:

I did not participate in this training before now	
I attended all the meetings with the trainers	
I attended some of the meetings (please give the number)	
I attended meetings and also did related activities at school	
Anything else (please add):	

4. Have you had any other training on CAPS during this time? If yes, explain.

.....
.....

5. If you have conducted activities at school, or made any changes, big or small, as part of this training, please tell us here what you did:

.....
.....

6. If yes, please also tell us what the results of these changes or activities have been so far. Tell about possible impacts on the learners, on your school, your teaching or assessment, etc:

.....
.....

7. If you have not undertaken any activities or any changes, please tell us why not? There are no wrong or right answers, we want to learn from you:

.....
.....

8. Have you been exposed to any new curriculum related environmental content in this project? Please list topics below, as many as is relevant.

.....
.....

9. Have you been exposed to new teaching methods in this project? Please list them below, as many as is relevant.

.....
.....

10. Have you been given any new content on assessment in this project? If so, please summarise it below:

.....
.....

11. Have you been exposed to any new TLSM (text books, other materials) for Life Sciences in this project? If yes, please list them below.

.....
.....

12. How would you describe your *experience* of the training you have now completed?

.....
.....

13. If you could change a few things about this training, what would you change, and why?

.....
.....

14. Please choose one or more options in the table to describe your *learning* as a teacher on this training programme. Please give explanations:

Does this describe your learning?	Tick	Explain
I have not learnt much on this training.		
I have learnt something but not as much as I would have liked to.		
I have learnt a lot		
I learnt that there is much more to learn		
Any other comment:		

15. In which area covered in the training do you feel you have learnt *most*? Why do you think that is?

.....

16. In which area do you feel you have learnt *least*? Why do you think that is?

.....

17. Now that you have completed the training, how would you rate your understanding of the following concepts?

Concepts:	Strong, completely adequate	Better than before, but still needs improvement	Weak, needs strengthening
Ecosystems			
Please explain your rating:			
Biodiversity			
Please explain your rating:			
Nature & people			

Please explain your rating:			
Taxonomy			
Please explain your rating:			

18. What further support, if any, do you need, to be confident in the teaching of Life Sciences in the CAPS?

.....

.....

19. Please choose an option that best describes you and your experience of the training (tick one option only for each answer):

	Yes	No
I get few opportunities for further training or professional development as a teacher		
I get many opportunities for further training or professional development or training		
This training was similar to other training I have been on before		
This training was much better than other training I have been on before		
This training was not as good as training I have been on before		
I cannot really tell if there is a difference.		

Explanation:

.....

.....

20. Prior to your participation in the pilot, please indicate with a tick the degree to which each of the following influenced what you taught.

Criteria	Strong influence	Somewhat influenced	Little influence	Not applicable
Content knowledge specified in the curriculum				
Textbook you were using				
Your confidence in a topic				
Preparation of learners for the next grade				
Weighting given to certain topics				

21. After your participation in the pilot please indicate with a tick the degree to which each of the following has influenced or will influence what you teach or will teach.

Criteria	Strong influence	Somewhat influenced	Little influence	Not applicable
Content knowledge specified in the curriculum				
Please comment on your rating:				
Textbook you were using				
Please comment on your rating:				
Your confidence in a topic				
Please comment on your rating:				
Preparation of learners for the next grade				
Please comment on your rating:				
Weighting given to certain topics				
Please comment on your rating:				

22. For each of the following professional development activities in which you participated in the pilot, indicate what best describes the impact of the pilot.

Activities:	Strong impact	Somewhat impacted	Had little	No impact
Working with CAPS curriculum				
Please comment on your rating:				
Knowing your subject				
Please comment on your rating:				
In-depth study of biodiversity				
Please comment on your rating:				
New methods of teaching				
Please comment on your rating:				
Improved assessment practices				
Please comment on your rating:				
Knowing your learners				
Please comment on your rating:				
Meeting the needs of your learners				
Please comment on your rating:				
Competence in working with environment & sustainability content knowledge				
Please comment on your rating:				
Confidence in teaching environment & sustainability content knowledge				
Please comment on your rating:				

Appendix C: Session 1 evaluation

1. What biodiversity concepts/knowledge were you hoping to understand more in this workshop?
2. Were these sufficiently covered? Please elaborate on any difficulties with particular concept/knowledge that you are still experiencing.
3. Could you please make links between the concepts/knowledge shared and your regular curriculum work? Please elaborate.
4. What methods for teaching biodiversity do you conventionally use in your classroom? Please give examples.
5. Did the workshop give you any ideas for extending the different methods you usually use? Please elaborate.
6. Please comment on the course materials (core text, content knowledge, improving my teaching practice, methods & strategies booklet, other hand-outs). Did these provide you with content knowledge and skills to deepen and improve your practice? Please elaborate.
7. Assessment was introduced in this session and will be elaborated in the next session. What are your expectations from this upcoming section of the course?
8. Have you felt that this course has enabled you to gain confidence in your understanding and use of the new CAPS curriculum? Please elaborate.
9. What further input would you like regarding curriculum understanding and implementation in future workshops?
10. Please add any other comments you would like to make about the course.

Appendix D: Session 2 evaluation

1. What knowledge have you acquired, which you will use in your teaching, through working on part 2 of the assignment?
2. Part 2 of the assignment requested that you had to look at different resources for a specific concept, was this process of value? Please elaborate
3. Do you feel that the session on assessment will assist you in improving your assessment AND teaching practice?

If yes, in what way? How will you be improving your current practice?

4. Could you make links between the knowledge that needs to be taught and the teaching methods to use to teach that knowledge and the assessment methods that you can use to assess that knowledge? Please elaborate.
5. Comment on the course materials (e.g. exemplar on assessment). Do you think it will assist you in improving your assessment practice? Please elaborate.
6. What further input do you think you still need with regards to knowing your subject, improving your teaching practice and improving your assessment practice?
7. How have these workshops, if at all, helped you to be competent in working with the CAPS curriculum?
8. Please add any other comments you would like to make about the workshop.

Appendix F: Observation schedule

1. The Teachers – Observers’ Notes	
Level of participation	
Nature of participation	
Approach to the process and content (if evident)	
Starting knowledge, skills (if at all evident)	
Learning (if at all evident)	
Anything else?	

2. The Trainer(s) – Observers’ Notes	
Approach	
Knowledge of the content	
Skills in teacher training processes	
Anything else?	

3. Practical arrangements	
Logistics	
Time & timing	
Mix of participants	
Anything else?	

4. Opportunities to follow up	
Requests for follow up, continued involvement or training beyond scheduled pilot	
Opportunities mentioned for such follow up	

5. Resources	
Resources used:	
• Core Text	
• Theme module	
• Other: (LIST)	
How are resources used? What processes do they support?	
How do participants respond to resources?	
How effective does the use of the resources seem to be?	

6. Pilot Course Framework and Processes

Describe course framework elements or processes observed (use copies of this sheet for additional elements):	
<p>Relationship between the course element / process and the CAPS requirements - <i>subject related concepts</i></p> <div data-bbox="325 600 778 757" style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>How does the course provide access to key concepts in the subject?</p> </div>	
Relationship between the course element / process and the CAPS requirements - <i>subject related skills</i>	
Relationship between the course element / process and the CAPS requirements – <i>environmental values</i>	
What strategies are used to meet <i>differing needs</i> among teachers?	
<p>What elements and strategies are used to facilitate <i>participation and meaning making</i> by <i>all</i> the teachers?</p> <div data-bbox="236 1585 644 1720" style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>E.g., what is the frequency of teacher talk/ questions versus trainer- talk/ questions?</p> </div>	
How are teachers encouraged to learn <i>from each other</i> ?	
How are teachers encouraged to take <i>ownership</i> of their learning?	

How is <i>assessment</i> used and to what end(s)?	
How are teachers assisted to articulate and <i>reflect on their learning</i> ?	

Appendix G: Focus group interview

1. What do you think are the major changes between the CAPS and NCS? Are there any changes?
2. So are you feeling more confident in with working with CAPS than you were with NCS? How was it in the NCS?
3. In which respects, in terms of the content that you need to teach or the way that you need to teach or the way you need to assess?
4. So did you attend any CAPS workshop in preparation for you to implement CAPS?
5. Who ran the workshop?
6. What was the nature of the workshop? What did you do? What were you told? How was it run? What was it about basically?
7. So was it a kind of workshop where you felt that at the end of the workshop I can actually go and implement CAPS? Was it able to help you to...?
8. So if you were to compare the workshop you had on CAPS and this one you are having now, how do they compare in terms of preparing you to actually do what you are supposed to do in implementing CAPS?
9. But now, not all the teachers who are implementing CAPS have come to this workshop. What can be done? What do you think needs to be done to support them?
10. But they ran a workshop and you feel you never got anything out of it, so how should it be run?

Appendix H: Individual teacher interview

1. What do you see as the major difference between CAPS and NCS?
2. Did you go to any CAPS workshop prior to coming to this one?
3. What was the nature of the workshop? How were you being prepared to implement CAPS?
4. Now in comparison to this one, what would you say about this one in terms of preparing you?
5. Now, not all the teachers implementing CAPS are at this workshop. Normally teachers only attend the workshops organised either by the Department or the union. What do you think needs to be done so that all the teachers can also gain the confidence that you have. What steps need to be taken?

Appendix I: Interview with Biodiversity units developer

1. Why were the exemplars developed?
2. Is the exemplar developed to be used by trainers as a training manual or by teachers as a resource?
3. So is it mainly for teachers?
4. In designing it, what kind of research did you do?
5. Were you guided by the curriculum in looking at the different aspects of biodiversity as outlined in the exemplar? Or are the aspects explicitly stated in the curriculum?
6. How did you then decide on what to include?
7. Did you develop it from scratch or did you look at some materials to see how biodiversity can be studied?
8. Did you work alone on the design of the exemplar?
9. What kind of expertise was brought by your co-designer?
10. In designing the exemplar did you think about the learning process, how it was going to be used, the pedagogical practices?
11. How did that influence how the exemplar was designed?
12. Did you run a workshop to orientate the trainers on how they can use the exemplar?
13. Did you think about how the exemplar could be used with other resources that teachers have?
14. Is there anything else you would like to add?

	<i>Deduction</i>	<i>Induction</i> ^a	<i>Abduction</i>	<i>Retroduction</i>
Fundamental structure/thought operations	To derive logically valid conclusions from given premises. To derive knowledge of individual phenomena from universal laws.	From a number of observations to draw universally valid conclusions about a whole population. To see similarities in a number of observations and draw the conclusion that these similarities also apply to non-studied cases. From observed co-variants to draw conclusions about law-like relations.	To interpret and recontextualize individual phenomena within a conceptual framework or a set of ideas. To be able to understand something in a new way by observing and interpreting this something in a new conceptual framework.	From a description and analysis of concrete phenomena to reconstruct the basic conditions for these phenomena to be what they are. By way of thought operations and counterfactual thinking to argue towards transfactual conditions.
Formal logic	Yes	Yes	Yes and no	No
Strict logical inference	Yes	No	No	No
The central issue	What are the logical conclusions of the premises? [?]	What is the element common for a number of observed entities and is it true also of a larger population? [?]	What meaning is given to something interpreted within a particular conceptual framework? [?]	What qualities must exist for something to be possible? [?]
Strength	Provides rules and guidance for logical derivations and investigations of the logical validity in all argument.	Provides guidance in connection with empirical generalizations, and possibilities to calculate, in part, the precision of such generalizations.	Provides guidance for the interpretative processes by which we ascribe meaning to events in relation to a larger context.	Provides knowledge of transfactual conditions, structures and mechanisms that cannot be directly observed in the domain of the empirical.

Limitations	Deduction does not say anything new about reality beyond what is already in the premises. It is strictly analytical.	Inductive inference can never be either analytically or empirically certain – the internal limitations of induction. Induction is restricted to conclusions at the empirical level – the external limitations of induction.	There are no fixed criteria from which it is possible to assess in a definite way the validity of an abductive conclusion.	There are no fixed criteria from which it would be possible to assess in a definite way the validity of a retroductive conclusion.
Important quality on the part of the researcher	Logical reasoning ability	Ability to master statistical analysis	Creativity and imagination	Ability to abstract
Examples	If A then B A Thus: B	From an investigation of the attitude of a representative sample of Swedes, draw the conclusion that 30% of the Swedish population is in favour of the EU.	Karl Marx reinterpretation/redescription of the history of humankind from the historical materialist view.	For a ritual to be just a ritual there must exist, <i>inter alia</i> , emotionally loaded symbols and common notions of inviolable/sacred values.

Note:

^a The concept of induction has been used in partly different ways by different philosophers/theorists, and within different disciplines. Here we are talking about induction in the sense of inductive logic. In social science the concept of inductive is also used to describe a certain form of research procedure. We shall return to this research procedure in the next chapter. It is important not to confuse inductive logic with inductive research, since these concepts in part imply totally different things.

Appendix K: Coding (recognising and realization rules)

Code	Explanation	Colour
Rec	Recognising rules	Orange
Rea A	Realization rules accessed	Green
Rea NA	Realization rules not accessed	Red

F1: lead facilitator

F2: another facilitator

F1: So let me ask you a question, another question. Therefore, therefore, what is the **relationship between methods and the way we teach and what we need to assess?** What is this **relationship between how we are teaching and how we are assessing?** [Assessing]. If you are telling me, **“my child struggles when I give them assignments and investigations”**. **Then I’m gonna ask you “how do you teach that?”** How do we actually look at the **methods we are selecting to enable us to be able to give them, that task?** Mr T4 has been dying to give something.

T4: Let me make an example, suppose I take a discussion as a method of teaching the advantages of this is that children work experience about themselves. There are those that are bright who can be able to help others. Children sometimes respond quiet well when they are with other pupils. The disadvantage of this is that there are children who will be spectators who will rely on others and that is a disadvantage but on the brighter side is that they happen to work best on themselves. What I do as a teacher during that time is just to give them direction this is what we are trying to achieve at this point in time.

F: Thank you Mr T4.

T2: It is just a question of the relationship between?

F2: **Assessment and teaching**

F1: How I teach and how I assess

T2: I think the relationship is that **you assess what you have taught**.

F1: Is that the only relationship?

T3: **And also, the relationship can be, the best you teach is the best the learners will be...eh...perfect to perform when you assess them. If they take maybe I know what I’m teaching, what I’m teaching them now I assess then them they will perform best [but how?] because I taught them best.**

F1: How are you teaching is my question T3, how am I actually teaching that? You're saying teaching but it is still too generic for me [oh]. I want you to be more specific T3. T1?

.....

F1: So your first assignment, the first assignment where you analysed your learners and the kind of things they are struggling with assessment. Many of you mentioned that they struggle with high order questions. You mentioned the contextual factors that come into play. In some cases the learners do not have access to libraries the learner not all of them have access to newspapers, there's language barriers etc. but the physical things when giving them an investigation and we are wanting to assess an investigation and we are giving them that assignment. My question is then, **as a teacher how did I, knowing my learners have the challenge of libraries, they have the challenge of accessing resources etc. and only perhaps they can maybe use a cell phone or textbook, how has my teaching supported my learners to be able to do the assignment? That's the question! I'm not gonna to say, I'm not here to tell you, I am only here to pose the questions.**

Appendix L: Colour coding themes (Teachers reflecting on first session and assignment tasks)

Themes	Colours
Assignment	Blue
Resources	Purple
Learning	Brown
Time issues	Grey
Support	Pink
Other	black

1. T1

Enjoyed the activities but quite challenging. Found some help by visiting WESSA, Sharenet and the Working for Wetlands team. Assisted with finding appropriate resources

like the content progression activity- eg. DNA and biodiversity looking at genetic variation

Subsistence farming- debate

I have realised the importance of having good resources before planning my lessons

My teaching methods have improved s looking at biodiversity requires a “hands on” methodology, this has helped me to see that there is a variety of methods I can use.

Challenging- sleepless nights, dreaming and googling but enjoyed the activities. It is really helping me to improve my teaching.

Subject advisor said more needs to be done in grade 10 and 11 as work covered will be assessed in grade 12 without having been taught. So this workshop is helping us. (since it covers the topic from grade 10 -12)

2. T2

The course has nurtured him with various strategies but the assignment!!! Eish, but he got stuck in some places. He also feels that he needs more time. Other points have been covered already.

3. T3

I like LS and is feeling positive- expectations are to improve competency. For this course I have not forgotten about the course like I normally do when I come from workshops- I carry the materials everywhere with her and always on her mind

Her school is under-performing but have been very supportive because the expectation is to uplift the school

The assignment was very challenging- once I started it realised that EISH! There is a lot of work. Started in May but then exams started.

Planning for time but the Dept because we are underperforming we had a 2 week winter school sleep in and attended a week long workshop in pMB then a grade 11 workshop on CAPS. The whole month until today I have been moving around from workshop to teaching to workshops and had no time and no holidays.

In previous workshops its like 1 day and then go back and teach (no time to absorb and understand the learning), **this course is different because it made her understand the CAPS and understand the progression so has a much better understanding** and now she understands this well.

Subject advisor came to my school with her team- and asked to see the exemplars, impressed and said there is a need for them for every topic not only biodiversity. Even the principal liked exemplars. Subject advisor advised me to use exemplar content knowledge to look at content in textbooks when ordering for CAPS grade 11.

4. T4

First encounter with Life Sciences, geography teacher and had attended the geography workshop as well and is drawn more to geography than Life Sciences. **Find it very difficult to work to do Life Sciences assignment**

Need more time **to work with the assignment- we need to look at the assignment with fresh eyes- he has moved to a new school** and that is challenging but they are **supportive because they see it as positive**. Found a difference between geog and LS. **Needs to develop his confidence with the subject content**

This is a learning process. **Does not feel confident enough or that he has the competence yet**. The environment around the school is also very different he has moved from a deep rural area to a township school

5. T5

Feeling is positively overwhelmed being a new teacher and found that the contact at the workshop was helpful in terms of my teaching and methods

Staying with my teaching schedule but have not started environmental studies

I have started making little aims in her teaching and being more adventurous- even with teaching the heart- taken models

Time management was a shock in terms of the assignment- gave her angst and had to put aside 7-8 days to work on it during her holiday. I needed time in the holidays to work on it. **But never felt I was wasting my time as I knew I was preparing for term 3**.

Even computer skills took her much longer but good for her own teaching

Very hard to take time away from school- in her context learners will be unattended at school during the time that she is here

Took her a long time to get going and questions in the assignment relied very heavily on the 4 resources that she had chosen so she had to keep reading forward then reflect backwards to see if the resources were appropriate

Forever searching- all questions linked

Eg. 2.4 Comment critically on your chosen resources- so took very long and very challenging. Made it very hard to get going had to keep reviewing the whole thing

Her expectations of the first workshop were different- she expected input at the workshop but did not realise that output (assignments) were expected

6. T6

It has empowered him eg. in the case of assessing he has different strategies- this file has become his friend even with other subjects that he teaches in terms of methods and assessment

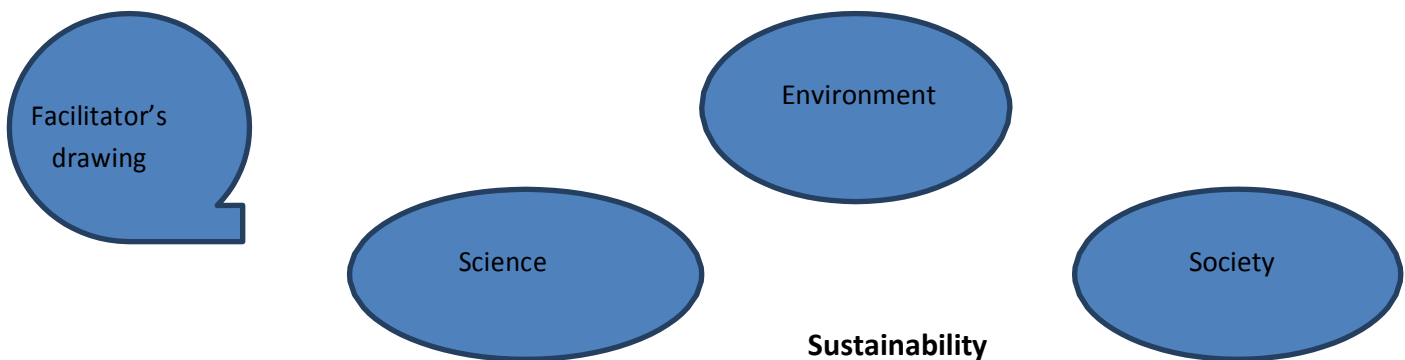
2.3 Resources- before he was using different textbooks only, now he is looking to different sources eg, human impact on biodiversity even did some work in geography so this influenced integration between the subjects

Assignment- thought it would take 2 days but in the end takes much longer than that- he still needs more time. Logistics is not about time management but time-frames. The week after this course he had to submit 7 assignments for his other study work.

Appendix M: Transcription of observation

Introduction: Course overview

Facilitator (F1): Biodiversity, it's why you all know that you are here. What I would like to take firstly is a little bit of a step back, and to give us a little bit of a context, a broad picture into which to look at biodiversity, okay. Once we give out the course to you, you will see that it's got a title called environment, science, society and sustainability and it's in that particular context that we want to look at biodiversity, so what I would like to do is just to open up and to see what you as Life Science teachers can do with this idea of these different concepts but particularly and I would like you just to spend a few minutes thinking of it and talking with somebody else before we bring it out to the front... Think particularly about what these words not necessarily what they mean to you.



I was think, certainly is that these three are quite basic, when we are talking about environment, what are we talking about?

Teacher (T)(chorus): surroundings

F1: When we are talking about science, what is science, a definition of science somebody? As Life Sciences teachers, what is science broadly about? **[silence]** I should have got you to talk about these. I just want to get you to talk but I want you to know what you are talking about. When I ask you to talk about science what are you going to talk about? What is science?

Teacher: Knowledge based on proven theories

F1: Okay, it's about knowledge, knowledge of what? Knowledge about what?

F1: Knowledge about our surroundings, so its knowledge and theories about our world, about our world. Anything else? I think there is more. About our world and how it works I would say, mhh? How our world works. We are always trying to explain things okay? So what are looking at in science, we are looking at concepts, we are looking at processes, okay so what is biodiversity? Process, how does an ecosystem work? Heh? These are the kind of things we do in science. Okay, and then society? What's society?

Teachers: the living organisms

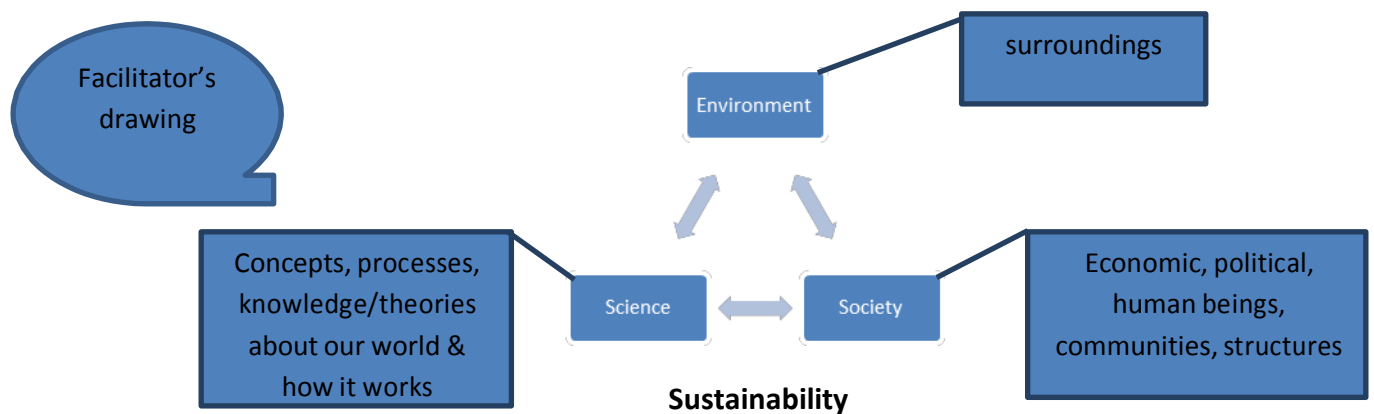
IS: the living organism, okay but what specific living organisms are we talking about when we are talking about society?

Teachers: Human

F1: Human yes, ...

Teacher: Communities

F1: so communities are part of society and.. communities represent how society works. And we've got communities of people in a little neighbourhood. We've got a school community. We've got provincial communities even, we've got national communities so they kind of represent the groupings within society, okay. Society so is human beings, communities and? The structures that we set up in order to organise, our world. We've got laws and we've got religion and we've got cultures and all of these things also help to organise our society so we've got organisational structures...**(writing on a white board)**



that help to drive and organise our society okay. So when we think about biodiversity, we need to think about biodiversity in this complex system okay, but now what I want you to do, is with to sit for a few minutes with a partner or in a group of two or three and just think about, these red arrows that I'm drawing. How does society influence environment and how does science influence, how science and society influence each other. What are these relationships between environment and science, science and society? So how do they work together in a system that makes our world work, okay? Can you think about that for a few minutes even if you are confused at the moment? Sit with someone else and start talking and let's see what ideas you can come up with.

IS: Anybody, break the ice.

Teacher: we started with society, we said society impact on the environment, that society uses the resources of biodiversity and we said that we all exploit the biodiversity that was the last line

IS: So use of resources, it's a question of how well do we use resources

Teacher: and then we moved on to science and society, we came up with as some, the, the improvement of science has impacted also society, like, like the things like ehm...cloning which we didn't know about that impacts on the society and that we can actually have parts of the body so the improvement of science on the society. The last point is that science is about the environment, and that knowledge, those theories are about the environment and are about the environment and based on the environment.

IS: Science gives us knowledge of ...environment, jah. which we have already mentioned. So alright let's go on into another group...

Appendix N: Teacher group activity

Assessment activity

T2: I think what can help us as well is fieldwork and ask the question that relate directly to our topic.

T6: Okay, in grassland what are we saying?

T3: Didn't she say we must start with what we want them to achieve?

T6: To define, organise

T2: Okay, define different types of grasses you have observed or describe. It fits, give, name, list, you see? [They are working with the assessment exemplar]

T3: Or classify...yeah, let's include it.

T6: Yeah, instead of starting with define, let's start with identify.

T2: That's taxonomy; we are still defining key concepts, so let's take from here [referring to exemplar]

T3: Say they must define?

T2: they must list different types of grass that they have, you came across or observed.

T3: Name them

T2: And describe them as well

T6: We can't have define

T3: Defining a plant will be difficult

T6: Which means we are saying describe...

T3: Describe different plants that you are having

T6: And have list

T2: Oh, that we write, we only work with what applies

T3: To us

T2: Oohh

T3: To our topic

T6: Observe also fits here and what else?

T2: So we ignore or leave out what doesn't apply?

T3: Yes and includes what applies

T6: Recall

T2: Draw

T6: Draw fits

T3: Yes we said name is the same as list nhe?

T6: It's the same

T6: Can we include classify or is it taxonomy?

T2: Taxonomy

T3: that's another topic; we will do for another day

T2: So we don't go down?

T3: No I don't think so

T6: It's a skill, I think we should do it

T2: We do everything [reads assessment activity from exemplar]. What are we going to do?

T6: are we going to use text? Didn't we say we will do field work? That means it's an investigation that will fit.

T2: Yes

T3: Mhh

T2: Investigation of a local natural ecosystem

T3: but we need to be more specific and say grassland, because that's what we choose.

T6: Oh, yes, investigation of a local grassland ecosystem

T3: are we also going to go to human impacts?

T6: I can see it

T3: What about taxonomy?

T2: How do we know where to stop?

T6: Didn't they say we choose one, are we going to do everything?

T3: I think we only choose one

T2: Does that mean we are done now? Are we done?

T6: Yes, we chose a topic, didn't we on what activities we will do and what skills we will assess

T2: Is that all?

T3: I think so

Appendix O: Critical review

"2.4. CRITICAL REVIEW

General, we are saying people need clean water to use to avoid to get sick, but at the same time the resources are saying unpolluted water is also becoming a scarcity. The little unpolluted water that is available is also unequally distributed. While people in the urban areas have access to this unpolluted water, those in the deep rural areas and many informal settlement do not clean water is needed to people at all times but to clean water/ cleaning water is highly complex and very costly. Chemicals need to be used to clean water but also become dangerous to people's life. Like many household detergents degrade at a slow rate, while some are not degradable at all. Therefore, it is everyone's responsibility to ensure that only quickly degradable detergents are used, and detergents are not released affect aquatic organisms. In rural areas like at my school streams are only place where people they can get water, they drink, they wash in it, they are not supplied with dust-bins for throwing papers, No proper toilets to pass faeces. People surrounding to the school no proper education is being conducted, but the suggestions are as follows- prevent soap from entering into water, do not throw rubbish into water do not urinate into water, but no proper arrangement being implemented by people in power.

Animals and plant in water they undergo processes e.g. respiration, reproduction etc. but all die processes when they are taking place as they supposed to take place so that life will continue in the hydrosphere at the same time water becoming polluted for human to drink.

In the department of education (curriculum) they are saying teaching and learning is a process that need to be continues to all grade e.g. grade 10-12 and should be clearly indicates the progression and interconnectedness but for environmental studies especially biodiversity, it start nicely in grade 10 and proceed to grade 11 but there is

Appendix P: Assignment marking sheet

Part 2: Know your subject (100)		
2.1. Quality of Document Analysis (20)		
Diagrammatic representation of an analysis of the CAPS document identifying interconnectedness of key knowledge concepts linked to biodiversity.	10	
The conceptual progression of knowledge related to biodiversity is discussed and highlighted either through a diagram or an explanation.	10	
Sub Total	20	
2.2 Quality and relevance of information research		
Selection of a key concept from the curriculum linked to 2.1. and biodiversity.	05	
Relevance of sources for the information research and completion of a synthesis of each of the sources in the format provided.	15	
2.3. Synthesis of researched information		
Summarised 2 page synthesis of the researched information. Relevant and sufficient depth of discussion provided.	15	
Discussion logically presented with a critical engagement with the knowledge concepts.	05	
Sub Total	40	
2.4. Critical Analysis of Knowledge issues (20)		
Using one selected reading from the Reading Pack, comment critically on the nature of environmental knowledge and what knowledge challenges this presents for the teaching of your subject (half - 1 page)	20	
Sub Total	20	
Total	80	
Assessor Comments:		

Appendix R: Part 1 assignment task

Part 1: Know your learners

1.1 Contextual analysis – description of the class that I teach

The name of the school is Shea O'Connor Combined situated at Nottingham Road under the District of UMGungundlovu. We are a rural school which is categorised as a quintile 1 which means poor, parents cannot afford to pay school fees. It is a no fee school. The school is surrounded by a multi-grades primary school which have two to three educators, teaching grade 1 up to grade 7.

This has a negative impact to our results because the basic foundation is not properly laid. Learners lack some skills they were supposed to achieve in lower grades e.g. reading, writing and speaking.

This become a big challenge to grade 8 and 9 educators instead of developing learners to other skills, they need to focus to the ones that they didn't achieve.

Learners coming from grade 9 entering grade 10 are faced with a lot of challenges caused by different assessment styles that is applied in grade 10 which they are not familiar with. In grade 9 they were used to assessments like few class tests out of 50 marks, assignments, projects and investigations. All these tasks that they do during the year comprise of 75% Continuous Assessment (CASS) and 25% for final exam (promotional requirements). Unfortunately in grade 10 it is a vice versa, 75% CASS and 25% final exam.

This transition led to poor performance in the first term's results. Last year the overall percentage was 67 in grade 9. Out of 67% about 30% were condoned to grade 10 due to age (learner is too old for a grade) or he/she has spent more than 4 yrs in a phase which means he/she repeated one of the grades between 7-9. A learner is supposed to spend 3yrs in a senior phase (grade 7-9) so he/she is allowed to repeat once in a phase.

They enter grade 10 lacking some of scientific skills that are important to Life Sciences like application of knowledge, approach to data response questions and essay writing. These challenges were noticed in the first term's test.

The scientific knowledge that they have gained in grade 9 are research and investigation process. The participation in science expo enabled them to acquire these skills because they have access to the library, internet, and magazines and people in order to get information.

They are also involved in co-curricular activities like eco school projects, which develop the environmental awareness and love of nature, digital art, where they learn to take photos and make movies, art to make story books and paintings.

Part 2: Know your subject

2.1.a. Diagram representing conceptual progression and connections across keys content areas for the CAPS

STRANDS	LIFE AT MOLECULAR, CELLULAR AND TISSUE LEVEL	LIFE PROCESSES IN PLANTS AND ANIMALS	DIVERSITY, CHANGE AND CONTINUITY	ENVIRONMENTAL STUDIES
GRADE 10	<ul style="list-style-type: none"> -Chemistry of life, Inorganic compounds -Organic compounds -Cell: unit of life -Cell division: mitosis -Plant and animal tissue 	<ul style="list-style-type: none"> -Support and transport systems in plants -Support systems in animals -Transport system in mammals 	<ul style="list-style-type: none"> -Biodiversity and classification -History of life on Earth 	<ul style="list-style-type: none"> -Biospheres to ecosystems
GRADE 11	<ul style="list-style-type: none"> Micro-organisms Viruses/Bacteria Protists Fungi Immunity 	<ul style="list-style-type: none"> -Support in plants and animals -Transport in plants and animals -Energy transformation photosynthesis -Animal nutrition -Energy transformation respiration -Gas exchange -Excretion 	<ul style="list-style-type: none"> -Biodiversity and classification of micro-organisms -Biodiversity in plants -Reproduction in plants -Biodiversity in animals 	<ul style="list-style-type: none"> -Population ecology -Human impact on environment: current crises
GRADE 12	<ul style="list-style-type: none"> -DNA code of life -RNA and protein synthesis -Meiosis 	<ul style="list-style-type: none"> -Reproduction in vertebrates -Human reproduction -Nervous system -Senses -Endocrine system -Homeostasis 	<ul style="list-style-type: none"> -Darwinism and Natural Selection -Human evolution 	<ul style="list-style-type: none"> -Human impact on environment: current crises Grade 11 work.

Analytical memo: CAPS grade 10 Life Sciences and FfC

What is Life Sciences?	FfC aims to...
<ul style="list-style-type: none"> ✚ Scientific study of living things and their interactions with one another and their environments ✚ Discovering new knowledge through a systematic, scientific inquiry approach ✚ Knowledge production is ongoing and changes over time ✚ Scientific debates and disagreements in order to reach consensus about the ways in which the world works 	<p>Build quality teaching and learning through supporting teachers to:</p> <ul style="list-style-type: none"> ✚ Know their subject ✚ Improve their teaching practices ✚ Improve their assessment practices

Life Sciences will enable learners to develop...	How does FfC aim to support teachers to teach biodiversity in a way that will enable them to assist their learners to achieve the aims of Life Sciences?					
	Know your subject (content knowledge)		Improve your teaching (teaching methods)		Improve your assessment (assessing learners)	
	Core text	Exemplar	Core text	Exemplar	Core text	activities
knowledge of key biological concepts, processes, systems and theories;	√	Biodiversity (Definitions & key concepts)	Listening with intent & reading and writing	Information transfer, deliberative & investigation methods	<u>Lower order</u> Knowledge/remembering	Show & tell
ability to critically evaluate and debate scientific issues and processes	√		Active & engaging methods	Debate	<u>Higher order</u> Analysing/evaluating/ synthesising	Discussions, debates
greater awareness of the ways in which biotechnology and knowledge of Life Sciences have benefited humankind	√	Roles of biodiversity (Ecosystem services & human wellbeing)	Listening with intent & reading and writing	Investigation	<u>Lower to middle order</u> Knowledge/remembering & understanding	Lectures/seminars/talks

an understanding of the ways in which humans have impacted negatively on the environment and organisms living in it;		Environmental issues (impacts of human activities on biodiversity)	Transformative learning & methods	Deliberative, learning by doing & Investigation methods	Middle order Understanding	Investigations, transect walk
a deep appreciation of the unique diversity of past and present biomes in Southern Africa and the importance of conservation;	√	Biodiversity (Definitions & key concepts) & Roles of biodiversity (Ecosystem services & human wellbeing)	Transformative learning & methods	Information transfer, deliberative & investigation methods	Middle order Understanding	Guest presentation
an awareness of what it means to be a responsible citizen in terms of the environment and life-style choices that they make;	√	Responses to environmental issues (biodiversity conservation)	Transformative learning & methods	Information transfer, learning by doing, deliberative methods	Middle order Understanding & application	Role playing
an awareness of South African scientists' contributions;	√	Environmental issues (impacts of human activities on biodiversity)	Listening with intent & reading and writing	Deliberative method	Lower order Knowledge/remembering	Media analysis
scientific skills and ways of thinking scientifically that enable them to see the flaws in pseudo-science in popular media	√		Deliberative method	Deliberative method	Higher order Analysing/evaluating/synthesising	Practical investigations

<p>a level of academic and scientific literacy that enables them to read, talk about, write and think about biological processes, concepts and investigations</p>	<p>√</p>	<p>Biodiversity (Definitions & key concepts)</p>	<p>Vocabulary development & Reading and writing</p>	<p>Deliberative method</p>	<p><u>Lower to middle order</u> Knowledge/remembering & understanding</p>	<p>Media analysis</p>
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