

**Exploring functionings and conversion factors
in biodiversity teacher
professional learning communities**

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by

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Abstract

The study explores the conversion factors, functionings (valued beings and doings), agency and structures in Professional Learning Communities (PLCs) for Life Sciences teachers' biodiversity knowledge. The teachers' valued beings and doings as well as conversion factors associated with these beings and doings were discussed within the conceptual framework of the capability approach using three PLCs in South Africa. Two PLCs were in the Eastern Cape Province (Grahamstown and Idutywa district), and one PLC was in the Western Cape (Cape Town) province. The PLCs involved in this study were course initiated and were positioned in the Fundisa for Change national teacher education programme. Fundisa for Change is a partnership programme that aims to enhance transformative environmental learning through teacher education. To illuminate constrained capabilities and how and to what extent the Life Sciences teachers' empirical actions are related to these, the concepts of the capability approach were underlaboured with critical realism's causal view of human action. A critical realist theory of causation was useful in explaining how the teachers' valued beings and doings, conversion factors and capability sets can be partly accounted for via an understanding of underlying mechanisms that are generative of events and empirical experience.

The study used a qualitative case study research methodology. Interviews, questionnaires, observations (of PLC activities), document reviews (of teachers' portfolios of evidence, Fundisa for Change implementation plan, evaluation forms and resources materials, and policy documents) and reflection tools were used to collect data. Using the critical realism modes of inference (induction, abduction and retroduction), the data was analysed in two phases. Phase one analysis was primarily inductive and used thick descriptions (mainly in the form of quotes) to present and discuss the teachers' valued beings and doings and associated conversion factors in the PLCs. This phase of analysis was abductive.

The study reported four main functionings valued by teachers: subject content knowledge, teaching practices, assessment practices, and use of teaching and learning support materials. These valued functionings were discussed in light of the beings and doings in the PLCs and the underlying mechanisms related to teachers' biodiversity teaching. Conversion factors that were associated with the teachers' valued beings and doings in the PLCs were discussed in line with capability approach's environmental, social and personal conversion factors. The

study found that most of the conversion factors within the PLCs and the Fundisa for Change professional development programme (good facilitation, collaborative learning space, site where PLC activities happened, individual teachers' capabilities, teaching and learning support materials and policy documents) were enablers to the teachers' capabilities for biodiversity teaching, and thus enhanced teachers' knowledge for biodiversity teaching. The study further found that teachers realised some of their achieved functionings in their actual teaching of biodiversity content in the Life Sciences curriculum, and that factors such as lack of resources, large class sizes, learners' abilities and lack of interest among some teachers were amongst the factors that constrained teachers' realisation of their achieved functionings in the PLCs.

The study therefore revealed that if professional development programmes take account of underlying mechanisms and respond to teachers' capabilities i.e. their valued functionings for biodiversity teaching in the Life Sciences curriculum, the professional development programmes can be an important conversion factor that enables the expansion of teachers' capabilities (especially their biodiversity knowledge, pedagogical and assessment practice but also other capabilities) in ways that have the potential to reshape teachers' classroom practices related to the teaching of biodiversity.

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Acronyms and Abbreviations

CAPE	Cape Action for People and the Environment
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism
DHET	Department of Higher Education and Training
DoE	Department of Education
DST	Department of Science and Technology
ECSECC	Eastern Cape Socio-Economic Consultative Council
EECI	Environmental Education Curriculum Initiative
EEPI	Environmental Education Policy Initiative
ESD	Education for Sustainable Development
FET	Further Education and Training
GET	General Education and Training
HEI	Higher Education Institution
ISPFTEd	Integrated Strategic Planning Framework for Teacher Education and Development
IQMS	Integrated Quality Management System
MEA	Millennium Ecosystems Assessment
NCS	National Curriculum Statement
NCTAF	National Commission on Teaching and America's Future
NEEC	Namibian Environmental Education Certificate
NEEP	National Environmental Education Project

NEEP-GET	National Environmental Education Project for General Education and Training
NGO	Non-Governmental Organisations
OECD	Organisation for Economic Cooperation and Development
PLC	Professional Learning Community
RNCS	Revised National Curriculum Statement
RSA	Republic of South Africa
SACE	South African Council for Educators
SANBI	South African National Biodiversity Institute
UNDESD	United Nations Decade of Education for Sustainable Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WESSA	Wildlife and Environment Society of South Africa
ZCD	Zone of Current Development
ZDP	Zone of Proximal Development

Chapter 1: Introduction and orientation to the study

1.1 Introduction

This chapter introduces a study that explored the conversion factors, functionings (valued doings and beings), agency and structures in Professional Learning Communities (PLCs) for Life Sciences teachers' biodiversity knowledge. The study is located in the field of Environmental Education¹. Of particular interest are PLCs positioned in the Fundisa for Change² national teacher education programme in South Africa (see Section 1.5). I begin the chapter with some biographical data which provides insights into personal motivation for the study. The chapter then draws on existing literature to provide the context of biodiversity nationally and internationally. Next I discuss literature to provide an overview on the inclusion of environmental education³ (encompassing the biodiversity components) in the changing South African curriculum. The chapter highlights the different professional development initiatives that have attempted to assist Life Sciences (among others) teachers implement environmental education in South Africa. The emerging policy concept of PLCs in South Africa is introduced to provide a basis for the study, and the main goals of the study are outlined along with the specific questions the study sought to answer. The chapter includes a brief description of the key concepts used in the study, and concludes with an outline of the thesis.

The capability approach to continuing professional development emphasises the valued beings and doings (functionings) of teachers, but also how existing resources (of teachers and Fundisa for Change partners) are converted into new functioning and capabilities. The capability approach is therefore useful for interpreting Life Sciences teachers' functionings in relation to biodiversity. Critical realism's theory of causation offers an analysis to demonstrate how Life Sciences teachers' functionings on biodiversity are constrained or enabled by structures in PLCs and structures provided by continuing professional development programmes such as Fundisa for Change. The study therefore works with the capability approach and critical realism as two theoretical frameworks (see Chapter Three).

¹ Also called Education for Sustainable Development (ESD), Sustainability Education, Education for Sustainability, Learning for Sustainability, environment and sustainability, but because of the South African context in which the study is situated, I will use environmental education (this is a PHD in Environmental Education). However ESD will be used interchangeably with environmental education in the study especially when drawing on literature.

² *Fundisa* is an isiXhosa word meaning "teach". The Fundisa for Change programme thus encourages teachers to "teach for change".

³ In this study, biodiversity is a theme encompassed in environmental education (Saito, 2013).

1.2 Personal interest and motivation of the study

As a young girl growing up in the early eighties, in the Northern part of Namibia, my life was mainly defined by duties such as collecting firewood. Collecting firewood would go on for hours as my friends and I would play and watch boys hunting birds while herding the livestock. As time went by, collecting firewood would mean walking long distances to get to the wood. Today much of the area has become bare and everybody blames my alcoholic uncle who makes a living from selling firewood. The love I have for nature and the passion I have for education motivated me to train as a high school Geography and Biology (Life Sciences in the South African context) teacher. I taught Biology grade 11 and 12 for six years. In 2007, I had an opportunity to enrol for an Honours degree in Environmental Education at the University of South Africa. During my honours studies I came across a quote by Loubser (2008:27):

We only have one planet to live on; we and our children may still be able to prevent the destruction of our planet. Please devote your attention to convincing students in your classes of the importance of this fact. The implementation of an environmentally directed teaching approach in ordinary classroom teaching is not only worthwhile, but also rewarding.

Upon completion of my Honours degree in 2010, I enrolled with the Polytechnic of Namibia for a Namibian Environmental Education Certificate (NEEC) course. As a requirement for the NEEC course, I had to identify an environmental issue in my context, and then propose a response. I chose to develop an educational booklet that aimed at raising awareness on loss of biodiversity in Havana⁴. I chose this issue because 1) the year 2010 was declared an international biodiversity year by the United Nations, and 2) the City of Windhoek⁵ continuously reported on activities that led to environmental issues such as loss of biodiversity in Havana.

Developing the booklet was a participatory process with the Havana community members, City of Windhoek and the Ministry of Environment and Tourism officials. Part of the activities involved sharing of knowledge related to biodiversity. What was evident was the lack of biodiversity knowledge among those who participated in the process. This was not surprising because as a teacher at that time, I also had very limited knowledge on biodiversity. It is this observation, the quote from Loubser given above and the reflections of my own practice as a Biology teacher that led to my questioning the implementation of biodiversity topics in the Namibian Biology curriculum. An opportunity to enrol for a Master's degree in Environmental Education with Rhodes University in 2011 made it possible to research this. Among other recommendations, my master's

⁴ Havana is an informal settlement on the outskirts of Windhoek with a population growth twice the overall population growth rate of the city. Havana has low income residents who rely mainly on selling fuelwood and carpentry for survival (Republic of Namibia. Ministry of Environment and Tourism, 2002).

⁵ The Municipality of Windhoek (Namibia)

study recommended a need to strengthen Biology teachers' environmental knowledge and change in assessment practices for environmental learning (Tshiningayamwe, 2011). Similar findings are reported by environmental education researchers in South Africa (Lotz-Sisitka, 2011; Mbuyazwe, 2011; Songqwaru, 2012; Lotz-Sisitka & Songqwaru, 2013; Chitsiga, 2015; Isaacs, 2015).

In 2012 and 2013 I worked on an educational project for the Sustainable Seas Trust in South Africa. Among other objectives, the project developed an educational programme for supporting coastal schools and communities with a focus on marine biodiversity conservation, in the Eastern Cape province. During the implementation of this project, I travelled along the coastline of the Eastern Cape province. My attention was constantly attracted by fisherman along the road selling fish and lobsters among other sea resources. Most of the fishermen described having an ocean as “a gift from God”, believing that marine resources would never be depleted. On some nights my Sustainable Seas Trust colleagues and I enjoyed home cooked meals in the villages that had been prepared on an open fire. This implies that the people in the Eastern Cape relied on firewood as a source of energy, and on marine resources as a source of food and income. On-going reliance on fuelwood and marine resources could lead to the loss of biodiversity (Groenewald, 2008). The objective of the educational project was therefore to educate the rural communities and support coastal schools on the importance of biodiversity and how human activities could potentially lead to the loss of biodiversity.

In working with the coastal schools, because of lack of human capacity in the Sustainable Seas Trust, lack of time and resources and available expertise, the focus was mainly on Life Sciences teachers in the Further Education and Training (FET) phase⁶. Working with these teachers revealed an urgent need for professional development support with a focus on biodiversity. Life Sciences teachers' expressed that due to contextual challenges such as lack of transport for subject advisors, poor infrastructure, lack of resources, long distances between schools and the district offices, they hardly received any support from the Department of Basic Education. Supporting Life Sciences teachers to develop knowledge of complex and controversial environmental issues such as biodiversity is critical for achieving transformation of education in South Africa (O'Donoghue, 2015). Science teachers' knowledge has an effect on Science Education results and also the foundational knowledge capacities of those graduating from the Sciences.

It was from all the above observations and reflections that a PhD study emerged. My initial interest was to explore resource materials on biodiversity and how teachers are capacitated to work with those in their actual teaching of biodiversity. Further observations, experiences and discussions with

⁶ In South Africa the school curriculum is structured in four phases: Foundation Phase (Grades R-3), Intermediate Phase (Grades 4-6), Senior Phase (Grades 7-9) and Further Education and Training Phase (Grades 10-12).

colleagues and supervisors made me realise that if Life Sciences teachers are to become capacitated on how to teach biodiversity knowledge, they need to identify their own valued beings and doings related to the teaching of biodiversity. Teachers should then participate in professional development activities that will expand their capabilities for biodiversity teaching. This motivated a study on professional learning communities.

1.3 Biodiversity context

South Africa is rated as one of the countries with the most biological diversity in the world (South Africa. Department of Environmental Affairs [DEA], 2014). The country is home to about 95 000 known species (ibid.). This represents six per cent of the world's mammal species, eight per cent of the bird species, five per cent of the reptile species and six per cent of the plant species (ibid.). More species are still being discovered. South Africa has three internationally recognised biodiversity hotspots: the Cape Floristic Region, the Succulent Karoo Region and the Maputaland-Pondoland-Albany Region hotspot (ibid.). However, an assessment of South Africa's biodiversity and ecosystems in 2011 found that compared to other southern Africa countries, South Africa has a high number of threatened plant and animal species (Driver et al., 2012). South Africa is a leading country for the international Red Listing processes. The Red List assessment shows that in South Africa:

One in five inland mammal species is threatened; one in five freshwater fish species is threatened; one in seven frog species is threatened; one in seven bird species is threatened; one in eight plant species is threatened; one in twelve reptile species is threatened; and one in twelve butterfly species is threatened. (South African National Biodiversity Institute [SANBI], 2013:48)

In South Africa, some of the endangered species are protected. Examples of endangered species in South Africa are the black rhinoceros (in 2012 alone 650 rhinos were killed for their horns), riverine rabbits, African wild dog, diverse bird species, leatherback turtle and several species of cycads (SANBI, 2013).

In South Africa, the number of people that rely on natural resources is in the millions (Driver et al., 2012). Between nine and twelve million people are dependent on the natural environment to meet their needs (ibid.). Political, economic and social inequities of the past have resulted in high rates of poverty and unemployment (ibid.). This contributes to overharvesting of biological resources which is one of the main causes of biodiversity loss in the country (SANBI, 2013; South Africa. DEA, 2014). Globally, 80 per cent of people in developing countries rely on traditional medicines of which the majority are derived from plants (UNEP, 2012).

Biodiversity loss is not only a South African crisis; it is a global phenomenon (UNEP, 2002a; UNEP, 2007; UNEP, 2012; UNESCO, 2014a). These United Nations reports emphasised that global biodiversity continues to decline, with substantial and on-going losses of populations, species and habitats. Biodiversity plays an important role in maintaining and enhancing the well-being of over 7 billion people in the world (Department of Economic and Social Affairs, 2014). It is predicted that the world's population will increase to 8.1 billion by 2025 and to 9.6 billion by 2050. This will put more pressure on the biological resources (ibid.).

There are many viewpoints as to why biodiversity needs to be preserved; this can be for spiritual reasons or because of its utilitarian value for humankind (Driver et al., 2012). The Millennium Ecosystems Assessment (MEA, 2005a; 2005b) noted that the following ecosystem services depend on biodiversity: i) provisioning services such as genetic resources and food; ii) regulating services such as the regulation of climate and water quality; iii) cultural services such as cultural heritage and spiritual fulfilment; and iv) supporting services such as nutrient cycling and soil formation. Species diversity in and of itself, for example, is valuable because the presence of a variety of species helps to increase the capability of an ecosystem to be resilient in the face of a changing environment (MEA, 2005a; 2005b). Loss of biodiversity can therefore potentially lead to the loss of food production, cultural practices, energy resources and tourism.

Some of the emerging responses to biodiversity include international conventions, policies, legislations, gene banks, collaborative management (Shava & Schudel, 2013). At the global level, there have been low carbon and green economy initiatives which encompass technological interventions to reduce impacts of climate change, ultimately reducing the impact of climate change on biodiversity (ibid.). The realisation of biodiversity conservation as a global concern has resulted in various international conventions to conserve biodiversity. These include the Convention of Biological Diversity of 1992; Convention of International Trade in Endangered Species of 1973; and the United Nations Framework Convention on Climate Change of 1992 (Shava & Schudel, 2013). South Africa is a signatory to these international conventions for biodiversity conservation (ibid.). The country also has national policies aiming at conserving biodiversity. Those include the National Environmental Management Act 107 of 1998; and particularly the National Environmental Management Biodiversity Act 20 of 2004 (Shava & Schudel, 2013). The National Environmental Management Biodiversity Act introduced a legal framework for governing sustainable development in South Africa and it includes a clause for all training and education programmes to integrate ESD (Republic of South Africa [RSA], 1998). There is thus no doubt that various policies and regulations are in place to help minimise the pressure on biodiversity by encouraging species recovery, habitat restoration and sustainable harvesting (UNEP, 2012). Despite all the policies and

regulations, in 2013, more than 17 000 species of plants and animals were threatened with extinction (UNFPA, UNDESA, UN-HABITAT, 2013).

This year (2015) the Millennium Development Goals expired. Millennium Development Goal seven aimed at ensuring environmental sustainability (Pisupati & Rubian, 2008). Despite all the efforts made in most countries to meet this goal, a considerable amount still needs be done to ensure environmental sustainability. This justifies why the United Nations have proposed 17 goals for sustainable development to succeed the Millennium Development Goals (ICSU & ISSC, 2015). The Sustainable Development Goals were adopted at the United Nations Sustainable Development Summit in New York, in September this year (2015) and will be implemented in January 2016. The Sustainable Development Goals aim to take action on climate and the environment, improve access to education and more (United Nations, General Assembly, 2015). In the interest of biodiversity conservation, goal 14 of the Sustainable Development Goals aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development (ICSU & ISSC, 2015). Goal 15 aims to protect, restore and promote sustainable use of terrestrial ecosystems, sustainable manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (ibid.).

Clearly, the importance of biodiversity has been recognised by policy makers. There is thus no doubt that the defence of biodiversity requires literate citizens who understand the various dimensions of biodiversity and the influence of human activity on biodiversity (Ramadoss & Poyyamoli, 2011). Some scientists claim loss of biodiversity is a natural phenomenon (Gayford, 2000). This notion implies that biodiversity is a controversial issue, and education has a role to play in biodiversity conservation (UNESCO, 2014a). “No education will be complete without understanding the significance of biodiversity for human life and well-being, and for the health of the planet, related species and life on earth” (Cape Action for People and the Environment [C.A.P.E], 2010:3). These debates have contributed to South Africa, like many other countries in the world, including ‘biodiversity’ and ‘a healthy environment’ in its different curriculum reforms (C.A.P.E, 2010; Holtman, 2010). Successful implementation of biodiversity education does, however, require high quality teachers (UNESCO, 2014a).

1.4 Biodiversity in the South African school curriculum

The environment is as much a matter of economic policy and social processes as it is a matter of natural systems and resources (Reddy, 2011). This statement suggests why environment and sustainability knowledge have been integrated in most subjects, from Mathematics, Social Science, Life Orientation, Languages to Economics Management and Science in all phases (ibid.). The inclusion of environmental education in the different curriculum reforms were motivated by the

South African Environmental Education Policy Initiative (Lotz-Sisitka, 2011; Reddy, 2011). This initiative contributed to the 1995 White Paper on Education and Training (Lotz-Sisitka, 2004; Lotz-Sisitka, 2011; Reddy, 2011). The White Paper on Education and Training (1995) emphasised the integration of environmental education into all levels and phases of the education and training system. The Constitution of South Africa highlights that every South African citizen has a right to an environment that is not detrimental to his or her health or well-being (Republic of South Africa [RSA], 1996). All curricula and training programmes in South Africa are mandated to resonate with the South African Constitution.

In 1996 the Environmental Education Policy Initiative changed its focus to curriculum and thus became the Environmental Education Curriculum Initiative (NEEP-GET, 2005; Reddy, 2011). The Environmental Education Curriculum Initiative was a state-civil partnership project that contributed to the inclusion and development of environmental education in the curriculum (Reddy, 2011). The Environmental Education Curriculum Initiative started gaining momentum and support from different provincial Departments of Education, but most efforts at provincial level failed because of lack of leadership and time for consultation (Lotz-Sisitka, 2002). Even though some environmental organisations enthusiastically assisted in the work of environmental education and teachers showed enthusiasm, there was a lack of systemic support from the Department of Basic Education for implementation (Reddy, 2011). This led to many environmental education activities being uncoordinated (*ibid.*).

Since 1994 South Africa has undergone four major curriculum reforms. Curriculum changes have been influenced by socio-political conditions in the country as well as external political and societal factors including a global shift in thinking about education and economics (Reddy, 2011). The first curriculum change sought to rid the school system of racially offensive curriculum materials inherited during the apartheid era (Maringe, 2014). However the most ambitious curriculum reform was the introduction of first post-apartheid curriculum: Curriculum 2005 (C2005) was built on the notion of outcomes based, learner centred and constructivist education frameworks (*ibid.*). With Curriculum 2005 environmental education (encompassing biodiversity) was introduced for the first time in South Africa (Reddy, 2011) as a 'phase organiser' across subjects (*ibid.*). Owing to its complexity and multiple challenges in its implementation (such as poorly trained teachers and ineffective preparation of the curriculum reform), Curriculum 2005 was reviewed (Chisholm, 2000) and the outcomes of the review led to a Revised National Curriculum Statement (RNCS) for the

General Education and Training⁷ (GET) together with the National Curriculum Statement (NCS) for Further Education and Training (Dada, Dipholo, Hoadley, Khembo, Muller, & Volmink, 2009).

Unlike Curriculum 2005, the RNCS curriculum had a well-defined structure (Maringe, 2014). The RNCS outlined the type of teachers required (competent, dedicated, caring and qualified) in accordance with the requirements of the department's norms and standards (South Africa, Department of Education [DoE], 2000). The RNCS had eight learning areas; in each area the values, skills and knowledge underpinning the content of the curriculum were clearly stipulated (Maringe, 2014). In reviewing the RNCS curriculum, Dada et al. (2009: 47) found that "content is found in different forms in different documents and at different levels of specificity". Unlike Curriculum 2005, the RNCS clarified the distinction between outcomes and assessment standards making the selection of the content for teachers clear (ibid.; Maringe, 2014). This allowed teachers to grapple with issues of access, equity and equality in a more realistic way (Maringe, 2014). Despite the RNCS's "vision of teachers and learners who are knowledgeable and multifaceted, sensitive to environmental issues and able to respond to and act upon the many challenges that will still confront South Africa in this twenty first century" (Dada et al., 2009:1), the revised curriculum was critiqued for having inadequate guidance and support on assessment.

Reviewing Curriculum 2005 also meant reviewing the environment content in the curriculum as one of the underpinning principles (Reddy, 2011). As a result, the RNCS had environmental learning outcomes in various learning areas (ibid.). The report of the review committee on Curriculum 2005 made a range of findings including the following challenges: i) a skewed curriculum design and structure; ii) lack of alignment between curriculum and assessment policy; iii) inadequate orientation, training and development of teachers; and iv) learning support materials that are variable in quality (Chisholm, 2003). These findings contributed to the Department of Basic Education's decision to develop the current curriculum: the Curriculum and Assessment Policy Statement (CAPS). CAPS came into effect in January 2011, "signalling the end of a 14-year attempt to focus teaching and learning primarily on outcomes rather than, for example on processes or inputs" (Motala, Morrow, & Sayd, 2014:21). CAPS has been designed as a comprehensive framework for teaching and learning from reception to grade 12 (Maringe, 2014). CAPS clearly stipulates "the content to be taught, activities to support the learning of content standards for assessment of knowledge, skills and values, and the amount for each learning area in the curriculum" (ibid.:45). CAPS is seen to be a prescriptive curriculum with clear guidelines to support the work of the teachers grade by grade and subject by subject (ibid.).

⁷ General Education refers to the first ten years of compulsory schooling and the first four levels of Adult Education and Training (ABET) in South Africa (Reddy, 2011:15).

[CAPS] introduced a more strongly content-referenced curriculum which has commitment to active and critical approaches to learning, and to environment and sustainability content, which is integrated into a range of subjects at all levels and phases of the schooling system. It also has clearly defined, structural guidance for assessment. (Lotz-Sisitka, 2011:31)

An analysis of the CAPS documents revealed that in some subjects about 50 per cent of the content is related to environment and sustainability concerns (Lotz-Sisitka, 2011). The main environmentally related themes identified in the CAPS review are: climate change, biodiversity, water security, environmental health and sustainable development (ibid.). In some subjects the environmental themes across the different phases are explicit. For example, in Life Sciences grade 10 to 12 'environmental studies' is a theme. For a full analysis of biodiversity in Life Sciences CAPS, see Appendix 1 (South Africa. Department of Basic Education [DBE], 2011a). But in summary, the CAPS curriculum covers key concepts of biodiversity including biomes, genetic diversity, population, taxonomy, human-environment relationships, ecosystem services, global warming and climate change (ibid.).

Underpinning principles in the curriculum relevant to environmental learning are: human rights, social justice, inclusivity and a healthy environment (South Africa. Department of Education [DoE], 2002; South Africa. DBE, 2011a). Inclusion of environmental education in the national curriculum also shows the Department of Education's commitment to sustainable use of biological resources for the benefit of all South Africans in the present and the future (Holtman, 2010). While integration of environmental education in policies has been successful (South Africa. DBE, 2011a), its implementation still lacks systemic coherence. Efforts have been made to support teachers with the implementation of environmental education in South Africa (NEEP-GET, 2004; 2005). However research shows that most teachers in South Africa still lack the capacity to implement environment and sustainability knowledge in the curriculum (Lotz-Sisitka, 2011; Songqwaru, 2012; Lotz-Sisitka & Songqwaru, 2013; O'Donoghue, 2015). The attitude is normally to 'leave out' what they do not understand in their teaching (Fundisa for Change, 2014). This is offering incomplete education to learners (UNESCO, 2012). To reconcile this, teachers need to be supported through continuing professional development activities (Songqwaru, 2012). Writing from India, Ramadoss and Poyyamoli (2011) maintained that biodiversity in the curriculum and teachers' capacity to teach biodiversity cannot be separated: they are intertwined and one has an impact on the other. Teacher education and professional development have a role to play (UNESCO, 2014a; 2014b). This leads to a question of what type of teacher education and professional development programmes are effective for teachers' biodiversity knowledge. Recent studies conducted in South Africa, focusing on teachers' biodiversity knowledge, have identified this as an area of further research (Mbuyazwe, 2011; Songqwaru, 2012; Chitsiga, 2015; Isaacs, 2015).

I will argue in this study that effective teacher education and professional development activities will have to consider teachers' valued beings and doings related to biodiversity teaching. This is in line with the Department of Basic Education that noted that teachers as individuals or as a collective should be at the centre of professional development activities (South Africa. DBE, 2014). They should then be supported to meet their professional needs (ibid.). This policy document argued that in South Africa "the process of getting teachers to shape their own professional development is long overdue" (ibid.: 2). To date most South African professional development activities have been described as burdensome, not taking into account what motivates teachers to engage in such activities (South Africa. DBE, 2015). This study will therefore argue that for professional development activities to expand the teachers' capabilities for biodiversity teaching and to be responsive to individual teachers' needs. This requires an understanding of individual teachers' valued beings and doings related to the teaching of biodiversity. Such a study is of significance in South Africa as it has the potential to provide information on what really motivates teachers to participate in professional development activities. Focusing on biodiversity knowledge makes the research of global significance. Bailey (2013) argued that any research that focuses on global phenomena, or research produced and articulated through a global frame such as environmental knowledge, contributes to global knowledge. As noted in Section 1.3, biodiversity and biodiversity loss is a global phenomenon, thus researching teachers' biodiversity knowledge has the potential to contribute to global knowledge.

1.5 Teachers' professional development on biodiversity

In her speech on 5 January this year (2015) at the announcement of the 2014 National Senior Certificate (NSC) examinations results, the Minister of Basic Education, Mrs Angie Motshekga said "the quality of education of any system is predicated on the quality of its teachers". From the United States, Wood (2007) argued that people may differ in the way they define teacher quality. She maintained however that "quality teachers know how to craft engaging and effective learning experiences, despite constant changes in the student population. They need to be knowledgeable and they need to know how to use their knowledge. On-going professional learning simply must be integral to their work" (p.281). This implies that for South African teachers to offer quality education, they need to continuously engaging in professional development activities. This means for quality biodiversity teaching, teachers need to be participating in on-going professional development activities to enhance their biodiversity knowledge. Given that South Africa researchers (Lotz-Sisitka, 2011; Songqwaru, 2012; Lotz-Sisitka & Songqwaru, 2013) have identified teachers' lack of biodiversity knowledge as a concern, on-going professional development activities might be the solution to this concern. However, there is little evidence of if and how on-going professional development activities may enhance teachers' biodiversity knowledge. There is however evidence

that the Department of Basic Education in South Africa has recognised on-going professional development activities as effective for improving teachers' practice, as is evident in a recent policy document:

Much professional development is still organized as isolated and onetime trainings, lacking a coherent strategy, monitoring and follow-up. Research has indicated that these one-off initiatives often fail to have durable effects on teaching and learning. Research also stresses the importance of working together as a cornerstone of effective professional development. (South Africa. DBE, 2015:4)

There is however no doubt that there have been initiatives in South Africa which aimed at supporting teachers to implement environmental knowledge (i.e. biodiversity knowledge) in the curriculum. For example, the Learning for Sustainability project was piloted in Gauteng and Mpumalanga province between the year 1997 and 2000 (Janse van Rensburg & Lotz-Sisitka, 2000). The project followed a three pillar approach of integrating environmental education in the curriculum: teacher development, curriculum development and materials development. The Learning for Sustainability project was shaped by influential educational theories such as learner centred education, critical pedagogy and reflective practitioner theories (ibid.). As part of the project, a spiral model approach (see Section 2.6) (Du Toit & Squazzin, 2000) to teacher professional development was introduced.

In the year 2000, the National Environmental Education Project for General Education and Training (NEEP-GET) expanded upon the Learning for Sustainability Project taking it into nine provinces (NEEP-GET, 2004). NEEP-GET was established by the South African Ministry of Education to support professional development of subject advisors and teachers (ibid.). NEEP-GET also aimed at strengthening environmental learning in the South African curriculum, within an outcome-based, learner centred curriculum framework (ibid.). Professional development processes and programmes were structured around a spiral, cluster based model (Du Toit & Squazzin, 2000). NEEP supported the emergence of a draft Education for Sustainable Development Strategy in South Africa (Lotz-Sisitka, 2011). A parallel programme also supported by NEEP is the Eco-School programme implemented by the Wildlife and Environment Society of South Africa (WESSA) (ibid.). In the NEEP-GET synthesis report, Lotz-Sisitka (2004) discussed the key outputs of the project as well as their achievements and challenges. One of the outputs she highlighted was the implementation of teachers' professional development in environmental education within which she observed the following achievements:

- Improved understandings of environment and environment in the curriculum;
- Broader exposure to, and knowledge of available teaching and learning support materials for environmental learning;

- A more in-depth understanding of the contextual nature of environmental issues, and contextual approaches to lesson plans; and
- Improved understanding of active learning processes. (p.13)

However despite the above achievements, “the project was not able to develop an in-depth focus on the environmental focus in the learning areas, and there is still an issue of superficial interpretations of the environmental focus in the learning areas ...” (Lotz-Sisitka, 2004:13). She recommended further support for teachers in environmental learning to ensure that learners are not exposed to superficial knowledge on environmental issues, a trend in South Africa over the years. In recent work, Lotz-Sisitka (2011) acknowledged the good practices and positive influence of the above mentioned projects (Learning for Sustainability project, NEEP-GET and Eco-Schools) on the curriculum. She emphasised, however, that “very little has been achieved in ensuring that environment and sustainability issues are consistently and coherently integrated into teacher education” (ibid.:33). Due to inadequate capacity to make a wide systemic impact, achievements were noted mainly at the pilot level (ibid.). Fundisa (Teaching) for Change, a national teacher education programme was established in 2011 as a response to this (Lotz-Sisitka, 2011).

1.6 The Fundisa for Change programme

Fundisa for Change⁸ is a national collaborative programme of state and parastatals, non-governmental organisations (NGOs) and Higher Education Institutions (Lotz-Sisitka & Songqwaru, 2013). Many Fundisa for Change partners were involved earlier in the NEEP-GET and the Learning for Sustainability project (discussed in Section 1.5). The Fundisa for Change programme was established from a set of findings in the major South African environmental sector (Environmental Sector Skills Plan, the Green Matter Biodiversity Human Capital Development Strategy, and the Global Change Grand Challenge National Research Plan Human Capital Development strategy) (Lotz-Sisitka & Songqwaru, 2013). These strategies found that the ‘foundations of environmental learning’ in South Africa require further attention (ibid.). Core to this are two issues, identified in all the strategic research:

- The quality of teachers’ knowledge, and teachers’ abilities to teach ‘new’ environmental knowledge;
- The curriculum content necessary for building national capacity for biodiversity management, sustainable use of natural resources, resilience to climate change challenges, and building a green economy. (Lotz-Sisitka & Songqwaru, 2013: no page number)

Following a two-year piloting programme involving a consortium of all national environment and education sector in South Africa set up to understand these issues, the Fundisa for Change

⁸ See www.fundisaforchange.co.za for more information on the Fundisa for Change programme.

programme was established (Lotz-Sisitka & Songqwaru, 2013). Among others, the Fundisa for Change programme implements a key objective of the South African Environmental Sector Skills Plan of the Department of Environmental Affairs: “put measures in place to ensure a longer term, more sustainable supply of quality skills to the environmental sector” (South Africa. Department of Environmental Affairs [DEA], 2010:36). The Fundisa for Change programme also implements the recommendation of the Global Change Grand Challenge National Research Plan Human Capital Development strategy on the “integration of global change pedagogical content knowledge into existing schools science education and sustainability programmes” (South Africa. Department of Science and Technology [DST], 2010).

The Fundisa for Change programme responds to the Department of Basic Education by focusing on environment and sustainability education content in the Science, Geography, Life orientation and Technology Curriculum and Assessment Policy Statements across the GET and FET phase (that was the initial focus) (South Africa. DBE, 2011a). The programme also responds to the Department of Higher Education and Training and Department of Basic Education policy framework that seeks to strengthen PLCs (South Africa. DHET & DBE, 2011a) and the quality of teachers’ knowledge and assessment practices (ibid.). Fundisa for Change is based on the notion of strengthening Literacy and Numeracy support in South African schools (Lotz-Sisitka & Songqwaru, 2013). The programme does this within the “broader notion of education quality, and recognises the histories and contextual challenges faced by teachers and schools in the South African education system” (ibid.: no page number). This is related to the fact that many South African schools struggle to achieve quality education and many school leavers make poor study choices leading to no access to career pathways (ibid.). Fundisa for Change aims at responding to these concerns by strengthening teachers’ environment and sustainability knowledge (such as biodiversity), including their teaching and assessment practice (ibid.). The key objective of Fundisa for Change is to **enhance transformative environmental learning through teacher education** (Lotz-Sisitka & Songqwaru, 2013). To help achieve this objective, Fundisa for Change has five sub-objectives:

- *Capacity building*: develop teacher education capacity which in turn will be oriented towards teacher capacity development for transformative environmental learning in the schooling system, as guided by the National Curriculum (CAPS) and its requirements.
- *Policy and advocacy (influence)*: enhance national take-up of transformative environmental learning within the national system of teacher education.
- *Build the national system of engagement*: expand the network of providers and the community of practice engaged with transformative environmental learning through teacher education.

- *Strengthen and review curriculum and learning and teaching support materials*: strengthen the quality, progression and validity of existing curriculum knowledge and its representation in the national curriculum system.
- *Provide co-ordination support to establish the Fundisa for Change partnership programme*: this objective seeks to provide the ‘underlabouring’ structural co-ordination, monitoring and evaluation and systemic implementation support necessary for the four objectives above. (Lotz-Sisitka & Songqwaru, 2013)

Central to the study is the objective on capacity building of teachers with a biodiversity focus.

Capacity building in environmental education means to build capacity not only for what we understand but also for what we do not fully understand (UNEP, 2002b). The Fundisa for Change objective on capacity building responds to national and international policies on capacity building and biodiversity education. Among other policies at international level, the Fundisa for Change programme responds to the Global Action Programme on Education for Sustainable Development priority action area three “building capacities of educators and trainers: Increase the capacities of educators and trainers to more effectively deliver ESD” (UNESCO, 2014b:15). The Global Action Programme identified biodiversity, climate change, disaster risk reduction and sustainable consumption as key areas for sustainable development (ibid.). The Incheon Declaration on Education adopted this year (2015) at the World Education Forum, commits to support the implementation of the Global Action Programme on Education for Sustainable Development: “we will ensure that teachers and educators are empowered, adequately recruited, well-trained, professionally qualified, motivated and supported within well-resourced, efficient and effectively governed systems” (UNESCO, 2015a:2). The Fundisa for Change programme further aims to contribute to target 4.7 of the ‘Education 2030: A framework for Action’ draft document that highlights:

By 2030, ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture’s contribution to sustainable development. (UNESCO, 2015b: 11)

At the national level, the Fundisa for Change programme is aligned with the CAPS curriculum policy (South Africa. DBE, 2011a). The programme is further aligned to the Teacher Education Qualifications Framework which requires teacher education institutions and programmes to foreground the different types of knowledge (fundamental, situational, practical, disciplinary, and pedagogical) in their accredited programmes (South Africa. Department of Higher Education and Training [DHET], 2011). The pilot phase of Fundisa for Change found that teachers can be

supported to understand and work with environment and sustainability content knowledge (such as biodiversity knowledge) through continuing professional development (Songqwaru, 2012). The Fundisa for Change programme aims at addressing these findings, through developing teachers' environmental knowledge and curriculum and textbook contributions (Lotz-Sisitka & Songqwaru, 2013). The programme aims to expand teachers' environmental and sustainability knowledge to be able to work with more than merely the curriculum requirements (Fundisa for Change, 2013).

The Fundisa for Change pilots recognised teaching as a complex practice in which a variety of different forms of knowledge intersect (Lotz-Sisitka, 2011). The pilots investigated pedagogical content knowledge and the relationship between knowledge and teaching practice (ibid.). Teachers' subject matter knowledge, pedagogical content knowledge and teachers' assessment practices are critical for teachers' practices (ibid.). Therefore the Fundisa for Change model for teacher professional development focuses on these three main aspects, as shown in Figure 1.1 (further discussed in Chapter Five) below:

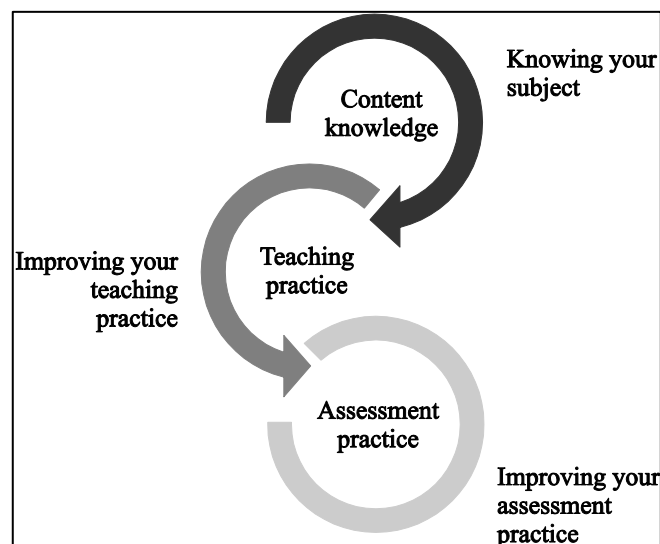


Figure 1.1: Fundisa for Change programme course structure (adapted from Fundisa for Change, 2013:2)

Environment and sustainability knowledge such as biodiversity knowledge is new and thus requires new content matter and new methodologies (Fundisa for Change, 2013; O'Donoghue, 2015). This includes imagining new futures, predicting possibilities and dealing with complexities and uncertainties, field-learning in and with the local community (UNESCO, 2014a). It is arguable that for teachers in South Africa to achieve new content matter and new methodologies for biodiversity teaching, they need to engage in professional learning communities (South Africa. DHET & DBE, 2011a; 2011b; South Africa. DBE, 2014; 2015). Figure 1.2 summarises the timeline events for the

curriculum changes in South Africa, and the teacher professional development initiatives that aimed at supporting teachers to engage with the environmental topics in the changing curriculum.

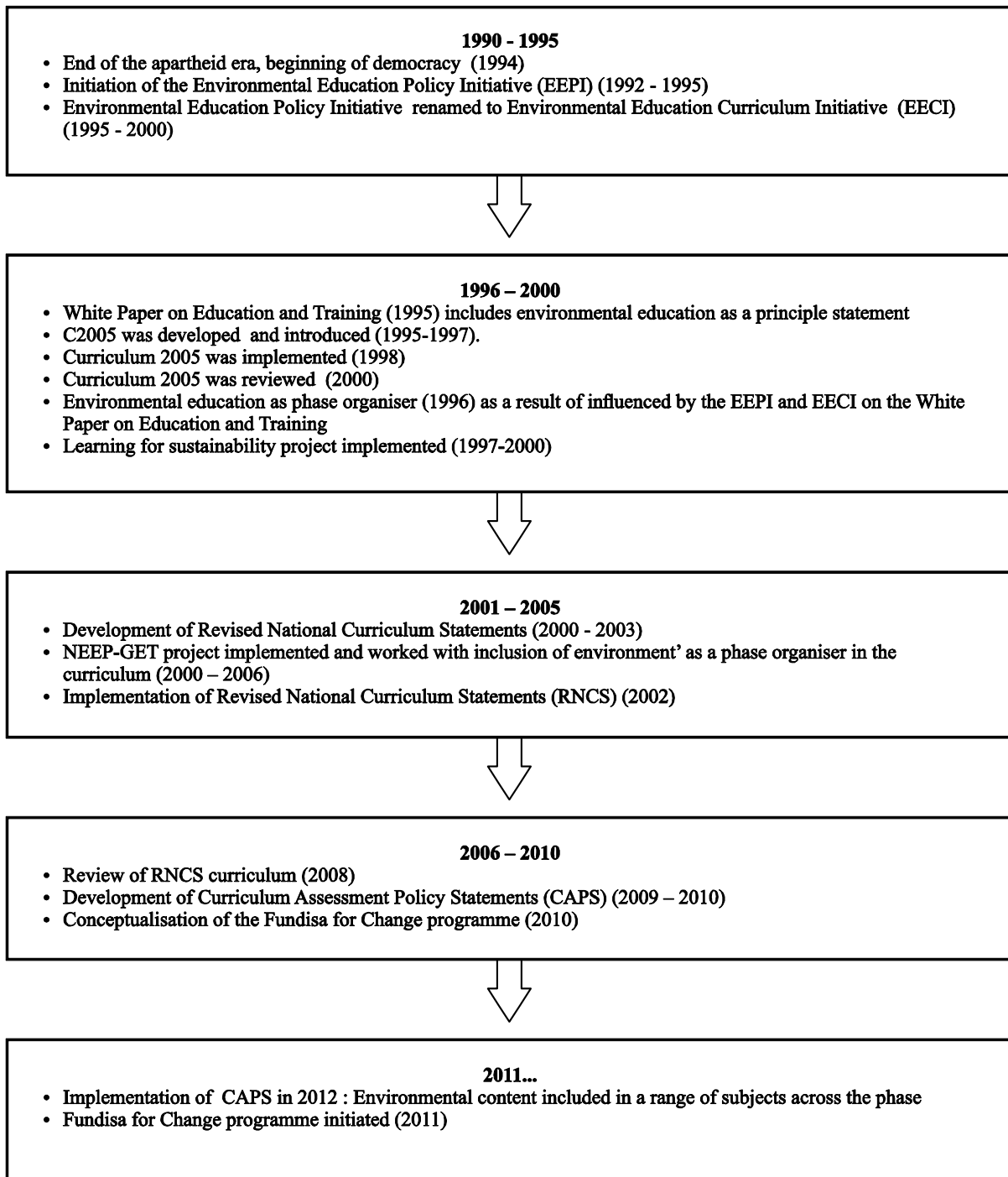


Figure 1.2: History of environmental education and teacher professional development activities for the curriculum changes in South Africa (adapted from Schudel, 2012)

1.7 The integrated strategic planning framework for teacher education and development (2011-2025)

In 2009, a teacher development summit took place in South Africa (South Africa. DHET & DBE, 2011a). The summit was described a ground-breaking event which for the first time in the history of South Africa brought together all stakeholders⁹ across the teacher education and development sector (ibid.). The summit's primary goal was to highlight and address the challenges experienced in teacher education and development in South Africa, especially by teachers (South Africa. DHET & DBE, 2011a). The outcome of the summit was the *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011-2025)*, hereafter abbreviated as ISPFTED, prepared by the Department of Higher Education and Training and Department of Basic Education (South Africa. DHET & DBE, 2011a). The primary outcome of the ISPFTED is “to improve the quality of teachers’ education and development in order to improve the quality of teachers and teaching” (South Africa. DHET & DBE, 2011a:1). To achieve this primary goal, the ISPFTED aims to support teacher education through recruitment of teachers, preparation of teachers, induction of new teachers in the world of work and most importantly, through continuing professional development activities (South Africa. DHET & DBE, 2011a).

The ISPFTED is aligned to the national policies such as *the Department of Basic Education’s Action Plan, 2014*, which aims to improve professionalism, teaching skills, and subject knowledge of teachers throughout their careers (South Africa. Department of Basic Education [DBE], 2010), and the *DHET Revised Strategic Plan (2010/11-2014/15)* aims at strengthening capacity and capability of the development of practising teachers (South Africa. Department of Higher Education and Training [DHET], 2010). Emphasis in the ISPFTED is **to promote Continuing Teacher Professional Development (CTPD) through support systems that promote establishment of Professional Learning Communities (PLCs) to strengthen teacher professionalism.** Establishment of PLCs will move teachers from being ‘subjects’ in the teaching and learning spaces to becoming ‘agents’ of educational change that motivates their work and provide spaces to teachers that affirm their voices in developing their own profiles on professional development matters (South Africa. DBE, 2014). PLCs are inherently connected to the concept of teacher agency, thus implementing PLCs aims to change the roles of teachers in continuing professional development activities (ibid.). This raises the question of whether the current climate in South Africa is

⁹ Participants included the Education and Training and Development Practices Sector Education and Training Authority, the Education and Labour Relations Council, the South African Council for Educators (SACE), the national Department of Education and Higher Education South Africa.

conducive to teacher agency, especially their professional agency for biodiversity teaching. Thus, in relation to biodiversity, the study explored what skills, resources, and knowledge, teachers needed to use in the PLCs, what they wanted to be able to do, and how as individuals and in groups they wanted to do things differently. The study was situated in the context of teacher continuing professional development, using the Fundisa for Change programme as a case study. Among reasons given above, the choice of Fundisa for Change is because the study is situated in the environmental education field. The study thus had potential to yield information relevant to continuing professional development programmes, specifically the Fundisa for Change programme.

The PLC concept is an emerging policy concept in South Africa. There is a need for a clear conceptualisation of what PLCs are to avoid losing the power of the concept (South Africa. DBE, 2014). This was one of the lessons learnt from the national colloquium on PLCs held on 18 - 19 September 2014 in Pretoria, South Africa. The colloquium was organised by the Ministry of Basic Education in partnership with the Flemish Association for Development Cooperation and Technical Assistance (VVOB) and the British Council as a first step towards implementation of PLCs, which are expected to be implemented nationwide by 2017. Among other objectives, the colloquium aimed “to provide platforms through which information could be gathered on the status of PLCs in the country; and to gather ideas from participants that will be incorporated into a document that will serve as a guide to provinces on how they could move forward in establishing PLCs” (South Africa. DBE, 2014:2).

Participants at the colloquium were from institutions of higher education, government departments, teacher unions, subject-based professional associations and continuing professional development initiatives like Fundisa for Change interested in teachers’ professional development (South Africa. DBE, 2014). A number of issues that involve the development, management, resourcing and effective functioning of PLCs across provinces were discussed (ibid.). In line with the ISPFTED, the Fundisa for Change programme aims to pilot and develop the concept of PLCs within the context of environmental learning (Lotz-Sisitka, 2011). This has the potential to improve the quality of education in South Africa. Writing from the United States, Levine (2008) noted that improving teacher quality is not simply about creating PLCs, but it is about the focus of the PLC. Without a clear focus, there is danger that PLCs will be little more than loosely configured groups of teachers that are unable to secure meaningful change and improvement (ibid.). This implies that for professional development initiatives like Fundisa for Change to support establishment and/or strengthening of teachers PLCs successfully, they should clearly define the focus of the PLCs. This study was an attempt to contribute to this.

1.8 The South African socio-ecological context

The South African Environment Outlook, compiled by the Department of Environmental Affairs and Tourism in 2006, reported on the state of the environment in South Africa and acknowledged significant progress in areas of environmental management as a result of laws and regulations that are in place. The document further highlighted water (both quality and availability), climate change, human vulnerability and loss of biodiversity as the four major environmental concerns in South Africa. If there is no careful management of water resources, by 2025 there will be insufficient available water (South Africa. Department of Environmental Affairs and Tourism [DEAT], 2006). Climate change is one of the issues at the centre of environmental debates in South Africa (ibid.). Among other factors, energy generation is one of the main contributors to climate change in South Africa. As much as 92 per cent of South Africa's electricity comes from burning coal (ibid.). South Africa's White Paper on climate change noted:

... even under emission scenarios that are more conservative than the current international emission trends, it has been predicted that by mid-century the South African coasts will warm by around 1 to 2⁰C and the interior by around 2 to 3⁰C. By 2100, warming is projected to reach around 3 to 4⁰C along the coast, and 6 to 7⁰C in the interior. With such temperature increases, life as we know it will change completely: parts of the country will be much drier and increased evaporation will ensure an overall decrease in water availability. (Republic of South Africa [RSA], 2011:9)

With the above predictions on climate change, we can start to anticipate the impact on aspects of biodiversity such as individual organisms and ecosystem compositions and functions. Change in climate may result in redistribution of species, change in harvesting seasons and change in breeding periods. The White Paper outlined the national government's responsibilities relating to mitigation and adaptation of climate change (RSA, 2011). The White Paper on climate change in South Africa adopts a strong sectoral approach to long term adaptation and mitigation, but also identified the need for coordination of responses between sectors (ibid.). In the biodiversity sector, adaptation planning has incorporated climate change impact scenarios into national plans for expansion of protected areas (ibid.).

Lotz-Sisitka and Raven (2001) observed that environmental issues are intertwined with development issues in South Africa. The country has a history of socially unjust conservation laws and protection of land benefits for a few to the detriment of others (ibid.). Poverty forces people to rely on the natural resources, but the same people who rely on natural resources will also suffer from land degradation (ibid.). People's quality of life is compromised by lack of access to basic services (ibid.). Many South African schools have inadequate facilities and large numbers of children are affected by poverty-related factors (Lotz-Sisitka, 2011). HIV/AIDS infection rates and

crime rates are also high in South Africa (ibid.). An estimated 12,2 per cent of South Africa's population were HIV-positive in 2012 (City of Cape Town, 2014). Despite the government's effort to equalise the education system, there are still a number of legacies that continue to impact on the education systems (South Africa. DoE, 2006; Lotz-Sisitka, 2011). The prevalent 'top down' hierarchical structure demands in schools puts constraints on teachers; as a result, they do not focus on improving classroom practices (Botha, 2012). This study was conducted in the Eastern Cape and Western Cape provinces (see Figure 1.2). The next section thus provides information on the social, economic, political and biophysical contexts of these two provinces.

1.8.1 Eastern Cape province

The Eastern Cape province is situated in the south-eastern part of South Africa. In 2012 an estimated 6,750,000 people lived in the Eastern Cape province. This was a representation of a little over 13 per cent of South Africa's population, of whom 88 per cent were black and six per cent were white and coloured (ECSECC, 2012). The Eastern Cape province faces significant social challenges: namely, addressing poverty, income inequality, food insecurity, and unemployment (ECSECC, 2012). The province is frequently measured as the poorest province in South Africa. The province is also characterized by high levels of food insecurity; close to 78% of the provinces' households may be classified as food insecure (ibid.). The economy of the Eastern Cape was both developed and underdeveloped (ECSECC, 2012). The Eastern Cape is the hub of South Africa's motor industry (South Africa. Department of Economic Development, Environmental Affairs and Tourism [DEDEAT], 2013). Other economic activities include: tourism, harbours, renewables and green industries, forestry and timber processing, pharmaceuticals, plastics and chemicals (ibid.). The province has diverse climates and agricultural activities include production of fruit orchards, pineapples, dairy products, coffee and tea cultivation, maize, sorghum and sheep and cattle farming (ibid.). The province has good roads and rail infrastructures plus four airports (ibid.).

Due to the apartheid legacy and issues of social inequality, among other factors, the province produces the worst grade 12 results every year (ECSECC, 2015). The CAPS curriculum was tested at matric level in 2014 for the first time. In her speech¹⁰ on 5 January this year (2015) at the announcement of the 2014 National Senior Certificate examinations results the Minister of Basic Education, Mrs Angie Motshekga said that of all the 81 education districts in the country, no district performed below 50 per cent in 2014. One district in the Eastern Cape had performed below 50 per cent in 2013. There was an overall improvement in the Eastern Cape results but this was still far from satisfactory (ECSECC, 2015). There are many social and economic factors that influence the performance rates of the learners in this province. The Nelson Mandela Foundation report on rural

¹⁰ For the full speech, see <http://www.gov.za/minister-angie-motshekga-announcement-2014-matric-results>

education 2005 discusses lack of library facilities, poverty and large class sizes as some of the factors leading to poor results in the province. Recent research confirms most of those factors as still prevalent and they continue to affect the education quality in the province (Ncanywa, 2014).

The Eastern Cape is characterised by different types of schools such as village, farm, township and town schools with a large number of village schools in the former Transkei (Ncanywa, 2014). There are twenty-three school districts demarcated across the province (ibid.). The districts are grouped into three clusters, geographically demarcated: cluster A, B and C. (ibid.). Cluster A and B are found at the eastern side of the province where a higher percentage of schools are located in villages and in small towns (Ncanywa, 2014). These clusters are 99,9 per cent rural and consist of schools situated in villages from the former Transkei and Ciskei in the apartheid era (ibid.). Most of these schools are underdeveloped with poor infrastructures and are made from mud and/or other inadequate building structures (ibid.). Cluster C has a number of former model C schools found in each district and three universities while clusters A and B have one university (ibid.). The study worked with teachers teaching in the Idutywa district in cluster B and from the Grahamstown district in cluster C (discussed in Section 4.3).

One of the main issues in the Eastern Cape is the lack of access to decent learning facilities, especially for the Science subjects (Hamann & Tuinder, 2012). Most schools lack libraries and many students do not have access to even the basic textbooks (ibid.). Lack of funding in the region and corruption scandals have further aggravated this problem leaving the province in dire need of a centre promoting Mathematics and Science at a school level (Nelson Mandela Foundation, 2005). The Eastern Cape has a hugely unbalanced distribution of teachers, and in some areas (particularly rural areas) many teaching posts have been vacant for years with parents having to pay from their own pockets (with the little they have) to ensure temporary teachers educate their children (ibid.). Class sizes and the learner teacher ratios in rural communities also tend to be high and thus have consequences on the quality of education here (Nelson Mandela Foundation, 2005; Murtin, 2013). Scholar transport is almost non-existent in some areas, making it extremely difficult for learners to attend school if they live more than a few kilometres from the school (Nelson Mandela Foundation, 2005). Other barriers to quality education in the rural areas include poverty; children often do not have enough to eat at home which negatively affects their ability to learn and despite government schools providing meals for students, these meals are often only mildly nutritional (Ncanywa, 2014).

It has been demonstrated that children with decent early childhood education have a much greater advantage than children who do not (UNESCO, 2003, cited in Nelson Mandela Foundation, 2005).

There are very few crèches and other early childhood development centres in the Eastern Cape rural areas, and this, coupled with the common lack of parental supervision (due to parents being away from home in order to find jobs), means children in rural communities are often greatly underprepared when they enter their first year of schooling (Hamann & Tuinder, 2012). A little over 15 per cent of over 20-year-olds in the province cannot read, and the same proportion cannot write (ibid.). In schools, language is also a barrier to effective teaching and learning (Murtin, 2013).

A report compiled as part of background research into the Eastern Cape by Hamann and Tuinder (2012) has provided useful information on the environmental threats in the province. These include land degradation, high levels of soil erosion and high pressure on groundwater. The main use of water in the province is irrigation, which accounts for almost two thirds of water resources required in the Eastern Cape (ibid.). In terms of biodiversity, the Eastern Cape has a higher biome diversity than any other province in South Africa, with all South African biomes¹¹ except the desert (ibid.). There are a number of endangered ecosystems in the province, though none were classified as critically endangered; however, a total of 316 threatened plant species are found in the province (ibid.). Hamann and Tuinder (2012) also reported that the Eastern Cape is home to four endemic freshwater fish species, eight threatened marine fish species, six threatened frog species (four of which are endemic), and 19 threatened reptile species (18 of which are endemic). Overall, the province's river ecosystems are under considerable pressure, because of high demands for water resources (ibid.). The Eastern Cape has more estuaries than any other province (Hamann & Tuinder, 2012). Most of these estuaries are described as healthy. These estuaries are important nursery and feeding areas for a wide range of fauna and flora, as well as being important recreational sites for tourists and residents (ibid.).

In addition to the Idutywa and Grahamstown districts in the Eastern Cape province, the study also reports on teachers in Cape Town (see Section 4.3), in the Western Cape province. The next section therefore provides contextual information on the Western Cape province.

1.8.2 Western Cape province

The Western Cape province is situated in the south-western part of the country (Groenewald, 2008). An estimated 6,082,849 people lived in the Western Cape province in 2014 (Statistics South Africa, 2014). In terms of the race, the majority were coloured (52 per cent), followed by black (29 per cent), whites (18 per cent) and Indians (1 per cent) (ibid.). The population in the province was estimated to increase because of migration, low HIV/AIDS rates and low infant mortality rates (ibid.; City of Cape Town, 2014). Poverty in the Western Cape remains widespread, and households

¹¹ Forest, fynbos, nama karoo, savanna, succulent karoo and thicket

moving into poverty showed a significant increase over the period 1996 to 2011 (City of Cape Town, 2014). The black African population has the largest proportion of households living in poverty (ibid.).

The climate and topography in the Western Cape province are very diverse, and the variations in vegetation are mostly favourable for agricultural activities (Agricultural Economic Services, 2014). The agricultural sector therefore plays a vital role in the economic activity of the collective economic growth of South Africa (ibid.). The Western Cape economy contributes roughly 14 per cent to South Africa's Gross Domestic Product (Agricultural Economic Services, 2014). In addition to the agricultural sector, sectors such as finance, real estate and tourism are growing and are the main contributors to the economy (Groenewald, 2008). The Western Cape province is an outlet for the exports of products such as horses and ostrich meat, fine leatherwear and feathers (Agricultural Economic Services, 2014). The rich fishing grounds on the west coast are protected from exploitation by a 200km commercial fishing zone and a strict quota system (ibid.). The Western Cape province has low unemployment rates (City of Cape Town, 2014). According to Groenewald (2008), the in-migration was anticipated to challenge the industries to increase job creation as an integral part of the expected economic growth of the province: “Skills and training will have to be adapted to become more relevant and responsive to the needs of work-seekers and employers. Education and training will have to be upgraded across the full spectrum of the training industry” (p.23).

In terms of education, the implications of the historically inequitable provision of education to the different population groups in South Africa are clearly reflected in the difference in literacy levels among the different racial groups in the Western Cape (City of Cape Town, 2014) with the black African population remaining with the highest illiteracy levels, followed by the coloured population. In 2003 to 2005, for example, no whites were illiterate (ibid.). In the Western Cape, the adult literacy trend is similar to the national trend, but with slightly higher percentages of the adult population being literate compared to national estimates (City of Cape Town, 2014).

In terms of formal education there are over 36 400 teachers providing schooling to one million learners in the Western Cape (City of Cape Town, 2014). The province generally boasts the best National Senior Certificate pass rate and the best endorsement rate – in 2012, the latter was 36,5 per cent compared to the national rate of 26,6 per cent (South Africa. Department of Basic Education [DBE], 2013a). The Western Cape province has a number of competitive advantages. A diverse range of activities include training and research facilities which contribute to the above average school results (South Africa. DBE, 2013a). Due to the historical legacy and difficult circumstances in some areas of the province, educational performance is good but can still be improved (ibid.).

Baxen (2008) discussed the challenges facing the education sector in the Western Cape; these included impacts of HIV/AIDS, student drop out, poverty, substance abuse, malnourishment, teacher attrition and infrastructures.

The State of Environment Outlook report for the Western Cape described the condition of the biodiversity and ecosystems of the province (South Africa. Department of Environmental Affairs and Development Planning [DEADP], 2013). The Western Cape is home to a rich and varied biodiversity and the province contains the Fynbos, Nama Karoo, Succulent Karoo and Thicket biomes (ibid). The Fynbos biome covers most of the province, is endemic to South Africa, and consists of Fynbos, Renosterveld and Strandveld vegetation (ibid.). The Western Cape province has the highest number of critically endangered terrestrial ecosystems (ibid.). There are 58 threatened terrestrial ecosystems in the Western Cape, of which only two are not endemic or near endemic to the province (ibid.). Of these, 21 are critically endangered, 14 are endangered, and the remaining 23 are classified as vulnerable (ibid.). These comprise almost exclusively fynbos vegetation types (DEADP, 2013). Most concerning is that ten critically endangered, six endangered and nine vulnerable ecosystems have no official conservation protection (ibid.). The Western Cape Province houses two of the three internationally recognised biodiversity hotspots of South Africa, namely the Cape Floristic Region, one of the six global floral kingdoms, and the Succulent Karoo Biome, one of only two arid biodiversity hotspots in the world (ibid.). These regions have exceptionally high endemism and unique assemblages of flora and fauna (ibid.). As such the Western Cape is an area of unique biodiversity that is of global value (ibid.). The Cape Town state of environment report completed in 2009 clearly stated that over 70 per cent of the Cape Floristic Region plant species are found nowhere else in the world (City of Cape Town, 2010). However, it have been observed that nearly 60 per cent of the original extent of Western Cape's natural vegetation has been lost, mostly in the lowlands, with over two thirds of the natural vegetation described either as endangered or critically endangered (ibid.). Of those vegetation types that were historically most extensive, significant amounts have been lost: 84 per cent of Cape Flats Sand Fynbos, 91 per cent of Swartland Shale Renosterveld, and 52 per cent of Cape Flats Dune Strandveld (City of Cape Town, 2014). For example, in terms of terrestrial ecosystems, 21 species are critically endangered, 14 endangered and 23 are vulnerable (South Africa. DEADP, 2013). In addition 70 per cent of the freshwater fish, 10 per cent of the mammals and 5 per cent of reptiles are under threat (ibid.). The causes of biodiversity loss in the Western Cape province are mainly agriculture, forestry plantations, mining, infrastructure development and urban expansion (ibid.).

Figure 1.3 on the page that follows provides a map and summary (as discussed above) of the two provinces in which the study is located.



Figure 1.3: Summary of the economic, social and political activities in the Eastern Cape and Western Cape provinces (South Africa, DEADP, 2013; South Africa, DEDEAT, 2013; Agricultural Economic Services, 2014; ECSECC, 2015)

1.9 Research goals and research questions

1.9.1 Research goals

The overall goals of the study will be to gain an understanding of:

- a) The functionings (valued beings and doings) of teachers and the conversion factors in biodiversity (related to biodiversity knowledge)¹² teacher PLCs, and
- b) Whether and how continuing professional development programmes provide conversion factors that expand and/or constrain the functionings and conversion factors in biodiversity teachers PLCs.

1.9.2 Research questions

1. What beings and doings (functionings) are evident amongst teachers in PLCs, and how are they valued, especially as these relate to biodiversity teaching?
2. What conversion factors are associated with functionings in PLCs for teachers' professional development related to the teaching of biodiversity?
3. How do the conversion factors in the PLCs contribute to teachers' professional development in biodiversity education?
4. What are the relationships between the conversion factors and functionings of continuing professional development programmes with the associated conversion factors and functionings in teachers' PLCs related to the teaching of biodiversity?
5. How can and does a continuing professional development programme act as a conversion factor that expands and/or constrains the conversion factors and functionings in teachers' PLCs related to the teaching of biodiversity?

The study's anticipated contribution was to the field of environmental education and the Zone of Proximal Development¹³ (see Section 2.5.2.1) of Life Sciences teachers. This was by providing a nuanced understanding into continuing professional development processes occurring in the form of PLCs, and how these can (best) be supported by additional continuing professional development programmes such as the Fundisa for Change programme, especially for enhancing biodiversity oriented teaching. This has the potential to improve the quality of education. At a personal level, the study allowed me to reflect on my own professional practices as a Life Sciences teacher and as an aspiring environmental education researcher, the study expanded my capabilities on conducting research.

¹² Biodiversity knowledge in this study refers to the different types of knowledge that underpin teachers practice (disciplinary, pedagogical, practical, fundamental and situational) as they specifically relate to biodiversity (South Africa. DHET, 2011).

¹³ This is "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978: 86).

1.10 Key concepts in the study

1.10.1 Capabilities and functionings

Functionings and capabilities are the core concepts of the capability approach which is a substantive theory used in the study. The study adopts the concepts as defined by Amartya Sen. A functioning is “the various things a person may value doing or being” (Sen, 1999:75) which are the practical realisation of one’s chosen way of life. Capabilities are “the alternative combination of functionings that are feasible for [a person] to achieve; they are ‘the substantive freedom’ a person has to lead the kind of life he or she has reason to value” (Sen, 1999:87). While capabilities and functionings are inextricably linked, they remain distinct (*ibid.*). Capabilities represent a possibility instead of an actuality (*ibid.*). Of interest to this study was to understand what Life Sciences teachers’ valued beings and doings were in relation to biodiversity teaching. The study argues that in the PLCs Life Sciences teachers might have similar functionings but different capabilities and thus they require different resources to achieve their valued beings and doings related to biodiversity teaching (Robeyns, 2005a).

1.10.2 Conversion factors

Another concept that is central to the capability approach is the concept of conversion factors. In this study I adopt a definition of conversion factors as defined by Robeyns (2005a:99): “factors that can allow people to convert resources to new functionings”. Robeyns (2005a) distinguished between three conversion factors that can constrain or enable capabilities. These are social, environmental and personal conversion factors. Thus, an individual teacher in a PLC’s capability is dependent on these conversion factors (Robeyns, 2005a). In the study, I sought to understand the Life Sciences teachers’ functionings and the outcomes as a result of different conversion factors within the PLC and from Fundisa for Change (Robeyns, 2005a).

1.10.3 Agency

The concept of agency is confusing, vague and elusive. Emirbayer and Mische (1998) noted that, despite the long list of terms with which it has been associated (selfhood, motivation, will, purposiveness, intentionality, choice, initiative, freedom, and creativity) the concept is still being debated. From the capability approach perspective, the concept of agency underpins Sen’s idea of freedom as not only the primary end but also the principal means of development (Sen, 1999). Agency is defined as the ability to act according to what one values or in Sen’s words – “what a person is free to do and achieve in pursuit of whatever goals or values he or she regards as important” (Sen, 1985:206). However, according to Archer (1995), agency refers to the reflexive, creative, innovative, and purposeful actions of people. It refers to the choices that people make in their daily lives which either reinforce existing structures and cultures or transform them (*ibid.*). In this study, I defined agency as an important aspect of Life Sciences teachers’ capabilities, which

refers to their ability to act, think, value and do (Cundill et al., 2014). The concept of agency in this study also refers to why Life Sciences teachers do things, and why they choose to do certain things instead of others in relation to their valued beings and doings that are related to the teaching and learning of biodiversity (ibid.).

1.10.4 Structure

Structures are a concept central to critical realism which is the meta-theory used in this study. Structure “suggests a set of internally related elements whose causal powers, when combined, are emergent from those of their constituents” (Sayer, 2000:14). Structures entail the identification of material resources, both physical and human, their relationships, and the powers they have over the actions of people (Archer, 1995). They exist independently of what people know, think, or feel about them, thus can be explored independently (ibid.). Structures exert causal influence on people’s actions (ibid.). In this study, structures are used to refer to the material aspect of things such as resources and the way people and things are socially organised at the global, national, policy development and PLC level (Archer, 1995).

1.10.5 Professional Learning Communities

There are many terms associated with the concept of PLCs. Among them are teacher learning communities, teacher networks, critical friends groups, study groups, teacher research collaboration, learning team model, professional networks and networked learning communities (Norman, Golian, & Hooker 2005). There are also many interpretations for the concept of PLCs. The ISPFTED that triggered the concept of PLC in this study defines PLCs as “communities that provide the setting and necessary support for groups of classroom teachers, school managers and subject advisors to participate collectively in determining their own developmental trajectories, and to set up activities that will drive their development” (South Africa. DHET & DBE, 2011a:14). In relation to the ISPFTED definition, the focus of the study is on teachers (FET Life Sciences teachers engaging with biodiversity aspects of the Science curriculum in a PLC). There is however consensus among a number of authors that the concept of a PLC means “a group of teachers sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way to support innovation and knowledge sharing” (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006: 223). In this study, I argue that the concept of a PLC is inadequately and vaguely understood in the South African context; I consider the concept underdeveloped and aim to contribute to the further development of the concept of PLCs in the South African context. *To be able to provide insights into the definition, I used the Life Sciences training conducted by the Fundisa for Change programme on biodiversity to mirror what is and what can be seen to be PLCs and PLC activities that can contribute to teachers’ professional development. PLCs used in the study are thus **course initiated PLCs**.* Adapting Stoll et al.’s (2006: 223) definition, I worked with

the definition of PLCs as a “space where teachers come together to reflect and share practices, and interrogate their learning collaboratively under the supportive conditions” of the continuing professional development programme.

1.10.6 (Continuing) professional development

There are many concepts used for professional development including staff development, in-service training, professional learning, or continuing education (Kennedy, 2005; 2014; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). The concept of professional development broadly refers to formal and informal activities that teachers engage in to improve their professionalism (Kennedy & McKay, 2011). More specifically, Guskey (2000) has defined professional development as participation in a process to improve teaching. Viewed differently by Mokhele and Jita (2010), writing in South Africa, professional development involves systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of learners. Villegas-Reimers (2003) asserted that teacher professional development is not merely about upgrading teachers’ careers or an individual’s personal growth, but is a long-term process that includes regular opportunities and experiences planned systematically to promote growth and development in the profession. In this study, the concept of professional development used is “all types of professional learning undertaken by teachers beyond the point of initial training, the concomitant skills learnt and developed in these learning processes, and changes in approaches to practice resulting from them” (Evans, 2002:134).

1.10.7 Biodiversity

Authors from the Netherlands noted that the concept of biodiversity is ill defined (Wals, 1999; Van Weelie & Wals, 2002). Wals (1999) made the point that biodiversity is not one broad concept, but rather a group of ill-defined concepts (such as genes, species, habitat, ecosystem diversity, process of evolution etc.). Saito (2013) argued that the difficulty in understanding the concept of biodiversity is not that it is ill defined but rather the complexity around the concept. “There is, in truth, great complexity around this concept and its web of relationships: biodiversity involves richness and diversity on three different levels (ecosystem, species and genes) and these patterns are connected to cultural, social and economic issues, among others” (ibid.:12). In South Africa, the C.A.P.E Biodiversity Conservation Education Programme (2010) defined biodiversity as “the variety of life on earth – all of the genes, species, ecosystems and processes that allow life to persist over time” (p.3). This study has worked with the definition of biodiversity from the Convention on Biological Diversity: “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems” (United Nations, 1992:3).

1.11 Study time frames

Fundisa for Change was piloted in 2011 and 2012. This study was conceptualised during the first formal year of Fundisa for Change implementation in 2013. It was also during this time that the CAPS curriculum was being implemented. In addition, during the conceptualisation of the study, I came across PLCs as an emerging concept in South Africa. This justifies why such a study is of significance in South Africa. Lack of teachers' capacity to teach biodiversity is not only a South African phenomenon, thus continuing professional development programme processes researched in the study can be of great use in other contexts (see Chapter Two). However, working with a new concept of PLCs, a new teacher education programmes (Fundisa for Change) and a new curriculum (CAPS) was challenging as much of this had not yet been researched. For this reason I was not able to, in this study, provide any conclusive information on the PLC concept. Instead, the study provides guidelines and insights as to what PLCs are and can look like in South Africa. The study also provides insights into how Life Sciences teachers can be supported to work with the complex and often controversial theme of biodiversity in their teaching of the CAPS curriculum.

1.12 Thesis overview

Chapter 1: This chapter has introduced the study by exploring the conversion factors, functionings, agency and structures in PLCs for Life Sciences teachers' biodiversity knowledge. The chapter also provided insights into my personal motivation for the study. It further provided an orientation to the introduction of biodiversity components in the South African (changing) curriculums, teachers' professional development and socio-ecological context. The research goals, research questions and anticipated contribution of the study were shared. Finally, the key concepts in the study were briefly discussed.

Chapter 2: The second chapter provides an overview of the history of environmental education as related to the study focus. It further provides the history of biodiversity inclusion in the formal school curriculum and its impact on teacher education and teacher professional development programmes. The chapter then considers the different modalities of professional development as relevant to the PLCs. Finally, the chapter provides the specific aims and purpose of the Life Science CAPS curriculum in South Africa, and relates this to the biodiversity interest in the study.

Chapter 3: This chapter introduces the capability approach and critical realism as two theories used in the study. The chapter discussed the applicability of capability approach and critical realism in the study and critiques of using the two theories in a study such as this one.

Chapter 4: The fourth chapter provides insights into the methodological approaches used in the study. The case study approach, data generation methods and the data analysis processes are

discussed. The research participants and selection strategies are highlighted in this chapter. Included are also issues of validity, quality and the ethical considerations.

Chapter 5: This is a data presentation chapter. It is a description and discussion of the valued beings and doings of the Life Sciences teachers in the three (Idutywa, Grahamstown and Cape Town) PLCs in this study as they relate to teacher valued beings and doings on the teaching and learning of biodiversity.

Chapter 6: This chapter presents and discusses data from the three (Idutywa, Grahamstown and Cape Town) PLCs, focusing on the conversion factors associated with the functionings of the Life Sciences teachers in the PLCs' as they relate to the teaching and learning of biodiversity.

Chapter 7: This chapter presents and discusses the achieved functionings of the Life Sciences teachers in the PLCs. The chapter further discusses the realisation (or not) of the Life Sciences teachers' achieved functionings in the PLCs. It then discusses the Life Sciences teachers' new valued beings and doings related to the teaching of biodiversity.

Chapter 8: This chapter draws on critical realist theory of causation to provide an in-depth explanation of how the valued beings and doings, conversion factors and capability sets identified, can be accounted for via an understanding of underlying mechanisms related to the teaching of biodiversity. This concluding chapter summarises the research findings. It then discusses implications of the research for the implementation of the policy on PLCs in South Africa, and implications for the Fundisa for Change teacher education programme. Finally the chapter provides critical reflections on the research process and makes recommendations for further research.

1.13 Conclusion

This first chapter has introduced the study that explored the conversion factors, functionings (valued doings and beings), agency and structures in Professional Learning Communities (PLCs) for Life Sciences teachers' biodiversity knowledge. The chapter started with providing a personal motivation for the study. Moreover, the chapter has provided a biodiversity context, the integration of biodiversity knowledge in the changing South African curriculum as well as the professional development context. The chapter further introduced the Fundisa for Change and the policy on PLCs in South Africa which are core to the study. The South African socio-ecological context, particularly the Eastern and Western Cape provinces where the study was conducted, have been discussed. Finally the chapter outlines the research goals, research questions, anticipated study contribution, key concepts and a thesis overview.

Chapter 2: Professional development and teachers' biodiversity knowledge

2.1 Introduction

The previous chapter provided an introduction and orientation to the study. This chapter provides literature on environmental education and teacher professional development. The chapter provides literature information on the influences, development and implementation of environmental education, the integration of biodiversity education in the formal school curriculums and literature on teachers' biodiversity knowledge. The chapter discusses the professional development modalities that might be effective for teachers' professional needs on their teaching and learning of biodiversity and findings of research on professional learning communities. Discussed in this chapter is also the purpose of the South African Life Sciences Curriculum and Policy Statement policy and the implications of professional learning communities in South Africa for Life Sciences teachers' competence to teach the curriculum, especially as they relate the teaching of biodiversity.

2.2 Environmental education and biodiversity

Environmental education has been spearheaded by international agencies such as United Nations Educational Scientific and Cultural Organisation (UNESCO) and the United Nations Environmental Programme (UNEP). These have been influenced by international conferences organised in response to a growing number of environmental issues. Among the conferences were the United Nations conferences on the Human Environment (Stockholm conference) in the early 1960s, the Belgrade Conference in 1968 and the UNESCO conference in Environmental Education in Tbilisi, Georgia, in 1977 (UNESCO, 1978). The Tbilisi declaration noted that environmental education should be viewed as a process aimed at developing citizens who are aware and have the knowledge, attitudes, motivation, commitment and skills to work towards solutions for environmental problems in the present and anticipated ones (UNESCO, 1978). Out of the Tbilisi conference a set of principles for environmental education were developed including the 'Caring for the Earth Charter' that often provide guidelines for environmental education (ibid.).

Another significant contribution to environmental education was the United Nations conference on Environment and Development held in Rio de Janeiro, Brazil in 1992. Out of this conference, biodiversity reduction was identified as one of the global issues society needs to help resolve (UNEP, 2012). The Convention on Biological Diversity was one of the conference outcomes (ibid.). Another significant event was the World Summit on Sustainable Development which was held in Johannesburg, South Africa, in 2002. At the summit, the United Nations Decade of Education for Sustainable Development (UNDESD) (2005-2014) was declared, and many countries including South Africa were signatories to this declaration (UNEP, 2012). The goal of the UNDESD was to

integrate sustainable development values and principles in all aspects of education and learning (ibid.). At the summit, the framework for action was to implement sustainable development policies, which covered five key areas (i.e. biodiversity, water, energy, health and agriculture) as key components of the sustainable agenda (UNEP, 2007). As noted in Chapter One, the Sustainable Development Goals, the Global Action Programme and the Incheon Declaration that have been launched recently, all aim at contributing to environmental education and sustainable development (UNESCO, 2014b; 2014c; 2015a; United Nations General Assembly, 2015).

There have been debates as to whether biodiversity is a new field of study or a theme encompassed in environmental education. On the emergence on the concept of biodiversity education, Saito (2013) in Brazil commented on Van Weelie and Wals (2002) and Navarro-Perez and Tidball's (2012) conceptualisation of biodiversity education. Saito's (2013) discussion focused on the relationship between environmental education and biodiversity education. He concluded that environmental education is a response to environmental issues such as biodiversity. Thus, as used in this study, Saito (2013) argued that biodiversity education is not a separate field but rather a theme encompassed in environmental education. Based on the outcome document of the first World Conference on Education for Sustainable Development in 2009, the Bonn declaration focused its work in ESD on three key sustainable development issues: climate change, biodiversity and disaster risk reduction, to be addressed through education (UNESCO, 2010). Later, UNESCO (2014a) identified health, water, biodiversity, climate change and energy as the top five issues to be addressed through education. These environmental issues have been escalated by human activities and cannot be mitigated if humans do not change their practices and ways of living (ibid.). Back in 2005, it was observed by the Millennium Ecosystems Assessment that over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, to meet growing demands for food, fresh water, timber, fibre and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on earth.

Biodiversity issues are characterised by uncertainty, complexity and a high degree of systemic interconnection (UNESCO, 2014a). In many cases, not enough is known about biodiversity (ibid.). Wals (1999) argues that working with the ill-defined concept of biodiversity provides a vehicle to explore the critical thinking skills. It is thus the task of environmental educators (such as Life Sciences teachers) to "teach meaningfully a concept that cannot be reduced to one idea and the dimensions of which cannot be reduced to one common statistic" (Dreyfus, Wals, & van Wheelie, 1999: 162). Wals (1999) argued that the conceptual fuzziness of biodiversity gives opportunities for contextual definitions. This creates space, for example, for individual and/or groups of people to make judgements and draw conclusions on the importance of biodiversity (ibid.). For example Life

Sciences teachers can reflect on their personal values and position on biodiversity. It is important they can ask questions such as what is known about biodiversity. Why does biodiversity matter? What human conduct needs to be reviewed to deal with the loss of biodiversity? And what practices might resolve the loss of biodiversity concerns?

As mentioned in Chapter One, about 50 per cent of the South African Life Sciences curriculum is environment and sustainability knowledge (including biodiversity) (Lotz-Sisitka, 2011). This prompts the question: are the Life Sciences teachers well prepared and supported to work with the biodiversity knowledge in the curriculum? According to UNESCO (2014a), we remain uncertain about the full scope, extent and implications of biodiversity. Failing to expose learners to such knowledge is to offer them an incomplete education (ibid.). Teachers are challenged with teaching this kind of incomplete knowledge that can be questioned (Fundisa for Change, 2013). This questions the role of teacher education programmes and initiatives such as Fundisa for Change in supporting teachers to expand their capabilities on the teaching and learning of biodiversity.

2.3 Teacher education and biodiversity education

2.3.1 Initial teacher education and biodiversity

Teacher education refers to both initial preparation for teachers (pre-service) and continuing professional development for practitioners (in-service) (McKeown & Hopkins, 2014). Teacher education is important as it helps to professionalise the teaching field and to improve the quality of education (ibid.). Institutions of higher education play an important role in preparing teachers for the teaching profession but also in professional development. It is thus important to have on-going partnerships between institutions of higher education and schools. This is to ensure that teachers have access to the latest knowledge in their subjects and have access to experts for the subjects they teach; this is particularly important for teachers and environmental issues such as biodiversity, because of their complex and incomplete nature (UNESCO, 2014a). This points to the important role that teacher educators and teacher education institutions can play to promote biodiversity conservation (Stevenson, 2007; Hopkins, 2012; McKeown & Hopkins, 2014).

Robinson and McMillan (2006) indicated that “teacher educators in addition to keeping up to date with developments in their discipline also have to keep abreast of a range of new curricular and policy imperatives in the country” (p.327). Curriculum changes such as in South Africa from Revised National Curriculum Statement to CAPS have an implication for teacher education, training and provision (Reddy, 2011). One can argue that new policies on biodiversity also have an implication for teacher education, implying an implication for teacher educators who have to prepare teachers to teach biodiversity content in the curriculum. Writing from Australia, Ferreira, Ryan and Tilbury (2007) indicated that teacher education is supposed to prepare teachers and ensure

that they are fully ready to implement ESD when they start their teaching profession. However they recognise that ESD in initial teacher training programmes does not prepare teachers fully to be able to implement ESD. This is because in most countries such as South Africa most teacher educators have not been trained to support teachers to teach the environmental knowledge (Holtman, 2010).

Historically, little attention has been given to environmental education in teacher education programme (McKeown & Hopkins, 2014). Supported by UNESCO's (2004; 2005) reiteration of the significance of mainstreaming ESD into teacher education, many countries such as South Africa have incorporated ESD in both their pre-service and in-service teacher training programmes. McKeown and Hopkins (2014) observed that during the UNDESD, ESD in teacher education has evolved and progressed. At the beginning of the decade, in many countries, ESD was an 'add-on' in teacher education; priority was given to reading, writing, mathematics and science (ibid.). But by the end of the decade teacher education institutions were making efforts to infuse ESD in their curriculums and professional development programmes (McKeown & Hopkins, 2014).

Reorienting teacher education for ESD is a multi-layered process which includes change in policies, practice, skills, knowledge and values (McKeown & Hopkins, 2014). It is also a reflective process (ibid.). One of the challenges to reorienting ESD in teacher education institutions is the "lack of or inadequately trained professionals who are knowledgeable about ESD" (UNESCO, 2005:31). This implies a need to build expertise at the teacher education institutions for ESD. Good teacher education for Life Sciences teachers' biodiversity knowledge should enable teachers to extend their horizons by exploring political, economic and other aspects of the issue rather than being concerned solely with the scientific content (Gayford, 2000).

Learning about biodiversity should be a continuous process that enables teachers to construct, critique, emancipate and transform their world in an existential way (Dreyfus et al., 1999; Wals & Dillon, 2013). Dreyfus et al. (1999: 158) unpacked these terms:

Construct in the sense of building upon the prior knowledge, experiences and ideas of the learner. *Critique* is the sense of investigating underlying values, assumptions, worldviews, morals, etc., as they are a part of the world around the learner and as they are a part of the learner him/herself. *Emancipate* in the sense of detecting, exposing and, where possible, altering power distortions that impede communication and change. *Transform* in the sense of changing and shaping the world around them.

In some contexts like Israel and the Netherlands, teaching biodiversity has been instrumental, seeking behaviour change in learners (Dreyfus et al., 1999; Gayford, 2000). It has not been emancipatory where students are expected to challenge their own values and attitudes (ibid.). An instrumental approach to biodiversity knowledge seems to contradict the whole notion of a

democratic society in which citizens do not copy the behaviours of the expert, but instead act as critical and emancipated citizens (Dreyfus et al., 1999).

However if education has a role to play in biodiversity conservation, there is a need to develop learners who are able to anticipate the future risks associated with biodiversity (UNESCO, 2014a). To achieve these, teachers need to expand the capability of learners for and with democracy in order to develop competent citizens who are able to contribute to a democratic society (ibid.). This is supported by Lotz-Sisitka, Fien and Ketlhoilwe (2013) who noted that education is no longer about reproduction of knowledge and skills for production which was the focus in the nineteenth and twentieth century. In the context of this study, it is arguable that for Life Sciences teachers to be able to expand learners' capability to be able to act in a democratic society, they need to be empowered to use emancipatory pedagogies in their teaching of biodiversity. This, according to the Department of Education, will require teachers to participate in continuing professional development that will, for example, enhance their knowledge on biodiversity (South Africa. DHET & DBE, 2011b).

Minimum Requirements of Teacher Education Qualifications in South Africa recognised that teaching is “a complex activity that is premised upon the acquisition of different types of knowledge practices or learning” (South Africa. DHET, 2011:10). The policy document noted the different types of knowledge that underpins teachers' practice “while encapsulating all these in the notion of integrated and applied knowledge” (ibid.: 10).

Competent learning is always a mixture of the theoretical and the practical; the pure and the applied; the extrinsic and the intrinsic; and the potential and the actual. In effect, competent learning represents the acquisition, integration and application of different types of knowledge. Each type of knowledge in turn implies the mastering of specific related skills. (South Africa. DHET, 2011:11)

The *Minimum Requirements of Teacher Education Qualification in South Africa* thus noted the following types of learning associated with acquisition, integration and application of knowledge for teaching purposes:

- *Disciplinary learning*: refers to disciplinary or subject matter knowledge and can be represented in two components within the teaching of the curriculum: the study of education and its foundation; and the study of specific specialised subject matter.
- *Pedagogical learning*: general pedagogical knowledge which includes knowledge of learners learning, curriculum, general instructional, assessment strategies; and specialised pedagogical content knowledge; which includes knowing how to represent the concepts, methods and rules of the discipline to create appropriate learning opportunities for diverse learners and how to evaluate their progress.

- *Practical learning*: involves learning from practice. This includes the study of practice using discursive resources to analyse different practices across a variety of contexts, drawing from case studies, video records, lesson observations etc. in order to theorise practice and form a basis for learning in practice.
- *Fundamental learning*: in the South African context this refers to learning to converse in a second official language, the ability to use Information and Communication Technologies competently and the acquisition of academic literacies which lays the foundation for effective learning.
- *Situational learning*: refers to knowledge of the varied learning situations, contexts and environment of education, as well as knowledge related to policy, political and organisational contexts. Situational learning refers specifically to learning about context. (South Africa. DHET, 2011:11-12)

Shulman (1986) also proposed seven categories of teacher knowledge: content; pedagogy; curriculum; learners and learning; contexts of schooling; educational philosophies, goals and objectives; and pedagogical content knowledge. In Shulman's theoretical framework, teachers need to master two types of knowledge which is content knowledge and knowledge of curricular development (Shulman, 1986). Content knowledge refers to extensive and in-depth knowledge of the subject matter. As individuals and as a collective, they need to participate in professional development activities that will help them achieve their functionings related to subject content and pedagogies (ibid.). This is in line with the Fundisa for Change training model to enhance teachers' knowledge and pedagogy (Fundisa for Change, 2013).

According to UNESCO (2012), biodiversity education is shaped by pedagogies as much as it is by content. "Education 2030 will ensure that all individuals acquire a solid foundation of knowledge, develop creative and critical thinking and collaborative skills, and build curiosity, courage and resilience" (UNESCO, 2015b:2). Biodiversity pedagogies should help stimulate learners to ask critical reflective questions and to make decisions in collaboration with others in order to be empowered to take action for biodiversity conservation (UNESCO, 2012; UNESCO, 2014a). This would involve discussions and application of values that stimulate creativity for learners to imagine and envision alternative futures that help them work towards positive change and help them develop a sense of social justice and self-efficacy as community members (Tilbury, 2011; Hopkins, 2012; UNESCO, 2012) and teaching methods that will allow learners to inquire and investigate the biodiversity status in their local contexts (C.A.P.E, 2010). Therefore, successful teaching and learning of biodiversity requires participatory teaching and learning methods (UNESCO, 2012). These methods should ideally help achieve individual learners' desired functionings and be aligned with specific subject methods (Fundisa for Change, 2013). For example, in Life Sciences they should be aligned with investigative methods (ibid.; South Africa. DBE, 2011a).

Writing from India, Ramadoss and Poyyamoli (2011) observed that the main methods used to develop learners' biodiversity knowledge include hands-on activities, experiential methods and fieldwork. Such methods move away from rote memorisation to participatory learning (ibid.). Ramadoss and Poyyamoli (2011) researched biodiversity conservation through ESD. They developed a framework (Figure 2.1) to assess the effectiveness of teaching and learning of biodiversity at high school level. Their main interest was to enhance students' interest, knowledge and skills on biodiversity. The conceptual construct they used included teaching methods (action), concepts and values for biodiversity is shown in Figure 2.1 below.

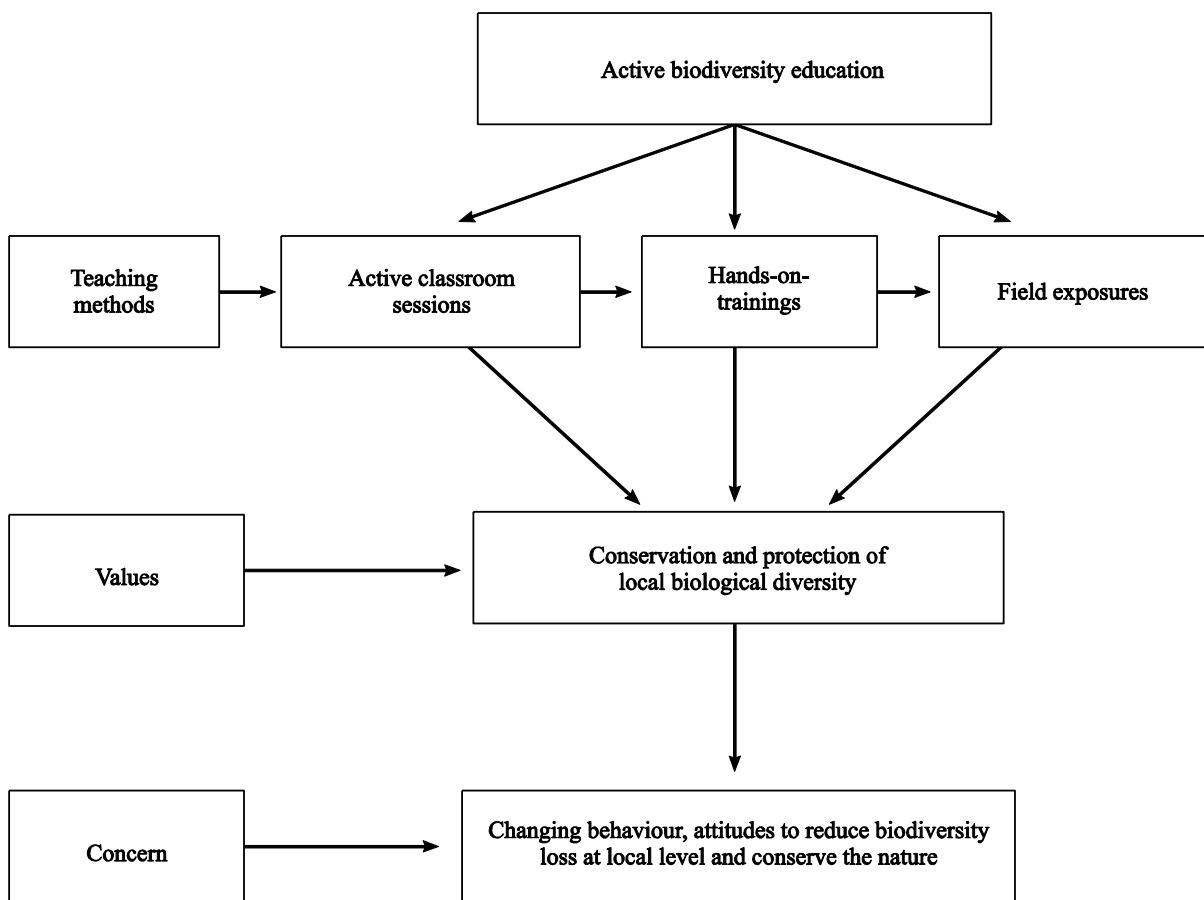


Figure 2.1: Conceptual diagram of the teaching methods and concerns in biodiversity education for school students (Ramadoss & Poyyamoli, 2011:101)

Ramadoss and Poyyamoli (2011) found that participatory methods encompassed students' cognitive and affective development related to the conservation of biodiversity. They thus stressed the need for teachers to use teaching methods beyond the classrooms to increase students' knowledge, skills and interest to protect the local biodiversity. Although more evidence is needed, research is thus beginning to suggest that students who learn through participatory methods develop greater awareness of and responsibility for the world around them (UNESCO, 2014a). In 2002, UNESCO noted that students were rarely asked to reflect upon the impacts of their activities on the wider

society and on the functioning of ecosystems. This has implications for learners' understanding and actions towards environmental problems such as biodiversity, how and why it should be conserved (UNESCO, 2014a). This then implies that teacher education and professional development programmes such as Fundisa for Change therefore have a role to play, in ensuring that, for example, Life Sciences teachers are exposed to the various methods recommended for biodiversity teaching. Such methods should give learners an opportunity to reflect on their biodiversity knowledge and biodiversity in local context.

Biodiversity pedagogies are often issue-based or place-based (Smith, 2013). Place-based education, especially in curricular domains such as science and social studies (ibid.), is closely related to John Dewey's central concerns about public school classrooms and their separation from the lives children lead when they are not in school (Dewey, 1938). Teachers should therefore have the capability to unpack abstract concepts related to biodiversity by using local examples (Gayford, 2000; Ramadoss & Poyyamoli, 2011; Hopkins, 2012). This provides an opportunity to engage students in analysing local biodiversity, making learning relevant and meaningful (Hopkins, 2012). When biodiversity content in the curriculum is presented in terms of local social, economic and environmental contexts, learning proves transformational for learners (Hopkins, 2012; UNESCO, 2012). Students develop a deeper understanding of biodiversity, better research skills and abilities in defending their opinions (Hopkins, 2012) and they develop interest in protecting and conserving local natural resources and biodiversity (Ramadoss & Poyyamoli, 2011).

Environmental education takes into consideration indigenous knowledge and practices. Shava (2000) noted that indigenous communities employ certain practices that help conserve biodiversity. He gave an example that it is taboo to eat, kill or destroy some species (such as owl, python). Another example is a belief that some trees such as the rain trees are not allowed to be cut down for firewood as this would bring bad luck to the family. He argued for the need to incorporate indigenous knowledge in environmental education for conservation of species. This would require drawing in expertise from the local communities. Mbuyazwe (2011) observed that in the Eastern Cape of South Africa, considerable local knowledge exists on marine resources.

According to UNESCO (2012) teachers' ability to use a variety of pedagogies is critical for working with learners' individual abilities and diverse needs. This is because students do not learn in the same way. Some learn through listening, others through reading or memorising (ibid.). Since education is for all, teachers need to employ pedagogies that cater for all learners' learning needs (ibid.).

In South Africa, the C.A.P.E Conservation Education programme that aimed at supporting teachers to implement biodiversity components in the school curriculum recommended deliberative approaches for effective biodiversity teaching (C.A.P.E., 2010). C.A.P.E. (2010) developed a conceptual framework for biodiversity teaching which involves deliberating what should and can be done to address biodiversity loss or threats in local areas. Figure 2.2 shows the conceptual framework suggested by the C.A.P.E. Conservation Education Programme.

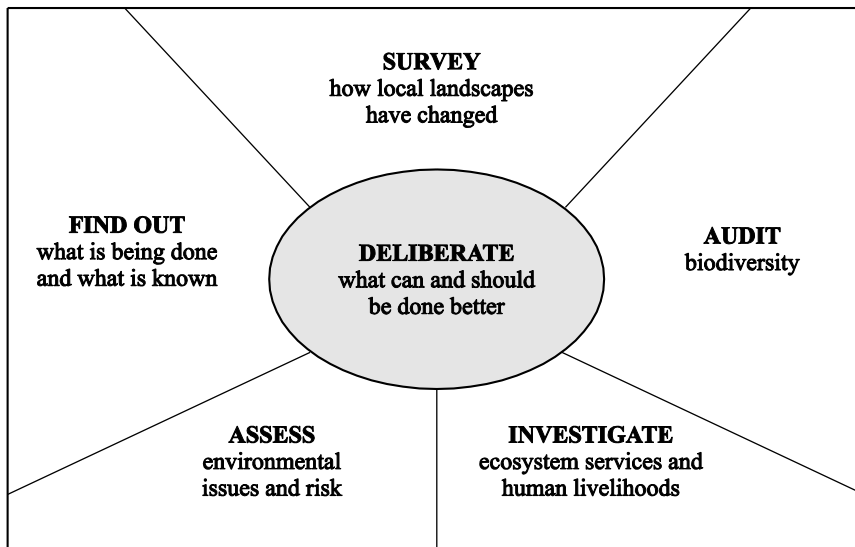


Figure 2.2: Biodiversity education practices framework (Rosenberg, O'Donoghue & Olvitt, 2008 adapted from C.A.P.E., 2010)

Below is a brief description of each aspect of the conceptual framework as adapted from C.A.P.E. (2010):

- *Finding out about the issues:* This provides space for inquiry, by asking questions such as: What do we know about an issue? What is being done? What can still be done? What is not known about the issue? This allows for development of new knowledge.
- *Surveying:* This is to find out the historical causes of the issue, by asking questions such as: How has the natural landscape changed? What caused the change?
- *Auditing biodiversity:* Ask questions such as: What is there? What has been lost? What human practices are contributing to the loss of biodiversity? These questions provide an understanding of the drivers of biodiversity loss and what species are extinct.
- *Investigating ecosystem services:* Ask questions such as: What ecosystem services exist? How are these ecosystem services supporting human livelihoods? What is threatening ecosystem services? These questions draw attention to the relationship between people and biological resources.

- *Assessing issues and risks:* Ask questions about issues or risks associated with biodiversity and ecosystem services such as are some natural resources being over-exploited.
- *Deliberate about what is being done and what can be done:* Here learners could be encouraged to review critically what is being done / and can be done in relation to biodiversity issues.

Reflecting on the pedagogies recommended above for environmental education (including biodiversity education) means that Life Sciences teachers in PLCs should be supported to explore teaching methods that allow learners to investigate deliberate and inquire about the biodiversity, and biodiversity loss in their local areas. Teaching methods chosen should also encourage learners to anticipate future scenarios related to biodiversity loss and deliberate possible solutions to anticipated biodiversity issues and associated risks. Life Sciences teachers should also be capacitated to expand learners' capabilities on assessing environmental problems related to biodiversity. In addition to the above, the choice of pedagogies Life Sciences teachers engage with in PLCs for biodiversity should inspire students to create solutions for uncertain futures, to foster a sense of hope, appreciation and respect for humans and nature. From South Africa, Schudel (2012) observed that a spiral approach to cluster-based teacher professional development could strengthen reflexivity in active learning processes. For biodiversity education, alternative methods of teaching can be explored. Those methods could be in line with transgressive pedagogies being explored by researchers such as O'Donoghue (2014). Professional development initiatives such as Fundisa for Change therefore have a role to play in continuously exposing teachers to various pedagogical practices for successful implementation of biodiversity.

2.3.2 Professional development and biodiversity education

2.3.2.1 An international perspective

Teachers are confronted by great challenges in their teaching such as changes in subject content (such as biodiversity content), new instructional methods, advances in technology, changed laws and student learning needs (Wood, 2007; Darling-Hammond, 2008). Thus regardless of the quality of pre-service training that teachers receive or how experienced they are, they will not be able to face all challenges in their careers without some form of continuing professional development. Teachers need to be encouraged to continue developing themselves professionally (South Africa. DHET & DBE, 2011b). Professional development is the way to help address these challenges by aiming at continually improving teachers' professional competence, and assisting teachers in identifying suitable continuing professional development programmes that may contribute towards their professional growth (South Africa. DoE, 2007). The 2014 action plan *Towards the realisation*

of schooling 2025 of South Africa highlighted that teachers should be confident, well trained and continually improving their capabilities (South Africa. DHET, 2011b).

There is no lack of literature on teacher education and professional development. Related to teachers and biodiversity knowledge, studies have been conducted in different parts of the world since the late 1990s. These include studies from Israel and the Netherlands (Dreyfus et al., 1999; Van Weelie & Wals, 2002), the United Kingdom (Gayford, 2000), India (Ramadoss & Poyyamoli, 2011), Brazil (Saito, 2013), Costa Rica and Germany (Fiebelkorn & Menzel, 2013; Jäkel, 2013) and the United States of America (Navarro-Perez & Tidball, 2012). Some of the studies focused on students' knowledge on biodiversity providing evidence that teachers' insufficient knowledge on biodiversity knowledge is reflected in learners' lack of knowledge on biodiversity (Chandrasekhar, Sundaravadivelan, & Selvan, 2012). Other studies researched both teachers' pre-service and in-service knowledge on biodiversity related concepts and most of those studies also found that teachers lack an understanding of biodiversity (Van Weelie & Wals, 2002; Jäkel, 2013, Jiwa & Esa, 2015).

A recent study conducted in Malaysia on student teachers knowledge of biodiversity (Jiwa & Esa, 2015) found that there were some students who had limited knowledge on biodiversity and understanding of methods of teaching biodiversity. The study thus concluded that there is a need for research directed at identifying student teachers' needs in training programmes on biodiversity to enhance their knowledge on biodiversity. As educators, they should be able to relate new scientific knowledge to everyday life and critically judge and analyse information (ibid.). In Germany it was observed that many graduate teachers had little interest in biodiversity as well as insufficient knowledge on biodiversity (Jäkel, 2013). And in India it was found that secondary school students lacked awareness on biodiversity (Chandrasekhar et al., 2012). Due to teachers' lack of confidence in Science, they were often reluctant to offer outdoor field activities on biodiversity (Howitt, 2007).

In the United States, Luft (2007) found that teachers' motivation, enthusiasm and commitment to implement what they know about biodiversity can be diminished by other factors such as learners' discipline problems. In accordance with Van Weelie and Wals (2002) from the Netherlands, the study found that good teacher preparation requires both good use of diverse methods and sound content knowledge. Luft (2007) thus concluded that for effectiveness, biodiversity education programmes should strike a balance between sound content knowledge and opportunities for teachers to obtain practical experiences in teaching of biodiversity.

Navarro-Perez and Tidball (2012) recognised that biodiversity education has gained recognition in national policy in the United States but there are challenges for its implementation in education.

This is because of the complex interrelationships in the concept of biodiversity (ibid.). They also noted that the real challenge is that biodiversity comprises of three levels (genes, species and ecosystems) but it is not always acknowledged by educators. Navarro-Perez and Tidball (2012) further observed that the other challenge for teachers is that biodiversity is a global problem and its concepts are surrounded by complex ethical, economic and social issues. The complexities pose problems for teachers (and for the learners they work with): “This implies that in order for people to understand what biodiversity is, they may need to understand what biodiversity means ecologically, culturally, socially or economically and how its loss affects all of these dimensions” (Navarro-Perez & Tidball, 2012:20).

It is thus evident that in many countries, both teachers and teacher educators lack knowledge and teaching methods to teach biodiversity. In some studies this is reflected in students’ lack of knowledge on biodiversity (Chandrasekhar et al., 2012). Recommendations from Van Weelie and Wals (2002) and Luft (2007) are thus clear that there is a need for both teachers and teacher educators to enhance their knowledge and teaching methods for the effective teaching of biodiversity (Randler, 2008; Ramadoss & Poyyamoli, 2011). What this could mean for this study considering the context is that if PLCs are to expand Life Sciences teachers’ capabilities on teaching biodiversity, they need to engage in both content knowledge and teaching methods for biodiversity teaching. Reflecting on Van Weelie and Wals (2002) and Navarro-Perez and Tidball’s (2012) insights, for PLCs to expand teachers’ knowledge on the complex concept of biodiversity, they need to engage in discussions that help understand the concept. In Ethiopia, Dalelo (2012) found that teachers were aware of the biodiversity topics in the curriculum they teach, but lacked conceptual understanding on the topic. The next section will provide literature from southern African research on teachers’ knowledge on biodiversity teaching.

2.3.2.2 Southern African perspectives

The Southern African Journal of Environmental Education publishes some of the research done in southern Africa in the field of environmental education. In reviewing the literature for the 25 journals published, it was evident that there has been a considerable amount of research conducted in the region. Similar to the international literature, some of the research focused on learners and students’ knowledge on environmental education and some focused on pre-service and in-service teachers’ environment and sustainability knowledge. Examples of studies conducted focusing on teacher education came from Zambia (Shumba & Kampamba, 2012/2013) and South Africa (Peden, 2008; Lotz-Sisitka, 2011; Reddy, 2011) among others. Kanyimba (2002) indicated that learner-centred education and related pedagogical approaches which are currently offered in Namibia are currently being challenged for not meeting the educational goals of social justice and for denying

learners access to powerful knowledge systems. Haingura (2009) and Tshiningayamwe (2011) agreed with him, recommending that there is a need to strengthen teachers' knowledge of learner-centred education and how to plan and implement it in Namibia. In reviewing literature, southern African research did not specifically focus on professional development of Life Sciences teachers and/or on Life Sciences teachers' biodiversity knowledge, hence it seemed useful for this research to focus on Life Sciences teachers' valued beings and doings related to biodiversity teaching and how professional development activities can act as conversion factors that expand and/or constrain teachers achieving their valued beings and doings.

In South Africa, I found evidence of research conducted in the last five years focusing on professional development and classroom practices of Science teachers related to biodiversity (Holtman, 2010; Mbuyazwe, 2011; Songqwaru, 2012; Gqoloqa, 2014; Chitsiga, 2015; Isaacs, 2015). This could be because of the rate at which biodiversity is being lost, or perhaps because of other interests researchers saw a need for research on professional development and teachers' biodiversity knowledge in South Africa and/or teachers classroom practices related to biodiversity. But irrespective of the motivation for the research, it was evident from these studies that in South Africa teachers lack knowledge on biodiversity and teaching methods and resources for teaching biodiversity, as discussed further below.

Research conducted on the teaching of evolution in South African schools (Holtman, 2010) found that teachers were willing to attend workshops and courses that "do not waste my time and will be meaningful to my learners" (p.106). This study thus recognised a need for institutions of higher education to form structures that would support teachers and subject advisors to work together on biodiversity (particularly on the topic of evolution) knowledge. Mbuyazwe (2011) explored how teachers acquire content knowledge of marine and coastal issues. In her study, she found that when adapted materials were used in the classroom activities there was little effective mediating of learning towards clear curriculum outcomes. She further found that teachers assessment of learners was not clear; it was limited to content presented and did not extend to feedback. She further found that teachers, in their reflections, acknowledged that they had limited use of materials as knowledge resources.

Songqwaru (2012) researched how teachers can be supported to understand and work with the environment and sustainability content knowledge in the CAPS grade 10 Life Sciences curriculum. In her study, she found that teachers had content gaps in environment and sustainability knowledge which can be addressed through professional development that emphasises rich subject knowledge. Songqwaru (2012) further found that Life Sciences teachers were not familiar with teaching methods that can be used to teach environmental and sustainability content knowledge, and they

struggled to see the relationship between teaching and assessing. Like Mbuyazwe (2011), she found that teachers had inadequate resources for teaching biodiversity. Songqwaru (2012) recognised, however, that through professional development programmes teachers developed confidence in their teaching of biodiversity.

Gqoloqa (2014) conducted research on how grade 11 teachers mediate biodiversity concepts in an English Second Language context. Her study found that Life Sciences teachers demonstrated knowledge of a variety of teaching strategies (mostly learner centred) to support learners. She further observed that teachers' reflections on their practice provided opportunities for them to identify strengths and limitations of their choice of strategies and possibilities for improvement.

Isaacs (2015) explored what teachers know, believe and say about biodiversity and the teaching of biodiversity. She recognised that there seemed to be an assumption among teachers that teaching from certain textbooks would meet the curriculum aims on biodiversity. She further observed that teachers' close adherence to activities prescribed in the textbook seemed to limit the depth, scope and criticality of their biodiversity teaching. The biodiversity knowledge of the teachers was mostly limited to what they access in the curriculum document and textbooks (Isaacs, 2015). Songqwaru (2012) found that through professional development activities, teachers' knowledge and use of assessment methods in biodiversity teaching improved. He further found that teachers' subject content knowledge and use of teaching methods in biodiversity teaching improved.

These studies recommended a need for better materials to support teachers in developing their content knowledge in line with the curriculum goals (Mbuyazwe, 2011). They noted that 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 (Songqwaru, 2012), how teachers could be supported with subject content knowledge, teaching and assessment methods (Gqoloqa, 2014) and training given to teachers should be interactive to enable them to recontextualise training received in their work places (Songqwaru, 2012). Teacher training should go beyond content knowledge that teachers have to teach and should also consider how teachers can teach and assess that knowledge (Mbuyazwe, 2011; Songqwaru, 2012). Chitsiga (2015) noted a need for more on-going content workshops on environmental knowledge and exposure to active learning pedagogy. Holtman (2010) recognised that the South African curriculum had major intentions to transform the lives of South Africans, but that this can only be achieved if teachers receive the right training and support.

To reflect on the above findings and what these mean for this study, it is thus arguable that if PLCs are to enhance teachers' capabilities on biodiversity teaching, the PLC activities should engage

teachers in new teaching methods, in new content knowledge and in how to develop resources that are aligned to curriculum aims and will help teachers go beyond their textbooks. As also evidenced in Mbuyazwe (2011) and Songqwaru's (2012) studies, PLC activities should engage teachers in assessment practices to expand teachers' capabilities on assessing biodiversity. And for these PLCs to be effective and a success, among other stakeholders, the higher institutions of education and subject advisors have a role to play (Holtman, 2010).

Research conducted in different contexts suggests a need for teachers' education programme and professional development activities that will enhance teachers' biodiversity knowledge. This is to help achieve transformative environmental learning. This has potential to improve the quality of education (UNESCO, 2014a). Quality education can be understood not only to instil basic competencies (such as literacy and numeracy) but also to develop lifelong values that underpin sustainability (ibid.). These competencies should allow both teachers and learners to exercise their individual and collective agencies and achieve their valued beings and doings related to biodiversity (UNESCO, 2014a). Quality education is about what and how teachers and learners learn, its relevance to today's world and global challenges such as biodiversity loss, and its influence on people's choices (UNESCO, 2014a). This type of education reinforces students' sense of responsibility as global citizens (ibid.). Education 2030 documents from the World Education Forum have noted:

Quality education fosters creativity and knowledge, and ensures the acquisition of the foundational skills of literacy and numeracy as well as analytical, problem-solving and other high-level cognitive, interpersonal and social skills. It also develops the skills, values and attitudes that enable citizens to lead healthy and fulfilled lives, make informed decisions, and respond to local and global challenges through education for sustainable development and global citizenship education. (UNESCO, 2015a: 2)

This quote demonstrates that for quality education to be achieved in South Africa, teacher education and particularly professional development models have to foster teachers' different types of knowledge and pedagogical practices that will promote analytical, problem solving skills and other higher cognitive abilities. PLCs for Life Sciences teachers should not overlook these issues, including paying attention to numeracy and literacy.

2.4 Professional development modalities

Different researchers have different views on what effective professional development is. For example, from the United Kingdom, Guskey (2003) asserted that effective professional development requires that, "teachers work together; reflect on their practice, exchange ideas, and share strategies" (p. 749). Desimone (2009), writing from the United States, maintained that professional growth of teachers can be best understood by social contexts of their work. She argued

that teaching improvement is embedded in a broader framework focus on increasing knowledge and skills which contribute to personal, social and emotional growth of teachers. In the United States, the most effective professional development emphasises active teaching, assessment, observation and reflection rather than abstract discussions (Darling-Hammond & McLaughlin, 1995) and it is sustained, intensive, on-going and connected to practice; aligned with school improvement priorities and goals; builds strong working relationships among teachers; and is focused on student learning and addresses the teaching of the specific curriculum content (Darling-Hammond, 1996; Darling-Hammond et al., 2009). Writing from the South African context, Mokhele and Jita (2010) observed that in order for continuing professional development programmes to be successful, they have to be personally meaningful to the participating teachers; they concluded that, continuing professional development programmes should be aligned with the personal circumstances and motivations of the teachers. Reflected in some of these arguments is the role of the teachers in professional development. These definitions also reflect that effective professional development needs to be continuous and focused on improving practice. What this study means for Life Sciences teachers in South Africa, if they are to improve their knowledge on biodiversity, is that they need to participate in professional development activities that are on-going and connected to their teaching practice of biodiversity.

Effective professional development for environmental education needs to be contextual, responsive, emergent, participatory, critical and praxiological (Robottom & Kyburz-Graber, 2000). This would allow teachers opportunities to be active, reflective and responsive of their own teaching practice (Fundisa for Change, 2013). Such professional development will enable teachers not only to be passive recipients of others' expertise, but also to be creators, disseminators and preservers of knowledge (Wood, 2007; Mayer & Lloyd, 2011). Wood (2007) positioned teachers as intellectuals, who can think, inquire and conceptualise their own biodiversity knowledge and not as disseminators of others' knowledge. In literature there is evidence of various types of professional development modalities. It is the responsibility of professional development initiatives, such as Fundisa for Change, to question the effectiveness of different modalities and teachers' role in those professional development modalities.

Before exploring the different professional development modalities discussed in literature, I would like to highlight that in South Africa, a system has been introduced whereby all the principals, Head of Departments and teachers will be gaining professional development points to be allocated and managed by the South African Council of Educators (SACE). These are with the following six main purposes:

- To improve schooling and the quality of learner achievements;

- To coordinate professional development activities with a view to achieving sharper focus and effectiveness;
- To revitalise the teaching profession and foster renewed commitment to the profession's seminal role in the development of our country;
- To contribute to the responsible autonomy and confidence of the teaching profession;
- To enable the profession to re-establish its professional standing and role in advancing the ideals of social justice; and
- To acknowledge the effective participation of teachers in professional development activities which are priorities for the education system and the teaching profession. (SACE, 2008: 4-5)

Professional development activities will be grouped into three kinds according to the main basis of their priority:

- *Teacher priority activities* are those chosen by teachers themselves for their own development and the improvement of their own professional practices.
- *School priority activities* are undertaken by the school leadership and staff collectively, focussed on whole school development, the institutional conditions for the improvement of learning, and improved teaching.
- *Profession priority activities* have directly to do with enhancing the professional status, practices and commitments of teachers in areas of greatest need, as defined by the Department of Education, SACE, national teachers' unions or other national professional bodies. (SACE, 2008:5)

Teachers will then be awarded points for participating in different activities in these categories. They will be required to earn 150 points in a three-year cycle (SACE, 2008). To acquire professional development points, the professional development activities have to be endorsed by SACE and the weighting system will apply (SACE, 2008). For teachers, the earning of professional development points will only start in 2016.

Professional development modalities include: seminars, conferences or workshops, coaching and mentoring, formal courses and collaborative models (Borko, 2004; Schmoker, 2004; Kennedy, 2005; Stoll et al., 2006; Darling-Hammond, 2008; Mizell, 2010). Professional development can also happen in informal contexts such as conversations with colleagues, independent reading and research (Mizell, 2010). Seminars, workshops and conferences are traditional models of professional development (Schmoker, 2004). These modalities are grounded in the assumptions that the purpose of professional development is to convey knowledge to teachers (Vescio, Ross, & Adams, 2008). In the United States, over 90 per cent of teachers participate in workshops during a school year (Darling-Hammond et al., 2009). Most of these professional development activities last for a couple of hours. They are generic, discuss one or two structured topics and are disconnected from teachers' classroom activities (ibid). Traditional models of professional development usually

do not allow teachers time to reflect on their classroom practice, thus have minimal effect on teachers' practice and learners' achievements (Wood, 2007).

The collaborative continuing professional development models represent a fundamental shift away from these traditional models, by assuming that teachers are not only implementers of other's ideas; they are also creators of knowledge and that practice is a central aspect of this knowledge co-creation process for teachers (Wood, 2007). This provides an argument for collaborative continuing professional development models and for engaging teachers in such models to improve their biodiversity knowledge and teaching practice. Stevenson (2007) supported this by highlighting that teachers have their own ideas that emerge from experience, circumstances and understanding of teaching and learning. It is thus important for professional development activities to provide spaces for teachers to learn collaboratively with colleagues on biodiversity.

Mentoring and/or coaching programmes may be effective for starting teachers off on biodiversity. Mentoring teachers who are new in the profession involves including them in planning meetings and in networks of teachers teaching the same subjects or grade level (Ingersoll & Kralik, 2004). The National Commission on Teaching and America's Future reports that in countries like China it is almost mandatory that new teachers are inducted into the community of teachers teaching the same subject (NCTAF, 2005). In Switzerland, new teachers are encouraged to observe practices of more experienced teachers (*ibid.*). In a number of Asian nations, new teachers are usually given time during the school hours to meet with their mentor teachers (*ibid.*). This gives them time to discuss issues related to professional development (NCTAF, 2005). Mentor teachers should be trained to induct new teachers into the profession effectively. Alternatively Clement (2000) noted that the best qualified and experienced teachers can act as mentors for new teachers, even across schools to ensure best practices. South Africa can consider mentoring as a professional development activity for new teachers on practices related to biodiversity. Mentoring can be coupled with action research. As suggested by Mbuyazwe (2011), action research gives teachers opportunities to test teaching strategies that allow them to inquire about local biodiversity and other environmental matters of concern. This implies that action research will also provide new teachers with opportunities to research their own practices related to biodiversity and to reflect on it.

In Europe and the United States, the 1980s were described as a 'collegial professional era' for teachers (Du Four & Eaker, 1998; Darling-Hammond, 1999; McLaughlin & Talbert, 2001; Hargreaves, 2002; Darling-Hammond et al., 2009). During this period, teachers were treated as professionals who were encouraged to share their practices with colleagues (Hargreaves, 2002). The Organisation for Economic Cooperation and Development observed that teachers engaged with a number of collaborative models where they planned together in collective departmental and subject

meetings (OECD, 2004). In literature it is evident that collaborative models differ from country to country. For example in Ireland, professional development is built into teachers' work schedules (about 15-20 hours set aside a week for professional development) (OECD, 2004). In countries like Singapore, only 35 per cent of the teachers time is spent in the classroom, the remaining time is spent on professional development activities (ibid.).

Collaborative models allow for on-going, sustained professional development activities and allow teachers to focus on one issue at a time in detail (Stoll et al., 2006). These models recognise the importance of teachers' agency (South Africa. DBE, 2014). This is critical for teachers' biodiversity knowledge. Collaborative models may consider collaboration possibilities with external communities that, for example, have an interest in environmental issues such as biodiversity loss (Stevenson, 2007). For their effective involvement, the external communities need to be properly coordinated (ibid.). External communities often engage in environmental and sustainability activities that do not necessarily promote educational processes (Scott & Gough, 2003). This is because of their different assumptions about educational processes (Stevenson, 2007). Many NGOs are experienced with practical skills but lack the understanding that learners need to be independent in their own learning, which is considered necessary for transformational learning (ibid.).

The lesson study is an example of a collaborative professional development model (Lewis & Hurd, 2011). This approach continues to be a paradigm shift for most educators outside Japan (ibid). The lesson study model has been and is still being experimented with in some parts of South Africa (i.e. the Western Cape, Mpumalanga and the Free state provinces) to help new teachers (especially in Maths and Science) begin their journey, and experienced teachers deepen their work (Mokhele & Jita, 2010; Ono & Ferreira, 2010). The lesson study approach provides teachers with a learning structure, to reflect on their own practice, build a shared knowledge base, foster intrinsic motivation and build a culture that emphasises continuous improvement and collaboration (Lewis & Hurd, 2011). They noted that the lesson study model allow teachers to seek answers from one another, from outside specialists, from research and from carefully studying their students during lessons. Unlike many other professional development models, these models are not 'one size fits all'. They are usually teacher directed, teacher driven and teacher oriented (ibid.). Lesson study is primarily about developing the knowledge, disposition, relationships and windows into each other's classroom that is needed to improve instruction and to make schools places where teachers continue to learn (ibid.).

In 2003, Cordingley, Bell, Rundell and Evans conducted a systematic review on sustained collaborative continuing professional development and its effect on teaching. They concluded that teachers who participate in collaborative models have greater confidence, develop enthusiasm for

collaborative working, greater commitment to changing practice and are willing to try new things. Learning within collaborative models involves active deconstruction of knowledge through reflection, analysis and its reconstruction through action in a particular context as well as co-construction through collaborative learning with peers (Mitchell & Sackney, 2009). Rosenholtz (1989) maintained that teachers who are supported in their classroom practice are more committed and effective than those who do not receive such support. Research shows that most professional development models have failed to improve teachers' practice (Schmoker, 2006). PLCs hold the promise to succeed where more standard types of professional development have failed (Killion, 2012). As mentioned in Chapter One, PLC is an emerging policy concept in South Africa and is also the focus of the study: it is thus important in the next section to explore the literature on PLCs.

2.5 Professional Learning Communities

PLCs have different interpretations in different contexts. In some contexts the concept has been misinterpreted and ubiquitously used to the extent that is in danger of losing its meaning (Du Four, 2004). Some of the definitions on PLCs given in literature include “on-going groups ... who meet regularly for the purpose of increasing their own learning and that of their students” (Lieberman & Miller, 2008:2). PLCs are “teachers who work collaboratively to reflect on practice, examine evidence about the relationship between practice and student outcomes, and make changes that improve teaching and learning for the particular students in their classes” (McLaughlin & Talbert, 2006:3-4). With a slightly different opinion, Fulton, Doerr and Britton (2010) have argued that to be able to define the concept of PLC, there is a need to understand it more fully. They therefore provided a more detailed view noting that *professional* means engaging educators in the development of their professional practice; *learning* means focusing on both the learning of the educators and the learning of the students; and *community* requires common vision, goals, purposes and a shared sense of trust as well as collaborative work (p.6). Reflected in these definitions of PLCs is that the focus of learning is not on individual teachers' professional learning but rather on the professional learning within the community context. This communal conception of learning, according to Sfard (1998), assumes an inextricable bond with identity formation. The community aspect of a PLC enables collegial support for individuals (Stoll et al., 2006). Salomon's (1993) notion of distributed cognition presumes that members of the community take responsibility for their contribution to the group and individual learning process.

Borko (2004) claimed that professional development is situative and that outcomes are influenced by personal and group processes. The contextual nature of teaching explains teachers' self-perception as experts in one domain and novices in another. Brody and Hadar (2011) wrote that the community have an impact on the individual teachers as learners. But how inclusive should the

community in PLCs be? In the review done on PLCs by Stoll et al. (2006), they found that there was no standard model of PLCs. PLCs can function in one school including teachers only or teachers, management and the whole school administration (ibid.). PLCs can also function in networks where teachers from several schools work together (ibid.). Teachers in PLCs may be teaching multiple subjects or one subject content (Katz & Earl, 2010). PLCs can also consist of teachers teaching different phases or same phase (ibid.). PLCs consisting of teachers teaching multiple subjects and phases can limit the depth or effectiveness of work on content knowledge or pedagogical content knowledge (Stoll et al., 2006; Fulton et al., 2010). Regardless of what PLC activities teachers participate in; their specific school context remains important (Katz & Earl, 2010). The social setting of the schools influence and support (or not) any changes that teachers want to undertake (ibid.). In this study, of particular interest are PLCs that operate outside the school and consist of Grade 10-12 Life Sciences teachers from various schools in one district. This is motivated by the model used by Fundisa for Change programme. Fundisa for Change support to teachers is subject, grade and environmental issue specific (Fundisa for Change, 2013).

Reviews on PLC literature concludes that PLCs support teachers' acquisition of new knowledge and skills, thus improves teachers' content knowledge and professional practice (Stoll et al., 2006; Feger & Arruda, 2008; Vescio et al., 2008). PLCs provide spaces for teachers to raise questions about their teaching, discuss content knowledge and to experiment with diverse models of students' problem-solving methods resulting in improved teaching practice (Vescio et al., 2008). The National Council of Teachers of English (2010) in the United States observed that PLC models bridge the gap between research and practice, connect pedagogical practice with disciplinary area knowledge and foster transformative teaching. Teachers in PLCs share successful teaching strategies, develop new approaches to shared problems and share the specific subject content knowledge (ibid.). These findings imply the potential of PLCs for Life Sciences teachers' biodiversity knowledge. Life Sciences teachers can use PLCs to collaborate on their knowledge on biodiversity and they can experiment with new teaching methods that are encouraged for biodiversity teaching. This has the potential to improve learners' knowledge on biodiversity and ultimately contribute to the conservation of South Africa's biodiversity.

2.5.1 History of the concept of Professional Learning Communities

The concept of PLC is relatively new in many contexts, but has its roots in the work of some older, well-known theorists. This includes Stenhouse's (1975) ideas of teacher as a researcher who plays an active role in curriculum development process; Schön's (1983) influential notion of 'reflective practitioner'; and Dewey's view that "...educational practices provide the data, the subject matter, which forms the problems of inquiry" (in Stoll et al., 2006:223). The collegial dialogue provided by

the PLC structure is an opportunity to rekindle the ‘Deweyan approach’ utilizing collective inquiry through systematic observations and analyses of classroom observation as the basis for professional learning (ibid.). The process, Dewey argued, ought to include focused professional conversations among colleagues, which in turn stimulate innovations and further inquiry (Dewey, 1938).

The concept of PLC however only became popular in the 1990s borrowing from the ‘learning organisation’ in business described by organisational theorist Peter Senge in *The Fifth Discipline*. Senge (1990) articulated workplace as learning organisations. Learning organisations are places “where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together” (ibid.:3). Characterising learning organisation is collaboration and active participation of employees in creating a shared vision and culture to effectively work together in identifying and solving problems (Senge, 1990).

The organisational structure of a PLC in education theory began to develop with the research conducted by Rosenholtz in 1989. She found that teachers who were provided with opportunities for collegial collaboration learned from the experience and applied the knowledge gained into their classroom practices. Drawing on the idea of organisational learning and education, Vescio et al. (2008) concluded that the concept of PLCs is based on the premises from the business sector regarding the capacity of organisations to learn. They noted further that, modified to fit the world of education, the concept of learning organisations became that of a learning community that would strive to develop collaborative work cultures for teachers.

Drawing on Schön’s (1983) ideas, Little (2003) asserted that in PLCs teachers get opportunities to tap their tacit knowledge, and to share their assumptions of teaching and learning, allowing for critiques from colleagues. PLC settings allow teachers to think of themselves as primary agents for necessary changes in teaching and learning (Wood, 2007). Yendol-Hoppey and Dana (2010) advised that teachers in PLCs should examine students’ work as that helps deepen their knowledge of the students’ strengths and weaknesses, the strengths and weaknesses of their curriculum and their own planning and raising questions about their own teaching practices. Change occurs as teachers learn to describe, discuss, and adjust their practices according to a collectively held standard of teaching quality (Little, 2003). PLCs privilege theory as well as practice, they encourage and support members to examine their practice, to try out new ideas, and to reflect together on what works and why; and they provide opportunities for the collective construction and sharing of new knowledge (Hord, 1997; Westheimer, 1999). In the 21st century, teachers should also be supported to explore online platforms as spaces for networks professional development (Yendol-Hoppey & Dana, 2010). Web 2.0 can be a useful learning tool for teachers. Using online

spaces provides flexibility for communication between teachers in PLCs (Yendol-Hoppey & Dana, 2010; Mayer & Lloyd, 2011). Thus in the interest of this study, professional development initiatives such as Fundisa for Change could consider setting up online spaces for teachers to share knowledge on biodiversity or modelling online PLCs as options for Life Sciences teachers continuing professional development. This would allow teachers to use digital tool which can help them develop both professionally and personally (Mayer & Lloyd, 2011). The PLC concept is associated with different learning theories (Stoll et al., 2006).

2.5.2 Theories on Professional Learning Communities

Theories of PLCs mainly point to communities of practice, adult development theory, workplace learning and organisational learning. Most of these theories of learning are grounded in various adult learning theories aligned with socio-cultural learning. The socio-cultural learning theories are grounded in the work of Vygotsky (1978).

2.5.2.1 Vygotsky's learning theory

PLCs are positioned in the social constructivist theories of learning. Social constructivist theories build on the work of a Russian child psychologist, Lev Vygotsky. Social constructivist learning theories argued that learning is a social activity (Vygotsky, 1978). Central to Vygotsky's work is the notion of the zone of proximal development. Vygotsky introduced this in the effort to deal with the practical problems regarding the assessment of children's intellectual abilities and the evaluation of instructional practice (Wertsch & Tulviste, 1992). Thus Vygotsky's notion of zone of proximal development links instruction and assessment as the means of regulating and learning and thereby fostering development (ibid.). Vygotsky (1978) defined zone of proximal development as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Wass, Harland and Mercer (2011) observed that Vygotsky did not clarify what he meant by 'more capable peer'. However it is widely accepted in literature that a 'more capable peer' can be a researcher, teacher, teacher educator, researcher, interventionist, parent, peer etc. (Walqui, 2006; Wass et al., 2011). Seemingly, the more capable other will depend on the context. For example, Wass et al. (2011), from the context of higher education, explored how Science students' critical thinking skills could be developed. Working with the concept of zone of proximal development, they noted that in their context 'more capable peer' meant the direct and indirect assistance students were receiving from other students, teachers, lecturers and researchers. Thus, in the context of this study, more capable peer includes the assistance that teachers in the PLCs receive from their colleagues, facilitators or subject specialists in the PLCs amongst others to improve their biodiversity knowledge.

Vygotsky explored the implications of the zone of proximal development on organising instruction and assessment (Vygotsky, 1978). He argued that instruction should be closely related to the potential level of development, rather than the actual development (ibid.). He observed that different learners with the same age, under the same circumstances, will have different zones of proximal development. To illustrate this he gave the following example about assessment:

Imagine that we have examined two children and have determined that the mental age of both is seven years. This means that both children solve tasks accessible to seven-year-olds. However, when we attempt to push these children further in carrying out the tests, there turns out to be an essential difference between them. With the help of leading questions, examples, and demonstrations, one of them easily solves test items taken from two years above the child's level of [actual] development. The other solves test items that are only a half-year above his or her level of [actual] development. (Vygotsky, 1956, cited in Wertsch & Tulviste, 1992:549)

Harland (2003) introduced the concept of the zone of current development. Wass et al. (2011) argued that if the zone of proximal development refers to the distance that a learner or teachers in PLCs can achieve with the assistance of the more capable peer, then the zone of current development “represents the level that the learner can reach through independent problem solving” (p. 319). Figure 2.3 shows a diagram that was used by Harland (2003) to explain the link between the zone of current and the zone of proximal development.

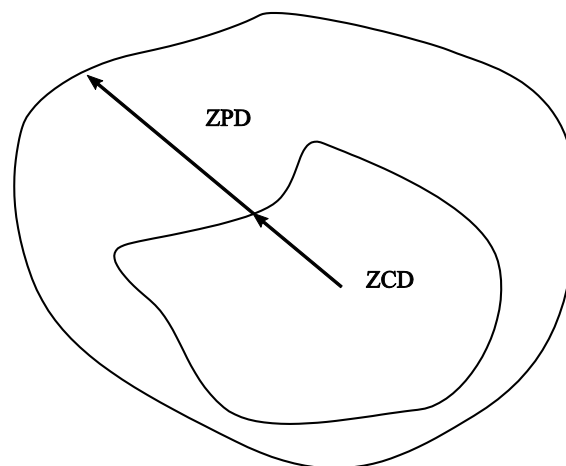


Figure 2.3: Movement through the zone of proximal development from the zone of current development through successful scaffolding (Harland: 2003:265)

Through Vygotsky's theories, the idea of scaffolding was identified by Bruner (1993) and defined as "...a process of setting up the situation to make the child's entry easy and successful and then gradually pullback and handing the role to the child as he [sic] becomes skilled enough to manage it" (p.60). The notion of scaffolding is closely related to Vygotsky's concept of zone of proximal

development. In fact, Walqui (2006) argued that “it is within zone of proximal development that scaffolding can occur” (p.163). Thus shown in Figure 2.3 is that learners can reach their zone of proximal development through successful scaffolding. Through successful scaffolding learners can reach a goal or engage in a task they could have not achieved without the assistance of the more capable peer (Harland, 2003). The aim of scaffolding is thus to support learners to get to a certain level of understanding which they could not have reached without the assistance of the more capable peer (Walqui, 2006). Through successful scaffolding, learners should be able to demonstrate that they are able to reach that level of understanding independently (ibid.). Once the learner has reached that level of independence, then the scaffolding support is gradually taken away to give learners more control to perform the task (ibid.). After successful scaffolding, the outer edge of the zone of proximal development defines the limits of the new zone of current development as shown in Figure 2.3 (Harland, 2003). According to Vygotsky (1978), “what is the zone of proximal development today will be the actual developmental level tomorrow” (p.87).

The above information explains why the zone of proximal development model has gained attention among researchers. The notion of the zone of proximal development is useful in understanding how learning and development can be enhanced (Wass et al., 2011). For example, as noted above, Wass et al. (2011) used the zone of proximal development model to explore how scaffolding happens in higher education to enhance Science students’ critical thinking and problem solving skills. In school contexts, the zone of proximal development can help understand how teachers scaffold learning to enhance learners’ learning. This is to inform the type of interventions that can help enhance the learners’ learning. Vygotsky’s starting point for instruction is the learner’s current knowledge and skills (Wertsch & Tulviste, 1992). From a constructivist perspective, there is always a strong relationship between what the learner already knows and can do, and what is to be learned (ibid.). Whatever strategy a teacher uses, each student will construct their own meaning based on an interaction between prior knowledge and current learning experiences (ibid.).

However in the light of this study, Warford (2011), in his article entitled ‘The zone of proximal teacher development’ noted that although Vygotsky’s model of zone of proximal development is well established, little is known about his approach to teacher development. There are thus more questions as to what a Vygotskian approach to teacher education might look like. Warford (2011) observed that there is evidence of researchers in sociocultural theory who have extrapolated Vygotsky’s genetic model to teacher development. These researchers have argued that teacher knowledge is continuously changing to accommodate the changing school and classroom contexts (ibid.). They thus note that a Vygotskian approach to teacher development sees education of teachers as situated learning (ibid.). In his view, teacher education programmes should also stay

within the zone between what the teachers “can do on their own without the assistance and proximal level they might attain through strategically mediated assistance from more capable others” (Warford, 2011: 253). Thus the zone of proximal development for teachers will go through the same process as for learners, starting with assistance of the more capable other, then self-assistance (ibid.). Warford (2011) further noted that the zone of proximal development of the teacher will start with reflections on prior teaching experiences and assumptions. Therefore, in the case of PLC models the above discussion signals that teachers must be able to reflect on their teaching and learning, they should understand their own acquisition of knowledge and the relationship within the social context, in order to be effective in the classroom (Brody & Hadar, 2011). Based on the above arguments, is also arguable that in the PLCs teachers will have different learning needs depending on their zones of proximal development. This implies that for teacher education programmes such as the Fundisa for Change programme to support teachers in the PLCs fully, they need to understand the teachers’ zones of current development and zones of proximal development. Vygotsky (1978) viewed learning as a social collaborative activity. This argues, according to Hord (2008), for forums where teachers are able to construct knowledge of teaching practice through a continuous cycle of learning rooted in reflection, social collegial interaction, and professional dialogue, all processes that can provide scaffolding for improved knowledge of teaching.

2.5.2.2 Theories of communities of practice

Concepts of PLCs and communities of practice are used interchangeably in some contexts. Although these concepts refer to similar structures, they have different origins. As discussed earlier, the concept of the PLC has its origin in learning organisations in the business sector (Senge, 1990). The concept of communities of practice has its origin in anthropology and ethnographic studies of how people learn (Lave & Wenger, 1991). This type of learning is a shift from cognitive and behaviouristic theories of learning to theories that acknowledge the role of the physical and social context in learning (ibid.). Characteristics of communities of practice draw on the value of individual reflection for learning (Schön, 1983), the earlier work on experiential learning (Kolb, 1984) and problem-based professional learning (Grady, Macpherson, & Mulford, 1995).

Wenger, McDermott and Snyder (2002) defined communities of practice as “groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an on-going basis” (p.4). Communities of practice exist among groups of people who share a common practice in their day-to-day lives (Wenger, 1998), such as Life Sciences teachers. The challenge of the community is usually to determine mutual concerns and approaches to enhance professional practice. Communities of practice claim that people build knowledge through social interactions (Lave & Wenger, 1991). Learning is situated,

meaning that knowledge is only meaningful in relation to the circumstances and social context where it is used (ibid.). This implies that if PLCs can be classified as a community of practice, then Life Sciences teachers in PLCs are most likely to apply what they learn about biodiversity. This is especially likely when the learning in the PLC is primarily related to problems identified as related to their practices linked to biodiversity.

Wenger (1998) observed that teachers generally belong to more than one community of practice. This may be the case with Life Sciences teachers in this study. One Life Sciences teacher may belong to a school PLC, but at the same time belong to a PLC for Life Sciences teachers in the specific district. In the community of practice, learning is becoming a member of a community, a participant, and knowing is belonging, participating and communicating (Wenger, 1998). Members of a community of practice learn knowledge, skills and capabilities within that community which enable them to be competent members (ibid.). Lave and Wenger (1991) noted that within the community of practice, newcomers will mostly function at the periphery but as they continue to observe the activities of the community of practice, they eventually learn the practice of the community, thus become more confident and move to the core. When teachers engage in PLC activities, aimed at improving practice in collaboration with other colleagues and experts, they are more likely to develop higher levels of expertise (DuFour, 2004). Lave and Wenger (1991) proposed that when learning in the communities of practice, participants gradually absorb and are absorbed in a culture of practice, giving them exemplars, leading to shared meanings, a sense of belonging and increased understanding. In a community of practice, social learning and collaborative learning are encouraged, for the learning of individuals in that community (ibid.). The study's main interest was concerned with Life Sciences teachers in PLCs who were focused on biodiversity. Research shows that PLCs are defined by certain characteristics, as discussed in the next section.

2.5.3 Characteristics of Professional Learning Communities

PLCs occur in different forms and contexts, but they are all characterised by the following attributes: shared beliefs, values and visions; supportive conditions and shared leadership; reflective dialogue; de-privatisation of practice; inclusive membership; collaborative learning; collective responsibility and shared practice (Louis et al., 1995; Hord, 1997; Westheimer, 1999; Hord, 2004; Feger & Arruda, 2008; Hord, 2008; Morrow, 2010). Stoll et al. (2006) confirmed the above characteristics and added mutual trust and respect. They argued that PLCs are built on trust and appreciation of difference, thus they provide settings for teachers to bring experiences and concerns from their classrooms. To develop trust among teachers in PLCs requires time and effort (Stoll et al., 2006). It is likely that most other characteristics of PLCs can only be met if teachers trust and

respect each other and each other's contribution in the PLC. The PLC characteristics can be summarised as follows:

2.5.3.1 Shared belief, values and vision

The shared value and vision among teachers in the PLCs focus on guiding teachers to make decisions about teaching and students' learning (Hord, 2004). Values are embedded in the day-to-day actions of the teachers (Darling-Hammond et al., 2009). These values then create the norms of a self-aware, self-critical and increasingly effective professional organisation, utilising the commitment of its members to seek on-going renewal and improvement (Morrissey, 2000). Critical for PLCs are the values and respect of the individual teachers who insist that all learners achieve high standards (ibid.). The assumption is that one of the reasons why the Life Sciences teachers will, for example, invest in the learning within the PLCs is to improve their biodiversity knowledge. It is thus likely that teachers will engage in conversations on biodiversity in the PLC and will ask questions such as: What type of knowledge is needed for learners to be able to solve problems related to biodiversity? What types of resources are needed to enhance their biodiversity knowledge? What is their role as teachers of biodiversity? What teaching methods are best for teaching biodiversity? What assessment strategies are best for assessing biodiversity? etc.

2.5.3.2 Reflective professional inquiry

Reflective professional inquiry is defined by Louis et al. (1995) as reflective dialogue. Hord (1997; 2004) viewed reflective professional inquiry as conversations about serious educational issues or problems involving the seeking and application of new knowledge in a sustained manner. Effective PLCs offer teachers time to reflect on their professional development and their classroom practices (Levine & Marcus, 2009). Reflective inquiry thus requires Science teachers to be reflective of their own practice, attitudes and understanding of biodiversity, as well as their learners' understanding of biodiversity. Life Sciences teachers also need to reflect on their school structures and teaching contexts as well as what influence they have on their learning and teaching about biodiversity. This can help Science teachers identify the type of support they can seek in the PLCs and from professional development initiatives such as Fundisa for Change. In South Africa, Science teachers in PLCs need to be supported on how to be reflective of their biodiversity knowledge to improve their teaching practice related to biodiversity. Research shows that in South Africa, many teachers do not have the ability to reflect critically on their own practice (South Africa. DoE, 2006).

2.5.3.3 Learning through collaboration

A collaborative environment has been described as the most important factor for successful PLCs (Stoll et al., 2006). PLCs are based on the belief that learning happens in a social context, where people learn by discussing and engaging together in practice (Sfard, 1998). This contrasts with the

traditional view of learning as acquisition of knowledge, a view that has been criticised by philosophers such as Paulo Freire (Freire, 1972). In PLCs, teachers are expected to work together and engage in continual dialogues to examine their practice and learners' performance (Stoll et al., 2006), for example, regarding biodiversity. This allows teachers to develop and implement more effective instructional practices (Schmoker, 2006). PLCs engage teachers in processes that collectively seek new knowledge and ways of applying that knowledge to their work (Feger & Arruda, 2008). The collegial relationships produce creative and appropriate solutions to problems. Schools that do well with learning have teachers working together rather than in isolation (Rosenholtz, 1989). Such schools move beyond discussions of revising the schedule or establishing new governance procedures to focus on areas that can contribute to significant school improvement, curriculum, instruction, assessment, and the school's culture (Louis et al., 1995). All teachers adopt high standards in content areas and take the responsibility to ensure high levels of achievement for all students (ibid.). Teachers seek the best strategies to engage their students in learning, and they respond to the students' diverse learning needs (Feger & Arruda, 2007). All teachers are learners with their colleagues (ibid.). Senge (2000) acknowledged schools as learning communities. He recognised schools as meeting grounds for learning dedicated to the idea that all those involved with it, individually and together, will be continually enhancing and expanding their awareness and capabilities.

2.5.3.4 Supportive conditions and shared leadership

Shared leadership is recognised as critical for PLCs (Stoll et al., 2006). Leadership in PLCs helps guide and support successful implementation of new policies and/or practice in schools, for example, curriculum changes in environmental learning or new laws on biodiversity (ibid.). PLCs require certain forms of leadership to be successful (Harris, 2011). This involves securing the resources to support professional learning, development and modelling the shared vision and focus of the PLC (ibid.). Traditionally, the principal took the leadership role (ibid.). This has been replaced by shared leadership structures where teachers and principals take leadership roles at different times or linked to certain activities in PLCs (Morrow, 2010). In PLCs, principals are required to participate in discussions and dialogues without intimidating teachers (Hord, 2004). They should freely allow teachers to share responsibilities and make decisions (ibid.). Organisational and structural support is necessary for enhancing teachers' collaborative work and to support the vision of PLCs (Hord, 1997; 2004).

Hord (1997) cited two types of supportive structures found within PLCs: structural conditions and collegial relationships. Structural conditions include time, space, support, communication procedures, proximity of teachers and staff development processes (ibid.). Collegial relationships

include positive educator attitudes, shared vision, norms of continuous critical inquiry and improvement, respect, trust, caring relationships, individual's orientation to change and group dynamics (ibid.). Considering these structures in PLCs could contribute to the sustainability and effectiveness of PLCs (ibid.). PLCs should also consider the local knowledge resources and contextual factors (Talbert, 2009). This is because PLCs do not operate separately from their surrounding entities, thus contextual factors can constrain and/or enable PLCs' activities. Effective facilitation is critical in PLCs (Fulton et al., 2010). This requires someone with experience and who is trained to facilitate the PLC activities. The PLC facilitator can help participants move past problem areas such as refining inquiry questions, promoting a willingness to ask critical questions about instructional decisions, classroom practices and student learning (Fulton et al., 2010). Morrow (2010) identified the role of the principal as a leader in the PLC. Considering that the South African Council for Educators (SACE) is encouraging professional development points for principals' professional development in South Africa (SACE, 2008), it is likely that if principals participate in PLCs, they will be more effective. But, the National Council of Teachers of English (2010) recognises that PLCs cannot be mandated by non-teachers. Instead, they must be teacher driven, tackling questions that emerge from authentic classrooms concerns (ibid.).

2.5.3.5 Shared personal practice

Through interaction in PLCs, teachers continue to build a culture of mutual respect and trustworthiness for both individual and school improvement (Stoll et al., 2006). Teachers also exhibit increased commitment to their work (ibid.). Shared personal practice is limited, even in highly functioning learning communities, and tends to be the last of the dimensions to develop (Vescio et al., 2008). Teachers who spend more time collectively studying teaching practices are more effective overall at developing higher-order thinking skills and meeting the needs of diverse learners (Darling-Hammond, 1998). Sharing personal practice requires a complete paradigm shift from traditional roles in education (ibid.). The teachers' collective focus on students' work also helped shift the group towards a culture of professional learning characterised by open, honest and thoughtful conversation (Yendol-Hoppey & Dana, 2010).

2.5.3.6 Inclusive membership

There is no minimum or maximum size of PLCs; they are inclusive (Stoll et al., 2006). Stoll et al. (2006) noted that diversity in PLCs is needed to enrich the activities of the PLCs. Diversity in the PLCs can be brought in by external supporters of PLCs such as Fundisa for Change partners, or may exist in terms of gender, teaching experiences and level of biodiversity knowledge of teachers in the PLC (Feger & Arruda, 2008). To be inclusive, the PLC activities should be structured so that all teachers are valued and heard, irrespective of their teaching experience, age, background and gender (Levine, 2011). The goal of the PLC is for teachers at all stages of their careers to learn from

one another (Nelson, Slavitt, Perkins, & Hathorn, 2008). The new teachers can learn from the experiences of the experienced teachers (Levine, 2011). And the experienced teachers can learn from novice teachers new pedagogies that experienced teachers may not have been exposed to in their training but which may enhance their biodiversity knowledge (ibid.). Novice teachers may also share technological innovations that enhance teachers' practices related to biodiversity (Nelson et al., 2008).

According to Stoll et al. (2006), individual teachers' orientation to change and group dynamics are potential challenges for the functioning of PLCs. In most cases PLCs are implemented superficially, without an awareness of the depth that is needed for producing an impact on learning (Feger & Arruda, 2008). This could be because teachers find it difficult to negotiate individual differences in philosophy, style and content because they are not trained to work together (ibid.).

Having presented the literature on the characteristics of PLCs, it is thus arguable that PLC characteristics create a structure for group and individual professional development through collaboration, continuous learning and meaningful learning. This may be through experience sharing, pedagogical analysis, observation, demonstration, feedback, experimentation, developing new methods, and technical consultations from advisors (Borko, 2004). This prompts a question: Does the South African policy on the call for establishment of PLCs consider all these characteristics? If so, are there structures in place to enable teachers achieving their valued beings and doings in the PLCs?

For PLCs to be effective, support of other levels within the education system is required (Harris, 2011). External support brings external knowledge threads into PLCs, such as reading resources, guests who are knowledgeable and this can help teachers build on knowledge introduced in their PLCs (Louis et al., 1995; Harris, 2011). It can be difficult for schools and districts to recognise that they do not have sufficient knowledge, skills or resources to reach high standards (Bausmith & Barry, 2011). There is no guarantee that the knowledge generated at local sites is correct or even useful (Hiebert, Gallimore, & Stigler, 2002). They noted that "local knowledge is immediate and concrete but almost always incomplete and sometimes blind and insular" (p.8). Therefore, as much as Life Sciences teachers are expected to be responsible for their own continuing professional development (South Africa. DBE, 2014), support from different stakeholders is critical to enable them achieve their valued beings and doings in PLCs, especially related to the controversial topic of biodiversity. Stevenson (2007) observed that in the case of environmental knowledge (such as biodiversity knowledge), many teachers have to go beyond their colleagues to deepen their knowledge of environmental issues. It is thus necessary for Life Sciences teachers to seek and receive external knowledge on biodiversity, a finding also reported by Songqwaru (2012) in her

study on the Fundisa for Change Biodiversity pilot cluster. Critical for this study was thus to explore if and what support the teachers in Science PLCs receive from different ‘supporters’ (in this study PLC supporters are mainly Department of Basic Education officials, Fundisa for Change partners and other teachers and teacher organisations) and how this support enhances or constrains Science teachers’ valued beings and doings related to biodiversity.

2.6 Professional Learning Communities: South African perspectives

Reddy (2011) recognised that in South Africa, professional development programmes offered to teachers are related to school reforms and education transformation. If teachers in schools are to meet the requirements of the curriculum, teachers’ pedagogical practices, assessment practices and knowledge needs to be examined (Lotz-Sisitka, 2011). This needs to be reviewed through professional development activities for teachers’ improved practices and successful implementation of the curriculum (ibid.). Following the launch of Curriculum 2005 in 1997 was the cascade model (also called the training of trainers’ model) (Lotz-Sisitka & Janse van Rensburg, 2000). The cascade model was introduced by the Department of Education to introduce teachers to Curriculum 2005 and help train them for the implementation of Curriculum 2005. In this model, a first generation of teachers were trained on a particular topic, aspect of teaching or subject matter, and once proficient, became the educators of the second generation (Griffin, 1999). This was part of the government’s advocacy campaign, which provided educators with tables contrasting learner centred and teacher centred education, constructivist and behaviouristic education, content based and outcome based education, and rote learning and activity based learning as a complete paradigm shift (Lotz-Sisitka & Janse van Rensburg, 2000). This situation has no doubt contributed to the simplifications and reductionism of educational reform (ibid.). The training was far from adequate, used inappropriate models and methods and focused on introducing complex terminologies in Curriculum 2005 (ibid.; Ono & Ferreira, 2010).

Professional development has been inadequately supported by teacher development staff who lacked the capacity to adequately complement workshops with follow-up work in the classrooms (Lotz-Sisitka & Janse Van Rensburg, 2000). This contributed to the implementation of outcomes based education and Curriculum 2005 not being as successful as was hoped (ibid.). Lessons learnt from the cascade model led to the piloting and implementation of collaborative models in South Africa (ibid.). The teacher cluster models were an attempt to respond to technicist teacher development models in South Africa, although at the time these were not policy (Du Toit & Squazzin, 2000).

As discussed in Chapter One, in South Africa the Learning for Sustainability project and NEEP-GET project were implemented. These projects aimed at supporting the implementation of

environmental learning in South Africa. As part of the projects, professional development processes and programmes were structured around the spiral model (Figure 2.4) within a cluster-based approach to professional development (Du Toit & Squazzin, 2000). The spiral model was introduced out of concern that traditional professional development models (such as the cascade model) used in South Africa were inadequate (Janse van Rensburg & Lotz-Sisitka, 2000). The spiral model, in keeping with constructivist and critical approaches to the professional development of environmental educators, presented its own problems to participating teachers. Spiral models for teacher professional development required adequate structure and coherence (ibid.). The spiral model promoted increased sophistication of knowledge and practice over time that is achieved through a reflexive approach of working together (in the cluster) and then working away (in classrooms), and then reporting on practice back into on-going cluster meetings (ibid.). The spiral model is briefly discussed below:

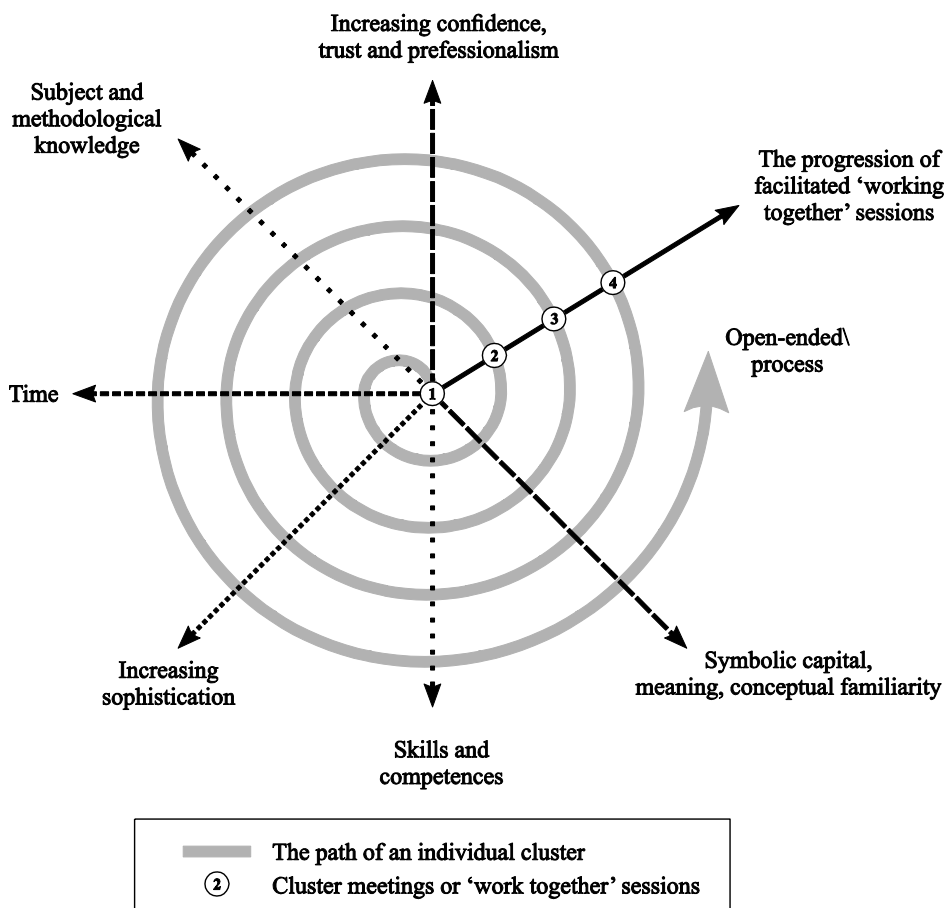


Figure 2.4: The spiral model informed teacher professional development in the Learning for Sustainability pilot project (Janse van Rensburg & Lotz-Sisitka, 2000:42)

Du Toit & Squazzin (2000) provided details on the spiral model. Key to the model was that professional development of teachers was an open-ended, continuous and reflective process (Janse van Rensburg & Lotz-Sisitka, 2000). The NEEP-GET project worked with both curriculum support

staff and teachers (NEEP-GET, 2004). Through a cluster-based approach, groups of educators (sometimes with curriculum staff supporters) met regularly to share ideas, perspectives and experiences related to curriculum development and professional development processes. The project development process in the NEEP-GET was approached differently in the different provincial project sites, shaped by various contextual factors, provincial organisations and management and geographic proximity of schools and resources (NEEP-GET, 2004). This led to an establishment of different cluster models in South Africa. Some were provincial based clusters, district based clusters, or clusters for specific learning areas, grade or phase (NEEP-GET, 2004). For example, in the Eastern Cape province, the cluster model started with the provincial subject advisor cluster, and through service providers, subject advisor clusters at district level were established (Raven, Timmermans, Lotz-Sisitka, & Nduna, 2005). Teacher clusters were established in four districts in the Eastern Cape (Grahamstown, King Williams Town, East London and Butterworth).

De Clercq and Phiri (2013) observed that clusters are in fact a South African version of PLCs. This study sheds more light on this statement. Clusters are a tool that schools can use to promote collaboration, reflection, sharing and continuous learning among teachers (Turkey, 2004). Clusters support teacher capacity to teach effectively and serve as an innovative network to support, promote and inspire teacher development leading to quality education (*ibid.*). However, most clusters do not function as expected (De Clercq & Phiri, 2013). Cluster meetings should be structured as a framework that can allow teacher engagement, continuous interaction, innovation and creativity to mutually benefit from one another (Mphahlele, 2012). This will result in teachers sharing resources, expertise and other facilities in their communities (*ibid.*). The success of cluster activities depends on the leadership; support materials; the system support; and teacher incentives or official recognition and praise of participating teachers (*ibid.*).

Jita and Ndlalane (2009) noted that, in spite of the fairly rich history of the clustering in the 1980s and early 1990s among a number of NGOs and teacher organisations, including the Transvaal Teachers' Association and the South African Democratic Teachers' Union, there had been little research conducted on teacher clusters in South Africa. This posed a challenge to understand the teachers' collaborative activities in South Africa, but motivated for a need for research on teacher collaborative models such as this study. Some of the evidence of research in South Africa on collaborative models is by Ndlalane (2006); Jita and Ndlalane (2009); Ono and Ferreira (2010); Botha (2012); Mphahlele (2012); Mokhele (2013); Steyn (2013); Jita and Mokhele (2012; 2014) but none has focused specifically on Life Sciences teachers and/or biodiversity. These researchers seemed to conclude that with all the challenges affecting education in SA, teacher collaborative

models might be one of the substantive ways to build teachers' skills and knowledge for their educational professional growth.

The research carried out by Jita and Mokhele in 2012 reviewed the official Department of Basic Education teacher clusters. They also found that other kinds of clusters operating outside the Department of Basic Education structures exist which they termed 'alternative clusters'. The formation of the alternative clusters had been driven by the needs of the participating teachers with support and sustainability from higher education institutions and/or NGOs. Teacher participation in the alternative clusters was voluntary (Jita & Mokhele, 2012). On the other hand, the Department of Basic Education clusters were more mandatory (ibid.). Welch (2012) observed that PLC activities should be voluntary; when systematised they stop functioning.

Jita and Ndlalane (2009) explored the "opportunities to learn" that teacher clusters in South Africa presented to Science and Mathematics teachers. They argued that the mere presence of cluster structures does not lead to effective professional development as this requires certain pre-conditions. Effective clusters should focus on improving teacher performance for better learner achievements and need quality teacher-led interactions, based on professional knowledge and skills, and a collegial reflective culture (ibid.). Reddy (2011) noted that teacher learning through collaborative models can contribute to better understanding, stronger policies and improved implementation in schools. Discourses of professional learning that reflexively build, sustain and develop spaces for meaningfully enacting environmental education in schools and recognise the importance of teacher agency and PLCs, have the potential to move the focus from educators' implementation to building their normative and technical capacity, both individually and collectively to improve their practice (Reddy, 2011).

Teachers have individual needs, experiences, motivations and personal circumstances (NEEP-GET, 2004). They experience professional development differently (ibid.). Thus, instead of imposing professional development on teachers, teachers should be actively involved in determining their own developmental trajectory (South Africa. DHET & DBE, 2011a). They should then be supported to pursue the identified needs. Support given should provide appropriate structures and processes to enhance learning and accelerate performance (South Africa. DBE, 2014). The quality of teacher priority activities will be dependent to a large extent on the quality of teachers' own education and their ability, not only to evaluate their own needs but to find appropriate opportunities to meet those needs (Welch, 2012).

2.7 Life Sciences Curriculum Policy Statements

Life Sciences was called Biology previously in South Africa (still called Biology in Namibia). Life Sciences is the study of living things from molecular level to their interactions with one another and their environments (South Africa, DBE, 2011a). According to the South African Department of Basic Education (2011a), for Life Sciences to be called a Science, it should be able to use certain methods that allow for discovering of new things and broadening existing science knowledge. The suggested methods include formulating of hypotheses, conducting investigations and experiments as to scientific inquiry (ibid.). “Knowledge production in science is an on-going endeavour that usually happens gradually but, occasionally, knowledge and insights takes a leap forward as new knowledge, or a new theory, replaces what was previously accepted” (South Africa, DBE, 2011a:8). The South African Department of Basic Education (2011a) recognised that, like in many other fields, scientific knowledge changes over time as new things are discovered and people develop better understandings with changed views on the world around them. This is also because scientists continue to explore the unknown, and engage in questions that have no definite answers such as why is climate changing? And perhaps as argued earlier in this chapter, to questions such as, is biodiversity loss a natural phenomenon? The South African Department of Basic Education (2011a) noted that by studying and learning about Life Sciences, learners will develop the following:

- 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 choices that they make;
- An awareness of South African scientists’ contributions;
- Scientific skills and ways of thinking scientifically that enable them to see the flaws in pseudo-science in popular media; and
- A level of academic and scientific literacy that enables them to read, talk about, write and think about biological processes, concepts and investigations. (South Africa, DBE, 2011a:1-9)

One could thus argue that if the Life Sciences teachers in PLCs aim to develop the grade 10-12 learners’ scientific skills (that will allow them to investigate biodiversity issues, knowledge of basic biodiversity concepts, awareness to be responsible citizens who care for biodiversity, deep appreciation of biodiversity and critical and evaluative skills to assess the problems and risks

associated with biodiversity loss), they should engage in discussions and activities that allow them to expand their capabilities on those issues. As a school subject, Life Sciences is comprised of various sub-disciplines (South Africa. DBE, 2011a). Among these are Botany, Entomology, Taxonomy, and Biotechnology, Microbiology, Environmental Studies and Zoology). There are three main reasons why learners need to take Life Sciences:

- To provide useful knowledge and skills that are needed in everyday life;
- To expose learners to the scope of biological studies to stimulate interest in and create awareness of possible specialisation; and
- To provide a sufficient background for further studies in one or more of the biological sub-disciplines. (South Africa. DBE, 2011a:9)

The Further Education and Training (FET) phase Life Sciences curriculum is organised into four knowledge strands; these are developed progressively over the three years (grade 10-12) (South Africa. DBE, 2011a). These are: Life at the Molecular, Cellular, and Tissue level; Life Processes in Plants and Animals; Environmental Studies; and Diversity, Change and Continuity (ibid.). It is indicated in the Life Sciences CAPS curriculum document that these knowledge strands contain different topics and they should not be studied separately (South Africa. DBE, 2011a). They do not have to be taught in the same sequence each year, they are not weighed equally; teachers are expected to make links between them in their teaching (ibid.). The Life Sciences CAPS curriculum content framework focuses mostly on ideas, skills and concepts and connections between them, rather than on methodologies (South Africa, DBE, 2011a). However, the teachers are given the freedom to expand on the concepts in the curriculum and they are expected to design and organise the learning experiences according to their local circumstances, including the availability of resources (South Africa. DBE, 2011a). There are three broad specific aims in Life Sciences:

- *Specific Aim 1:* This aim relates to knowing the subject content (theory); this includes acquiring of knowledge, understanding and making connections between ideas and concepts to make meaning of Life Sciences, applying knowledge on Life Sciences in unfamiliar contexts and analysing, evaluating and synthesis of scientific knowledge, concepts and ideas.
- *Specific Aim 2:* This aim relates to doing science practical work and investigations; and investigation of phenomena in Life Sciences, following instructions, handling equipment or apparatus, making observations, recording information or data, measuring, interpreting, designing and planning investigations or experiments.
- *Specific Aim 3:* This specific aim relates to understanding the application of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science, understanding the history and relevance of some scientific discoveries, the relationship between indigenous knowledge and Life Sciences and the value and application of Life Sciences Knowledge in the industry in respect of career opportunities in everyday life. (South Africa. DBE, 2011a)

The CAPS Life Sciences curriculum also aims at developing learners' language skills including their reading and writing skills (South Africa. DBE, 2011a). The Life Sciences CAPS curriculum document also explicitly specifies when and what type of assessment needs to be done (South Africa. DBE, 2011a), noting that higher order questions are critical for assessment (ibid.). However, the Department of Basic Education diagnostic report (2013b) shows that learners are usually not able to answer middle and higher order questions. The diagnostic report thus notes that learners should be introduced to higher order questions and need to be trained to analyse higher order questions (South Africa. DBE, 2013b). Thus Life Sciences teachers in the PLCs have to be supported to set the type of questions that demand high order thinking. Professional development initiatives such as Fundisa for Change should encourage Life Sciences teachers in the PLCs to analyse high order questions and be supported in supporting learners answering those types of questions. As mentioned earlier in this chapter, this is critical for developing learners' critical thinking and problem solving skills that are required for biodiversity education.

2.8 Conclusion

This chapter has answered questions such as how did environmental education emerge? What research has been conducted internationally and in South Africa on teacher education and biodiversity? What are the different professional development modalities used internationally and in South Africa? Why the interest in the collaborative models, especially the professional learning communities? And what are the purpose and aims of the South African Life Sciences CAPS curriculum? However some of the limitations in literature in this chapter demonstrate a need to understand whether and how continuing professional development programmes provide conversion factors that expand and/or constrain the functionings, agency and structures in Science teachers PLCs. There is a need to theorise causal links between Science teachers' observed actions in PLCs and their complex realities. The next chapter provides the theoretical framework for the study.

Chapter 3: Theoretical framework

3.1 Introduction

The previous chapter provided insights into teacher education and biodiversity from the literature. As noted in Chapter Two, there is a need to understand whether and how continuing professional development programmes provide conversion factors that expand and/or constrain the functionings, agency and structures in Life Sciences teachers' PLCs, especially in the South African context. There is a need to theorise causal links between Life Sciences teachers' observed actions in PLCs and their complex realities. This chapter explores the theoretical frameworks used to facilitate those ends, and that allowed me to answer the research questions outlined in Chapter One. The chapter discusses how the theoretical frameworks are used in the study, to understand Life Sciences teachers valued beings and doings related to biodiversity, and how the PLCs and the continuing professional development programme act as conversion factors that enable or constrain teachers achieving their functionings in the PLCs.

3.2 Conceptualisation of the theoretical frameworks

Before discussing the theoretical framing of the study, I will share some of my experiences of being in South Africa in 2011. The time spent in South Africa in 2011 was mainly working on my masters degree. As noted in Chapter One, my master's research involved investigating the implementation of environmental learning in the Namibian Biology curriculum. To begin I read through different theories on teachers' knowledge and pedagogical practices. Of the frameworks I explored, I chose Lee Shulman's Pedagogical Content Knowledge theoretical framework for the study (Tshiningayamwe, 2011). I therefore needed to read literature on teachers' pedagogical and content knowledge on environmental learning. During the process I discovered literature that identified gaps in teachers' knowledge on environmental learning and teachers' professional development broadly. Some of the literature on teachers continuing professional development processes has been analysed in Chapter Two of this study. This broadened my interpretations of theoretical frameworks used to understand teachers' continuing professional development processes with the aim of enhancing teachers' knowledge and pedagogical practices. While exploring literature on teachers' experiences in professional development activities I came across the capability approach. I was drawn to the way the capability approach frames the concepts of functionings and capabilities which I could relate to continuing professional development processes particularly in South Africa.

As mentioned in Chapter One, I was humbled by the way South African teachers spoke about their challenges in continuing professional development processes related to biodiversity teaching. I found a methodological stance in the capability approach that resonates with the models

recommended for teachers' professional development as it draws attention to what teachers' value. I was also attracted to the capability approach as it considers both internal and external factors that impact on teachers' professional development processes and their actual teaching practice. I will elaborate further in this chapter by providing an overview of the capability approach, drawing mainly on the writing of Amartya Sen and authors drawing on his work.

3.3 The capability approach

3.3.1 Brief history of the capability approach and education research

The capability approach is a broad normative framework for evaluation and assessment of aspects of human well-being and development (Sen, 1999; Robeyns, 2003; Alkire, 2005; Crocker & Robeyns, 2010). Some aspects of the capability approach can be traced back to the work of Aristotle's understanding of human flourishing; Karl Marx's discussion on the importance of functioning and capability for human well-being; and Adam Smith's analysis of relative poverty in 'the wealth nation' in terms of how a country's wealth and how different cultural norms are affected by material goods were understood to be a 'necessity' (Sen, 1999; Nussbaum, 2003). The key contributor to the capability approach is Nobel Laureate Amartya Sen (Sen 1985; 1987; 1992; 1993; 1999; 2009) who identified, detailed and campaigned against forms of global inequalities. Sen had an extensive background in development economics, social choice theory and philosophy before developing the capability approach in the 1980s. He was awarded a Nobel Memorial Prize in 1998 for his contribution to welfare economics.

Sen introduced the concept of capability for the first time in 1979 during his Tanner Lectures on *equality of what?* (Wells, 2013). Sen has many followers of his capability approach including philosopher Martha Nussbaum. Nussbaum has used Sen's ideas to develop a partial theory of justice; thus, like Sen, she has also critiqued utilitarian theories of well-being (Nussbaum, 2000; 2003). Even though Martha Nussbaum and Amartya Sen share some similar views on the capability approach, they also share significant differences, thus the critiques to one may not necessarily apply to the other (Robeyns, 2003). One difference for example is that Nussbaum's work is situated in perspectives of moral-legal political philosophies, where she argued for a general list of central human capabilities that should be incorporated in all government constitutions (Robeyns, 2003), while Sen's work was interested in the *equality for what* question in the liberal-egalitarian literature and argued for capability instead of resources of utility (ibid.). This implies that Sen's arguments are close to economic reasoning, whereas Nussbaum's work is closer to the traditions in humanities (ibid). Another difference between Sen and Nussbaum's work is in the notion of capability: Sen's notion of capability is primarily that of a real or effective opportunity, while Nussbaum's notion of

capability pays attention to people's skills and personality traits (Robeyns, 2003). This study has worked largely with Sen's ideas as discussed in this chapter.

Combining his work on economics and philosophy, Sen has made significant contributions to many fields most prominently in social and political philosophy, welfare economics, development studies and social policy (Crocker & Robeyns, 2010) but his work has also been misinterpreted in some fields (Nussbaum, 2003). Sen is not an educationist, thus he has not directly explored his concepts in education but an emerging literature has considered the implications of his capability approach for education research (Saito, 2003; Unterhalter, 2003; Walker, 2005; Bates, 2007; Unterhalter & Brighouse, 2007; Unterhalter, Vaughan, & Walker, 2007; Walker & Unterhalter, 2007; Boni & Walker, 2013; Tao, 2012; 2013a; 2013b; Chikunda, 2013; Kronlid & Lotz-Sisitka, 2014; Tao, 2014; 2015). These researchers have asserted that the capability approach has a number of core elements to offer to education research and they are puzzled as to why Sen has not worked more rigorously with his ideas in education. Implications for capability approach in education research are however yet to be fully explored and theorised (Saito, 2003). Some of the authors who have worked with Sen's ideas of the capability approach in education have provided entry points into thinking about the instrumental role that teachers play in expanding students' capabilities (Unterhalter, 2003; Bates, 2007; Unterhalter & Brighouse, 2007). However, the issue of teachers' own capabilities remains largely unexplored. Interestingly, there is also an emerging body of literature of higher education research that draws on the capability approach (Walker & Boni, 2013; Wang, 2013). These studies used Sen and Nussbaum's inspirations to make contributions on re-imagining the spheres of university work: pedagogy, curriculum, social engagements and even physical environments (Boni & Walker, 2013).

Studies that have worked with the capabilities approach and teachers capabilities (and teacher education programmes) include Tao (2012; 2013a; 2013b; 2014; 2015) who wrote about the thinking surrounding capability approach and formal schooling by exploring how it can be used to investigate teacher capabilities as well as broaden the discourse surrounding school improvement. Urenje (2011) explored how an international professional development programme on ESD empowered professionals in the Kingdom of Swaziland Ministry of Education and Training. Chikunda (2013; 2013/2014) worked with the capability approach to explore and expand capabilities, sustainability and gender justice in Science teacher education in Zimbabwe and South Africa. Wahlstrom (2013) researched teachers and curriculum work from a capability approach. Focusing on the design for a foundation phase teacher education programme, Baxen, Nsubuga, and Johanson (2014) worked with the capabilities approach to research perspectives on education quality. Nsubuga (2014) used the capability approach to propose an analytical framework to help

unearth core education quality issues and questions in different teacher education orientations. Kronlid and Lotz-Sisitka (2014) used the capability approach to research transformative learning and individual adaptation. These studies provided a useful foundation for me to understand how teacher education, particularly professional development, could potentially expand Life Sciences teachers' capabilities for biodiversity teaching. This study also contributes to the debates on using Sen's capability approach in education research by exploring how continuing professional development processes enable and/or constrain Life Sciences teachers' capabilities for biodiversity teaching (see Chapter Eight).

Sen (1992) has criticised traditional approaches to thinking about well-being such as welfare economics, utilitarian and income based theories. For example, welfare economics utilised income as the information base for evaluation (ibid.). He did acknowledge that income is an important resource for well-being, but his argument was that there are components of well-being that are not directly acquired with income (for example, being confident, being part of a community, being able to make choices) (Alkire, 2005). Sen (1999) thus rejected the welfarist theorists that believe in utility and exclude non-utility for evaluation. He argued that those spaces of evaluation did not account for the fact that different people attain different levels of well-being when given the same income or bundle of goods. Thus, he suggested that "instead of focusing on the *means* that might facilitate a good life, we should instead focus on the *actual living* that people manage to achieve; and more importantly, the freedom that people have to achieve and the types of lives they want to lead" (Sen, 1999:73). This way of thinking about human well-being led to the development of Sen's concepts of *functionings* and *capabilities* (ibid.). The following section will discuss these concepts and the concepts of conversion factors and agency as key concepts of the capability approach worked with in the study.

3.3.2 Key concepts of the capability approach

3.3.2.1 Functionings and capabilities

According to Sen (1987:36):

A functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions, since they are different aspects of living conditions. Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have regarding the life you may lead.

Alternatively put, Sen (1993) noted that the "capability of a person reflects the alternative combinations of functionings the person can achieve, and from which he or she can choose one collection" (p.271). For example, being able to learn how to swim or how to read are capabilities, while the ability to swim or the joy of reading a novel are examples of functionings (Sen, 1999).

Robeyns (2005a) defined capabilities as people's potential functionings. Functionings are "beings and doings" (ibid.:94). To relate this to this study, capabilities therefore refer to what Life Sciences teachers in the PLCs are able to do (activities), as well as the kinds of teachers they can be (being). Sen (1999) expressed that capabilities are what allow people, for example Life Sciences teachers to perform certain functionings to lead the kind of lives they value and have reason to value. He added that the sum of an individual capability is his/her *capability set*. Lanzi (2007) categorised capabilities into three groups: S-caps which includes concrete skills and knowledge; E-caps which includes social and political rights and institutions, cultural practices and norms; and M-caps which are ethical principles and judgments.

Walker and Unterhalter (2007) noted that capabilities and functionings are linked but different. To differentiate between capabilities and functionings they gave an example of two young women who both achieved a degree in Biology at the same university. One young woman comes from a middle-class background and did not need a tertiary qualification to work in her father's business as a junior manager. Nonetheless she wanted an experience of tertiary education and coped well with the academic demands because her background has prepared her well. On the other hand, the second young woman from a working-class background struggled to cope with academic demands because her secondary education did not prepare her well for higher education. Despite her lack of confidence she was desperate to excel so she worked hard and obtained her degree. This example according to Walker and Unterhalter (2007) demonstrates that both women had a similar functioning (to obtain a Biology degree), but their capabilities were different. To relate it to this study, this example demonstrates that two Life Sciences teachers in the PLC may have the same functioning related to the teaching and learning of biodiversity but may have different capabilities to achieve that functioning.

To re-emphasise, key to the capability approach is what teachers are able to do, able to be, and choosing the quality of life they have reason to value (Walker, 2005). The notion of 'reason to value' is important as it points to reflective, informed choices (ibid.). Sen stressed the significance of 'reasoned value', pointing out that what we, for example, need to scrutinise is the Life Sciences teachers' motivations for valuing what they value in terms of biodiversity teaching (Robeyns, 2005a). Therefore at the boundary of functionings and capabilities is the matter of choice where Life Sciences teachers, for example, exercise their agency, having the requisite set of capabilities, ability to reason about choices and exercise agency to choose from a range of available options (Walker, 2005). Lack of agency constrains one's ability to choose preferred functionings (ibid.).

3.3.2.2 Agency

According to Crocker (2008), the concept of agency marks what a person does or can do to realise any of her goals and not only ones that advance or protect her well-being. Agency is defined as the ability to act according to what one values or in Sen's words – “what a person is free to do and achieve in pursuit of whatever goals or values he or she regards as important” (Sen, 1985:206). Agency has to be studied within the social context in which it is exercised such as the PLC (Peris, Belda & Cuesta, 2013). What this implies is that Life Sciences teachers in the PLCs can, for example, exercise their agency in relation to the teaching of biodiversity. Sen also uses the concept of an agent (Sen, 1999). He noted that “I am using the term of agent as someone who acts and brings about change, and whose achievements are to be judged in terms of her own values and objectives, whether or not we assess them in terms of some external criteria as well” (ibid.:19). Life Sciences teachers in PLCs can therefore be agents that bring about change related to their beings and doings in the teaching and learning of biodiversity. Fundisa for Change partners can also be agents who can bring about change in the Fundisa for Change programme which may enhance Life Sciences teachers' functionings related to biodiversity. Sen (1985) also talks of ‘agency freedom’, which is freedom to achieve whatever the person, as a responsible agent, decides he or she should achieve. He recognises that the freedom of agency that we individually have is inescapably qualified and constrained by the social, political and economic opportunities available to us.

Deliberation and reflexive dialogues are core elements for developing human agency (Crocker, 2008; Crocker & Robeyns, 2010). There must be a certain reflection and conscious deliberation of the reasons and values upholding agency (Crocker, 2008). What is needed is the freedom and power to act, but also freedom and power to question and reassess the prevailing norms and values in a social context such as Sciences teachers PLCs related to biodiversity (ibid). According to Walker and Unterhalter (2007) people are understood to be active participants in development, rather than passive spectators. Agency here is taken to “ mean that each person is dignified and responsible human being who shapes his or her own life in the light of goals that matter, rather than simply being shaped or instructed how to think” (ibid.:5). These goals are reached through reasoned reflection (ibid). People are agents of their own learning, the agents of learning (or failure to learn) of others, and the recipients of other's agency (ibid.). Sen (1999) argues that people exercise their agency individually and in co-operation with others. Critical thinking and participation skills are critical for developing their professional agency (Crocker, 2008). As mentioned in Chapter Two, successful implementation of biodiversity education requires participatory methods and should enhance students' critical thinking skills. Significant to this study, was to explore if and how Life Sciences teachers exercise their agency in the PLCs to enhance their biodiversity knowledge. It was also significant to explore if and how PLC activities enable the teachers to exercise their agency.

This was particularly important because the Life Sciences teachers in this study are part of the Fundisa for Change programme which aims to support transformative environmental learning (Lotz-Sisitka & Songqwaru, 2013). According to Walker (2005), for transformative environmental learning and social change, teachers' agency and autonomy are both desired functionings and valuable capabilities. Human agency develops over time: "it is a process of both being and becoming" (Walker & Unterhalter, 2007:6).

3.3.2.3 Conversion factors

The concept of *conversion factors* (Robeyns, 2005a) is important within the capability approach. Conversion factors are factors that can allow teachers in PLCs to convert resources to new functionings (ibid.). Sen's standard example of explaining the concept of conversion factors is the bicycle which is only useful if accompanied by the respective infrastructure, e.g. a bikeway (Sen, 1999). He argued that one can interpret certain acquired skills as commodities, which are useful only if accompanied by respective labour market structures which help turn these skills into outcomes (ibid.). The concept of conversion factors was central to this study, to explore if and how Fundisa for Change acts as a conversion factor that expands and /or constrains Life Sciences teachers' functionings related to biodiversity in the PLCs. The choice of using the concept of conversion factors in this study is motivated by Robeyns (2005a). She distinguished between three sources of conversion factors that can constrain or enable people's capabilities. These are:

- a) *Personal conversion factors*: These are conversion factors determined by one's mental and physical aspect (Robeyns, 2005a). They are internal to the individual, such as metabolism, physical condition, reading skills, or intelligence. To give an example of what she meant by a personal conversion factor, Robeyns (2005a) noted that if a person has a physical disability and has never learned to ride a bicycle, a bicycle will be of limited help to enable that person's functioning of mobility. In terms of this study, personal conversion factors in the Science PLCs could be the individual teachers' qualifications and personal time (Tao, 2012) that will allow them to engage in PLC activities that will help expand or constrain their valued beings and doings related to biodiversity. To draw on the previous chapter, other personal conversion factors in the PLCs that could enable Life Sciences teachers to achieve their valued beings and doings related to biodiversity also include the individual teacher's level of confidence (Howitt, 2007) and the motivation and enthusiasm to learn about biodiversity (Luft, 2007).
- b) *Social conversion factors*: These are conversion factors determined by the society in which one lives, such as social norms (for example, rules of behaviour, materialism), social institutions (such as public policies, political rights), social norms, discriminating practices,

societal hierarchies, or power relations related to class, race, or gender (Robeyns, 2005a). To give an example of social conversion factors, Robeyns (2005a) noted that if in a country there is a law that a woman is not allowed to ride a bicycle unless accompanied by a family member who is a man, then it becomes difficult to use the good to enable the woman's functioning. An example of a social conversion factor in the PLC that will enable or constrain the Life Sciences teachers to expand their valued beings and doing related to biodiversity could be the CAPS curriculum (South Africa. DBE, 2011a) expectations regarding the teaching of biodiversity.

- c) *Environmental factors*: These are conversion factors determined by or emerging from the physical environment in which a person lives (Robeyns, 2005a). These can be aspects of one's geographical location or climate, pollution, the proneness to natural disasters, the presence or absence of seas and oceans, the state of buildings, roads and bridges, and the means of transportation and communication. A good example of an environmental conversion factor in the PLC that could enable or constrain the Life Sciences teachers to expand their valued beings and doings related to biodiversity is the context in which the PLC activities happen. For example, Smith (2013) and C.A.P.E (2010) promoted pedagogies for biodiversity that allowed for local biodiversity investigation, thus the context in which the PLC happens will determine if there is any presence of biodiversity that teachers can explore to learn about biodiversity, for example the presence of a wetland.

According to Robeyns (2005a), the personal, social and environmental conversion factors are interrelated. Therefore the capability of individual Life Sciences teachers in the PLCs is likely to be dependent on these interrelated conversion factors (Robeyns, 2005a). In this study I consider the PLCs themselves to be potential conversion factors that can enable and/or constrain Life Sciences teachers' capabilities for biodiversity teaching. The PLCs in this study are situated in the broader professional development programme, Fundisa for Change (Fundisa for Change, 2013). In this study I therefore consider the Fundisa for Change programme to be a potential conversion factor that can either enable and/or constrain the Life Sciences teachers' capabilities relating to biodiversity teaching. The PLC context and teachers relationships in the PLC may have the potential to expand or constrain individual Life Sciences teachers' capabilities (Robeyns, 2005a). It is thus not enough to know what functionings Life Sciences teachers can or cannot achieve; we also need to know the circumstances in which the PLCs are situated (Robeyns, 2003; 2005a).

The capability approach is sensitive to individual differences as well as facilitating or impeding factors that impact on conversion of resources into valuable functionings (Robeyns, 2005a; Crocker, 2008). It is the notion of human diversity in the capability approach that explains why, for example,

two Life Sciences teachers with identical capability sets are likely to end up with different achieved functionings in the PLCs (Robeyns, 2005a). She further noted that there are sometimes complex intertwined factors that affect and influence, for example, Life Sciences teachers' choices to participate in PLC activities. This may be related to family, religion, tribe, cultural ties and community background (Robeyns, 2005a). This debate prompts the question: what factors influence the Life Sciences teachers to achieve their desired functionings in the PLCs?

Walker and Unterhalter (2007) recognised that individual people have different abilities to convert resources into valued functionings. To expand on this, Sen gave an example of an individual commodity of food and a functioning of being well-nourished; the relationship will vary depending on individual's body size, metabolic rate, age, activity levels or presence of parasitic diseases and so on (Sen, 1985). With regard to this study, what this example demonstrates is that a distinction needs to be made between the presence of the PLC and the Life Sciences teachers' functionings. This thus implies that the resources used in the PLCs are likely to generate different capability sets for individual teachers. The study sought to explore what resources the Life Sciences teachers in this study required to achieve their individual functionings in the PLCs related to biodiversity. This study investigates how teacher education programmes such as Fundisa for Change can potentially act as conversion factors that may enable or constrain teachers achieve their functionings. Lewis and Hurd (2011) warned that if professional development programmes are designed to act as conversion factors that expand teachers' capabilities on the teaching of biodiversity, they may not be effective if they are designed in a 'one-size fits all' manner. Figure 3.1 below sums up some of the key concepts of capability approach as discussed above.

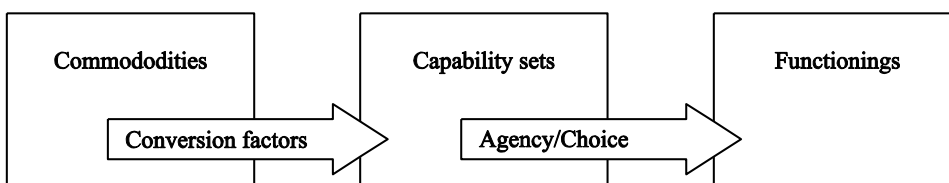


Figure 3.1: The building blocks of capability approach (Goerne, 2010:7)

Commodities are resources that an individual can dispose of, such as money and other material goods (Goerne, 2010). The capability approach criticises the assessment of individual outcomes based on commodities, argues for measurement of individual functionings instead of commodities. The concepts in Figure 3.1 are the building blocks of capability approach (Goerne, 2010). These concepts were used in this study to help understand if and how Life Sciences teachers in PLCs achieve their functionings related to biodiversity teaching. Analysing these concepts in the study

helped explore how Fundisa for Change potentially acts as a conversion factor for Science teachers in PLCs to achieve their functionings related to biodiversity.

3.3.3 Further considerations linked to using the capability approach in the study

“Scholars use the capability approach for different types of analysis, with different epistemological goals, relying on different methodologies, with different corresponding roles for functionings and capabilities” (Robeyns, 2005b: 193). Table 3.1 demonstrates the variety of uses of the capability approach.

Table 3.1: Modes of capability approach analysis

Epistemological goal	Methodology	Role of functioning and capabilities
Welfare/ quality of life measurement	Quantitative	Social indicators
Normative theories	Philosophical	Part of philosophical foundations
Thick descriptions / Descriptive analysis	Qualitative	Elements of a narrative

Source: (Robeyns, 2005b: 193)

An example of a quantitative measurement influenced by capability approach is the Human Development Index that was developed in 1990 by the United Nations Development Programme (UNDP, 1990). The United Nations Development Programme emphasises the development of human choices and returns to the centrality of people and it is reflected in measuring development not as the expansion of commodities and wealth but as the widening of human choices. In terms of philosophical methodologies, Nussbaum (2000; 2003) has used the capability approach to theorise what is fundamental for human flourishing. She has compiled a list that isolates those human capabilities that can be convincingly argued to be of central importance in any human life, whatever else the person pursues or chooses (Nussbaum, 2000). As a qualitatively descriptive tool, the capability approach can explain “behaviour that might appear irrational according to traditional economic analysis, or revealing layers of complexities that a quantitative analysis can rarely capture” (Robeyns 2005b: 194). This is of significance especially when analysing specific situations as it allows for deeper levels of understanding of conversion factors, which help to explain circumstances such as those that can affect teachers’ ability to achieve valued functionings related to the teaching and learning of biodiversity (Sen, 1999). By acknowledging conversion factors, the capability approach takes into account the broader social and environmental contexts that can affect teachers’ capability sets, which can assist in providing thick descriptions and in-depth analyses (Robeyns, 2005a) as I will do in this study.

Sen views education as an overarching capability that should expand other human capabilities (Walker & Unterhalter, 2007). This may include gaining skills and opportunities that these skills afford, or gaining other intrinsically important capabilities (such as critical thought) (Lambert &

Morgan, 2010). These are valid connections. However, it has been argued that Sen's conflation of education with freedom or capabilities overlooks particular educational aims, content and processes that could potentially be the cause of capability deprivation (Unterhalter, 2003). One of the reasons why I chose the capability approach for this study is because of its belief that social arrangements such as PLCs should aim to expand capabilities – their freedom to promote or achieve 'functionings' which are important to them (Unterhalter et al., 2007). As mentioned earlier, the focus on capabilities would require us to evaluate not merely satisfaction with teachers' learning outcomes, but to question the range of real continuing professional development opportunities available to teachers and whether they had the genuine capability to achieve the valued educational functionings (Walker & Unterhalter, 2007).

The concept of capabilities is often confused with the concept of capacities. Cundill et al. (2014), working with the capabilities approach in climate change adaptation research, argued that the distinction between the two is that capacities refer to knowledge, skills and alternative options. They however highlighted that achieving aspirations involves converting resources (i.e. money, natural resources, and social relationships) into actions that contribute towards the overarching capability of the individual. Appadurai (2004) argued that we need to understand whether teacher's educational aspirations (what they hoped for now and in the future) had become adapted to their circumstances, and whether the teachers have a range of valued learning opportunities to choose from. Cundill et al. (2014) talked about aspirations in a context of 'uncertain futures'. What this means is that teachers' existing valued beings and doings or aspirations might not be appropriate for the changing biodiversity context, thus the need to think about alternatives, for example, if a teacher's value is in line with anticipated risks related to biodiversity loss and teaching methods that can prepare learners for the anticipated problems and risks associated with biodiversity loss. Teachers need to develop new knowledge and new skills that can expand their current practices and knowledge (Cundill et al., 2014). Their argument implies that Life Sciences teachers in the PLCs need to be reviewing their aspirations and valued beings and doings. This argument is of significance in this study, as Wiek, Wathycombe & Redman (2011) argued for anticipatory competencies for ESD, and one can argue that it is possible to develop such competence in PLCs.

The arguments above demonstrate that education has the potential to expand learning and valued choices (Lambert & Morgan, 2010). The capability approach opens spaces in which we can be critical of continuing professional development processes within a normative framework (Boni & Walker, 2013). Sen's capability approach does not explicitly claim that formal education may not always operate as an unqualified good (Radja, Hoffmann & Bakhshi, 2003). But a bad education experience can cause long term negative implications (Tao, 2013a). It is therefore important to

consider that teachers' capabilities can be diminished and/or enhanced through continuing professional development processes. The capability approach calls for a focus on how social contexts such as PLCs set the conditions for teachers' freedoms. So in the case of education, we need to aim at equalising people's capabilities both in and through education (Unterhalter et al., 2007). In this way, the capability approach provides a framework which is sensitive to diverse social settings and groups (Radja et al., 2003).

The arguments above related to the capability approach, show that the exploring of Life Sciences teachers capabilities and functionings in the PLCs is not straightforward. Social structures and cultural norms can influence what Life Sciences teachers' value and their choices to participate in PLCs (Robeyns, 2005a). Sen (1992) proposed that social conditioning can make a person lack the courage to choose the capabilities that they are denied. Thus in exploring the Life Sciences teachers' functionings in PLCs related to the teaching and learning of biodiversity there is a need to distinguish explicitly between what these teachers "really prefer and what they are made to prefer" (Teschl & Comin, 2005:236). This points to the structure agency debate, where there is tension between the determinants (teachers) of value and behaviour: are values a product of an agent's authentic preference, deliberations and choices, or are they constituted by the norms, cultures and social institutions that tacitly shape agents' thoughts, motives and decisions? (Sewell, 1992).

3.4 Critiques of the capabilities approach

As mentioned earlier, Sen's capability approach has inspired a considerable amount of research that seeks to understand better and evaluate the status and processes of human well-being and development. But its abstract definition has created space for some critiques (Robeyns, 2005a). Conceptualising and incorporating the social aspects of capabilities requires a basic understanding of how societies and individuals together constitute capabilities (Smith & Seward, 2009). The underlying argument of the capability approach is that capabilities should be used as the space for evaluating human development (Sen, 1999). Sen (2009) does indeed "take reasoned scrutiny from different perspectives to be an essential part of the demands for ethical and political convictions" (p.45). While critics may remark that Sen's capabilities theory remain insufficiently specified (Nussbaum 2000; 2003), this often arises from misunderstandings of Sen's work (Martins, 2006).

Sen's capability approach is deliberately incomplete and vague; he does not stipulate which capabilities should count nor how different capabilities should be combined into an overall indicator of human well-being (Robeyns, 2005a). For him, "a workable solution" is possible without complete social unanimity (ibid.). Incompleteness is fundamental to his capability approach (ibid.). He argued that all the members of any collective should be able to be active in the decisions regarding what to preserve and what to let go (ibid.). This implies that Life Sciences teachers in the

PLCs should decide what they value in relation to the teaching and learning of biodiversity which, according to Sen, is a social justice need (Sen, 1999). Sen encouraged open deliberations and public debates as well as open discussions, to arrive at a collective and reasoned decision of what capabilities count (Walker, 2005). He argued that those affected by any policy and practice should be the ones to decide on what will count as valuable capabilities (Robeyns, 2005a). Opportunities “are also influenced by the exercise of people’s freedoms, through the liberty to participate in social choice and in the making of public decisions” (Sen, 1999:5). Thus Sen’s capability approach pays attention to theories of deliberative democracy, theories of power, theories of voice and participation as he is more concerned about the process of who is making the choice arrived at, rather than the outcome itself only (Walker & Unterhalter, 2007). Thus for Sen (1999), like John Dewey (1938) and Paulo Freire (1972), freedom is concerned as much with the process of decision making as with the opportunities to achieve valued outcomes.

Refusing a list of capabilities, Sen noted that freedom is intrinsically important in making us free to choose something we may or may not actually choose (Sen, 1999). His reasoning for not having a specified list of capabilities has, however, been criticised as it is not clear in his argument how the “processes of public reasoning and democracy are going to take place, and how we can make sure that minimal conditions of fair representation are guaranteed” (Robeyns, 2005b:106). Not all Sen’s applications allow for fully democratic discussions among all those affected (ibid.). Sen was clear that by reasoning he did not mean we will get to the truth but that it will try to prevent us from being as objective as we can (Sen, 2009). He drew on Adam Smith’s concept of the *impartial spectator* to argue the importance of public reasoning in choosing what one values (ibid.). He saw this spectator as representing a range of diverse opinions in order to achieve a fuller and fairly deliberated decision (ibid.). This impartial spectator is a theoretical reflective tool that requires participants to go beyond their own reasoning that may be constrained by “local conventions of thought, and to examine deliberately, as a procedure, what the accepted conventions would look like from the perspective of a ‘spectator ‘at a distance’” (Sen, 2002: 451). He argued that the role of participants in the public debates has intrinsic, instrumental and constructive values (ibid.).

Unlike Sen, Nussbaum (2000; 2003) had a different view on the idea of the capability list. She argued that we need to have some ideas of what we are distributing, and we need to agree that these things are good. She thus produced a list of capabilities for human flourishing and a life of dignity. Nussbaum’s list comprised life; bodily health; bodily integrity; senses; imagination and thought; emotions, practical reason; affiliation; other species; play and control over one’s environment (Nussbaum 2000; 2003). She claimed that her list of capabilities constituted “a minimum account of social justice” (Nussbaum, 2003:40). While she argued that her list was humble, open-ended and

revisable, she believed that the ten categories on her list should be endorsed by all individuals irrespective of their circumstances and cultures (Robeyns, 2005a). Nussbaum's list of capabilities has been endorsed by some, such as Radja et al. (2003) who argued that the Dakar Framework on education (learning to know, learning to do, learning to be, learning to live together) on quality education can be aligned with Nussbaum's list of capabilities. Nussbaum's list of capabilities has been criticised by some authors like Robeyns (2003) who noted "we do not know through what, if any process of public debate the list was produced, whose voices were heard, or how it is to be revised, when, by whom and on what grounds" (p.38). The process taken to come up with the list might lack democratic legitimacy (ibid.). For Sen, what mattered were the processes rather than the outcomes only (Sen, 1999).

While the capability approach undoubtedly has an individualistic orientation, it is widely acknowledged that a complete account must include both individual capacity and social factors (Sen, 1999). Ibrahim (2006) argued that the capability approach is limited in its ability to capture the interrelationship between individuals and social structures. He highlighted the intrinsic importance of social structures and their two-way relations with individual agency by reaffirming the social-embeddedness of individuals and denounced as a serious mistake the attempt to interpret individual agency regardless of social relations. Robeyns (2000; 2005a) argued that those who view the capability approach as overly individualistic are conflating ethical and ontological individualism. She proposed that the capability approach embraces ethical individualism but does not defend methodological or ontological individualism. Ethical individualism "postulates that individuals, and only individuals, are the ultimate units of moral concern" (Robeyns, 2005a:107). This does not imply that social structures and societal properties cannot be evaluated; rather it implies that structures and institutions will be evaluated by virtue of the causal importance they have for individuals' well-being (ibid.). In other words, while the ethical focus is on the individual, there is no problem incorporating social ontology into the framework as a factor that determines capabilities (ibid.).

Jackson (2005) also disagreed with claims made that Sen did not pay enough attention to social structures. He argued that the social context of capabilities has been latent in Sen's work but was marginal and undertheorised. Sen was aware of the cultural and social aspects of capabilities; he alluded to them in his writing. He argued that there is a deep complementarity between individual agency and social arrangements (Sen, 1999). Robeyns (2005a) also argued that the capability approach does acknowledge that social structures and institutions have an influence on people's capability sets. The social structures and policies are the means of capability, thus it is important in the capability approach to understand the social determinants of the capabilities (ibid.). Sen (2004)

has pointed out that the capability approach can only account for the opportunity aspect of freedom and justice, and not for the procedural aspect. In other words, Sen did acknowledge that institutions and structures need to be also procedurally just, apart from the outcomes they generate. Sen pointed towards the social and structural influences on capability, and he noted the significance of social factors (Sen, 2009). Jackson (2005) pointed out that capabilities depend not only on entitlements but on institutional roles and personal relations: these can be represented openly if capabilities are disaggregated into individual, social and structural capacities. The three layers interact, and a full analysis of capabilities should consider them all (ibid.). A full account of behaviour must recognise both human agency and social structure, along with the bonds between them (ibid.). Martins (2007) also argued that key ontological categories implied in Sen's writings are social structures and interconnectedness. Sen (1983) argued that one's position *vis-à-vis* others does not just result in a unique perspective and reasons, but also provides objective resources that enable and/or constrain particular activities, regardless of the beliefs of the individual. This implies, among other things, that any one development intervention will have differential impacts on different individuals depending upon the individual's physical and mental make-up as well as their relative position in society.

Sen directly addressed the concern that the capability approach is overly individualistic and thus might somehow not be able to take into account social causes (Sen, 2009). In doing so he specifically referred to the notion of relational connections as central to capabilities (ibid.). Naturally, individuals have particular capacities and they can act on these capacities. This idea reflects Nussbaum's (2000) notion of basic and internal capabilities. Basic capabilities can be seen as the inherent capacities of individuals to function as human beings. Internal capabilities are inherent to being human, but are also fostered through an individual's interaction with the external environment. It is at this level that we can discern the fundamental capacities of individuals that are the causal powers that interact with and are shaped by social structures. 'Interpretivist' approaches to research that are concerned with 'understanding' arguably focus on these types of individual causal mechanisms. It is possible to identify a whole range of causal mechanisms that emerge from the inherent structure of an individual, such as reasons, beliefs (Sayer, 2000), emotionality, memory, desires, reflexivity, sense of self, personal and social identity (Archer, 2007). These inherent capacities of humans are developed and altered through the individual's unique history allowing people to engage in reflexive intentional behaviour and realise their potential as human beings and social creatures. Despite the critiques outlined above, the capability approach still proved to be the most appropriate theory in the study; this is because of the way it conceptualises functionings, capabilities, and conversion factors. Its lack of conceptual clarity of the concept of agency and social structures thus will be complemented by critical realism as discussed in the next

section. Martins (2006) argued that the capability approach can be used as a philosophical underlabourer in clarifying concepts of choice, agency, freedoms, potentials and capabilities. But he did, however, recognise that Sen does not engage in explicit ontological analysis at the same level of abstraction as critical realism. Sen's capability approach is not aimed at understanding causal structures and mechanisms, hence the need for critical realism in this study to explain and understand the causal structures and mechanisms that influence PLC functionings.

3.5 Critical realism

3.5.1 Introduction to critical realism

Critical realism is a philosophy of natural and social sciences developed by Roy Bhaskar (1978; 2002). He described his philosophy of science as 'transcendental realism' (Bhaskar, 1978). Critical realism has served as the base for the work of many social scientists, including Margaret Archer, Tony Lawson, Alan Norrie and Andrew Collier (Martins, 2011). These advancements have led to an increasing number of social science researchers using critical realism in their research (Pawson & Tilley, 1997; Danermark, Ekström, Jakobsen, & Karlsson, 2002) including in the field of education (Maxwell, 2004; Scott, 2005; Shipway, 2011) and particularly in ESD (Schudel, 2012; Sabai, 2014). Bhaskar (1978; 2002) developed three forms of philosophy: first wave or basic critical realism, dialectical critical realism and the philosophy of meta-reality. In this study, only the epistemological and ontological arguments of basic critical realism were used to underlabour the capability approach. The study therefore only explored those concepts of critical realism that helped underlabour the capability approach. According to Potter and Lopez (2001), basic critical realism has its origin in the critique of positivism in Natural Science and hermeneutic in the Social Sciences. Positivism's assumption is that knowledge of reality can only be gained through empirical means while the assumption in hermeneutics is that reality is only a product of our social construction of knowledge (ibid.). Critical realism has been linked to hermeneutics and postmodernism in agreeing that, "the production of knowledge is itself a social process and one in which language is deeply embedded" (ibid.: 9). However, critical realism diverts from hermeneutics and postmodernism by arguing that knowledge of reality cannot be solely reduced to its social determinants of production or social meanings. Critical realism put forward an argument that reality is an actual independent entity and it is a misunderstanding of it that has led to distortion. Thus critical realism's ontological position, is that reality is independent, structured and to a large extent not observable (Bhaskar, 1978).

Critical realism is based on the assumption that there are real generative mechanisms underlying the events of the world and our experiences of it offering the theory of ontological realism (Benton & Craib, 2001; Scott, 2005; Easton, 2010). Critical realism believes that natural and social phenomena

are real (ontological realism) but that our knowledge about them is theory-laden, imperfect and fallible (epistemic relativity) (Sayer, 1992; 2000). Therefore what constitutes scientific knowledge will necessarily change over time as theories with better approximations to the truth are developed. This led Bhaskar (2002) to describe his position in terms of ‘epistemic relativity’ and to argue against the correspondence theory of truth. Bhaskar advocated epistemic relativity simply because given the lack of a direct access to a manifest truth, our knowledge claims are relative to some fallible theory or perspective (Cruickshank, 2003).

3.5.2 Key aspects of critical realism drawn on in the study

3.5.2.1 Stratified reality

Critical realist researchers base their explanations of how people experience a phenomenon on mechanisms that operate at deeper levels of reality. The three levels of reality in basic critical realism are the *empirical*, *the actual* and *the real*. Bhaskar accepted that each of these levels is real, thus there seem to be a terminological confusion with the term ‘real’ also classified as one of the levels of analysis. Benton and Craib (2001) asserted that the metaphor of levels indicates that critical realism is a form of ‘depth’ realism, implying that scientific research employing a critical realist methodology goes beyond what is experienced, to uncover generative mechanisms. A generative mechanism is “the way of acting of things” (Bhaskar, 1978:14).

The *empirical* is the layer of reality that is most accessible to us. It refers to our observations and experiences of the world. This layer, according to Danermark et al. (2002), contains our data or facts and these facts are always what mediates our theoretical conceptions. This layer consists of knowledge that is fallible and unstable. In the case of this study, empirical knowledge consists of Life Sciences teachers’ conceptions of their valuable beings and doings as teachers and as participants in PLCs or their understanding of their own practice and continuing professional development. The *actual* is the layer of reality which consists of the events of the world, experienced by people or not (Danermark et al., 2002). An example of events in this study is actual Life Sciences teachers’ practices. The *real* refers to anything that exists, be it natural or social, which has power to cause events and experiences at the level of the actual and the empirical (Sayer, 2000). It is within the level of the real that causal mechanisms and causal powers are found. These mechanisms may exist unexercised: “... what has happened does not exhaust what could happen” (Sayer, 2000:12). It is through an understanding of the real that I sought to explore the structural factors that shape the PLCs events and experiences in this study responsible for PLCs functionings, events and experiences. The strata of critical realism imply that observation is fallible, thus we are not fully able to provide a complete understanding of any social situation (Potter & Lopez, 2001).

3.5.2.2 *Mechanisms, power and structures*

Drawing from critical realism, Martins (2006) differentiated between the concepts of structures, power and mechanisms as three fundamental concepts of critical realist ontology, noting that:

Structures are the underlying conditions of possibility that enable or facilitate the occurrence of a given phenomenon. Structures comprise *powers* that may or may not be exercised and, when exercised, may or may not be actualised in actual events and states of affairs. *Mechanisms* refer to the mode of operation of structures and exist as the power that a structure possesses of acting in a given way. (p. 676)

In accordance with the quote above that structures comprise powers that may or may not be exercised, Collier (1994) gave an example of a motorbike that is capable of speeds of 200 km/h but might never be driven that fast. On mechanisms, Bhaskar (1978) argued:

The world consists of mechanisms not events ... They may be said to be real though it is rarely that they are actually manifest and rarer still that they are empirically identified by men ... they are not unknowable, although knowledge of them depends upon a rare blending of intellectual, practice-technical and perceptual skills ... This is the arduous task of science: the production of the knowledge of those enduring and continually active mechanisms of nature that produce the phenomena of our world. (p.37)

Bhaskar (1978:3) noted that mechanisms are “nothing other than the ways of acting of things”. Mechanisms are ways in which structured entities, by means of their powers and liabilities, act and cause particular events (Easton, 2010). Entities have causal powers (ibid.). They provide building blocks for critical realism’s explanations and can be things such “as organisations, people, relationships, attitudes, resources, inventions, ideas, and so on. Entities can be “human, social, or material, simple or complex, structured or unstructured” (Easton, 2010:120). They are usually structured with nested structures within them that affect one another i.e. an organisation has departments, people, processes, resources which all affect one other. “When activated, particular mechanisms produce effects in conjunctures, which may sometimes produce different events and conversely the same type of events may have different causes” (Sayer, 1992: 116). Easton (2010) warned that the concept of mechanism needs to be used with caution because it has problematic connotations which imply clear structure and invariance in operation, something that critical realists reject.

Sayer (2000) argued that the same structures and mechanisms with different conditions cause different observed events. He noted that, causal mechanisms do not act deterministically. They are better understood as tendencies (Bhaskar, 1998). Tendency means “to capture the idea of a continuous activity that may or may not be actualised in concrete events and states of affairs, even when it is continuously exercised” (Martins, 2006:676). This implies that generative mechanisms as causal forces should only be conceived of as partial causes (Sayer, 2000). Causes are always a

partial explanation of an outcome, implying that mechanisms are always acting and interacting in a context of other causes that generate the observed outcome (Sayer, 2000). Tendencies can be linked to courses of action that one would take; for example, Life Sciences teachers participating in the PLC activities in order for their valued beings or doings to come to fruition (Tao, 2013a). The concepts of mechanisms, tendencies and structures were significant in this study as justified in Section 3.6 in this chapter (and as shown in Chapter Eight).

3.5.2.3 Open systems and tendencies

In addition to stratified reality, critical realism argues that reality is differentiated and this differentiation is between open systems and closed systems (Shipway, 2011). Bhaskar (1978) noted that open systems result in a situation where particular mechanisms cause certain effects and those effects are observed. The objects of knowledge in the Social Sciences are only experienced in the open systems (ibid.). What this implies is that education programmes such as the Fundisa for Change programme are always placed in the open systems. Collier (1994) noted that in most situations (except in a few controlled experiments) events happen in open systems where there are many multiple co-determining mechanisms that make it somehow difficult or impossible to draw conclusions on constant conjunctions between a particular cause and effect. To explain this statement, Shipway (2011) gave an example of the wet patch found on the carpet, which could be a case of a glass of water that was spilled by Jim who was trying to get some water because he was very thirsty. The argument being made here is that the event is *co-determined* in the sense that we cannot claim that every time Jim is thirsty, the final result will be a wet patch on the carpet.

Tendencies operate within the open systems (i.e. in the PLCs) of the social world amongst counter-tendencies, which are “counteracting forces [that] can override and conceal the effects of the operation of a particular mechanism” (Collier, 2005:110). Archer (2007) noted:

If there is a congruent relationship between an individual’s tendency with concurrently operating tendencies, there is enablement of action: but if there is incongruence, there is a constraint. At that point, an individual has the power to reflect upon one’s circumstances and to decide what to do in them or to do about them; and this reflexive deliberation may result in compliance to counter-tendencies (in which original course of action is negated), or evasion of it (in an attempt to realise the action, albeit in a constrained way). (p.20)

Relating this to the three levels of reality, Tao (2013a) observed that the outcome of a decision made regarding the enabled or constrained tendency lies in the actual domain of critical realism. Any observations made related to the outcome lie in the level of the empirical, and any explanations given for the experiences entail the underlying causal mechanisms, tendencies and counter-tendencies (Shipway, 2011). It was important in this study to understand the causal factors and the causal processes that explain how the generative mechanisms relate to the Life Sciences teachers’

PLC activities. This is linked to the critical realism concept of causality. The concept of open systems is significant in this study as it helps explain the tendencies and counter-tendencies that may override or conceal activities within the PLC as an open system (see Figure 3.2), affecting teachers' capabilities and functionings.

3.5.2.4 Causality

Causality is “to ask the cause of something is to ask what makes it happen, what produces, generates, creates or determine it, or more weakly, what enables or leads to it” (Sayer, 1992:104). In the realist view, “analysis deals with the necessary conditions and powers of structures, abstracting from the particular historical contingencies which brought those conditions into being” (Sayer, 2000:141). In essence, a critical realist approach to research is a search for *transfactual causality* in which the exercise of powers and tendencies of generative mechanisms are contingent on different structural and social relations in an open-ended societal system.

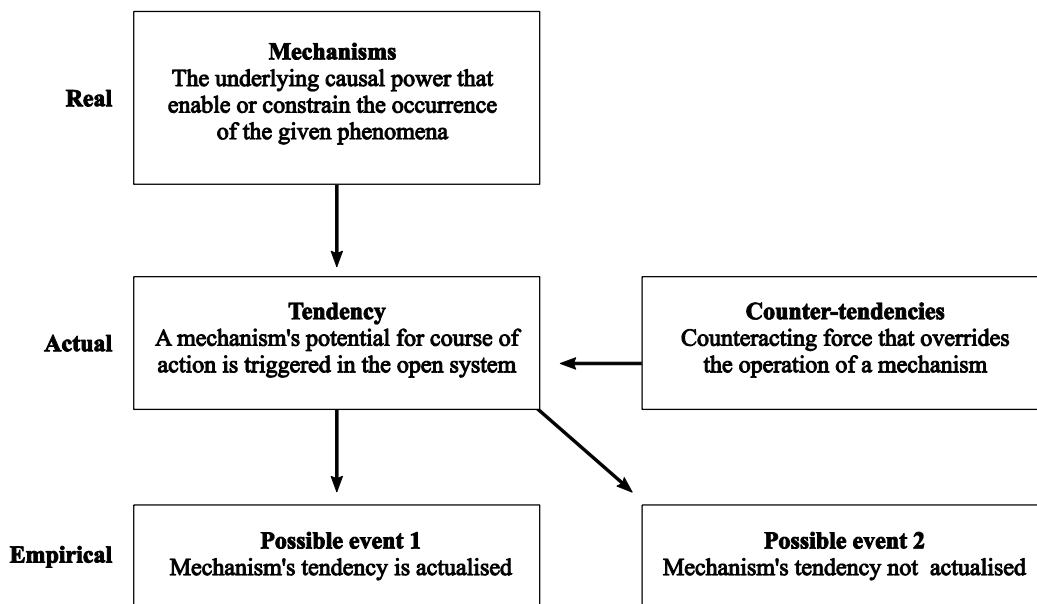


Figure 3.2: Critical realist view of causation (adapted from Tao, 2013b and Sayer, 2000:15)

Figure 3.2 demonstrates how the same mechanisms in an open system can be affected by different counteracting forces that can override the operations of the mechanism causing different events / outcomes.

3.5.2.5 Social structures

Significant to critical realism is the notion of social structures (Sayer, 2000). Like natural entities, social structures emerge from relations: the relations between people, and relations between people and nature (Easton, 2010). Included in this set of relations is culture, which can be considered the existing set of ideas that can be understood or known by someone (Archer, 1995). While analytically it is straightforward to state that social entities and individuals are separate, the

distinction is not clear (ibid.). Social structure and individual agency may be autonomous to some degree, but they are also mutually constitutive (ibid.). The social mechanisms that emerge from social relations shape an individual's situation and individuals as constituent parts of society reproduce and sometimes transform society through engaging in socialised or unique social practices (Archer, 1995). Martins (2006) noted that, structures can be physical, biological, psychological or social structures. Social structures are constituted by social rules, which are attached to given social positions (ibid.). And social positions are internally related (ibid.). As Lawson (2003) explained, aspects or items are said to be internally related when they are what they are, or can do what they do, by virtue of the relations in which they stand. When parts of a given phenomenon are *internally related*, these parts in isolation will not possess the essential properties of the whole. These (internally related) social positions (that are attached to given social rules) constitute the underlying social structure that facilitates or constrains human agency and social practices. Social entities have causal influence through how they shape the circumstances of the agency of individuals, shaping their choices and capacities (Bhaskar, 1998). The web of relations condition and influence an individuals' reasoning and action through the provision of material resources and normative ideas (Archer, 1995).

The point of contact between the social structure and individuals is to be found in positioned practices; that is, "*positions* (places, functions, rules, tasks, duties, rights, etc.) occupied (filled, assumed, enacted, etc.) by individuals, and of the *practices* (activities, etc.) in which, in virtue of their occupancy of these positions (and vice versa), they engage" (Bhaskar, 1998:41). Occupying a particular role, relative to others, is what determines what a person can or cannot do (Sayer, 2000). In this way, a person's relative position in society subjects them to the causal mechanisms that constrain and enable behaviour. In the context of this study, this means the positions occupied by different people, i.e. Fundisa for Change coordinator, partner, teacher or PLC coordinator, will determine what they can do or not do.

3.6 Critiques of critical realism

According to Sayer (2000), critical realism seems to slide between two exclusive definitions of reality. The first is the definition linked to the transitive domain of fallible theoretical interpretations of reality and the second claims that ontology is said to imply a direct representation of the intransitive domain which is the reality beyond our knowledge (ibid.). The argument or critique being made by Sayer is that defining ontology in terms of the transitive domain was said to mean committing the epistemic fallacy, and claiming the intransitive domain implies a privileged position which allows the definition of the features a reality beyond our knowledge (ibid.). Price and Lotz-Sisitka (2016), in their book entitled *Critical Realism, Environmental Learning and Social-*

Ecological Change, have critiqued critical realism by noting that realists have not adequately resolved the issue of methods used in critical realist research. Their argument is that critical realism seems to be more concerned about philosophical positions rather than the methodology. The use of the critical realist DREIC approach and underlabouring for other methods such as Cultural Historical Activity Theory (CHAT) and laminated systems analysis responds to these critiques of critical realism (ibid.). The use of methodological and theoretical triangulation in this study (see Chapter Two) responds to these critiques of critical realism to some extent.

3.7 Critical realism and capability approach in this study

As described in Section 3.3, the rationale for using capability approach in the study lay in its ability to offer an analytical space in which to understand the teachers' functionings evident in the Life Sciences teachers' PLCs, and as it elucidates how environmental, social and personal conditions constrain the valued beings and doings that the Life Sciences teachers value. The capability approach is used to analyse Life Sciences teachers valued beings and doings on the teaching and learning of biodiversity as well as provide casual explanations for teachers' experiences in PLCs and the experiences of Fundisa for Change partners in supporting teachers' PLCs for expanding biodiversity knowledge. Martins (2006) argued that it is possible to clarify the ontological nature of capabilities and functionings. Martins' (2006; 2007) arguments of any ontological nature are inspired by Tony Lawson, who works with critical realism in Economics. He argued that critical realism complements the capability approach's analysis even though at different levels of abstraction (Martin, 2006). Critical realism seems to be operating in the philosophical – ontological level, whereas the capability approach is operating at the empirical – scientific level (Martin, 2006). Interpreted within critical realism, capabilities can be seen as structures with particular internal relations from which their causal powers emerge. Functionings are the realisation of the activations of these causal mechanisms (Smith & Seward, 2009).

Locating the capability approach concepts of capabilities, valued functionings and conversion factors within the theory of causation provides a fuller explanation of what teachers' valued beings and doings are in PLCs. This offers tools for conceptualisation and explanation of the causal, generative mechanisms and tendencies which either enable or constrain Life Sciences teachers' capabilities in the PLCs, leading to teachers' valued functionings being achieved or not. In addition, the capability approach and critical realism framework provides for a more comprehensive approach for analysis of how professional development programmes such as the Fundisa for Change can potentially act as a conversion factor that enables or constrains structures, agencies and functionings of science teachers in the PLC. What inspired the use of the capability approach and critical realism in this study is Tao's (2012; 2013a; 2013b; 2015) analytical framework. In this

framework, Tao (2012; 2013a; 2013b; 2015) showed how the capability approach and critical realism can be connected (see Figure 3.3 that follows).

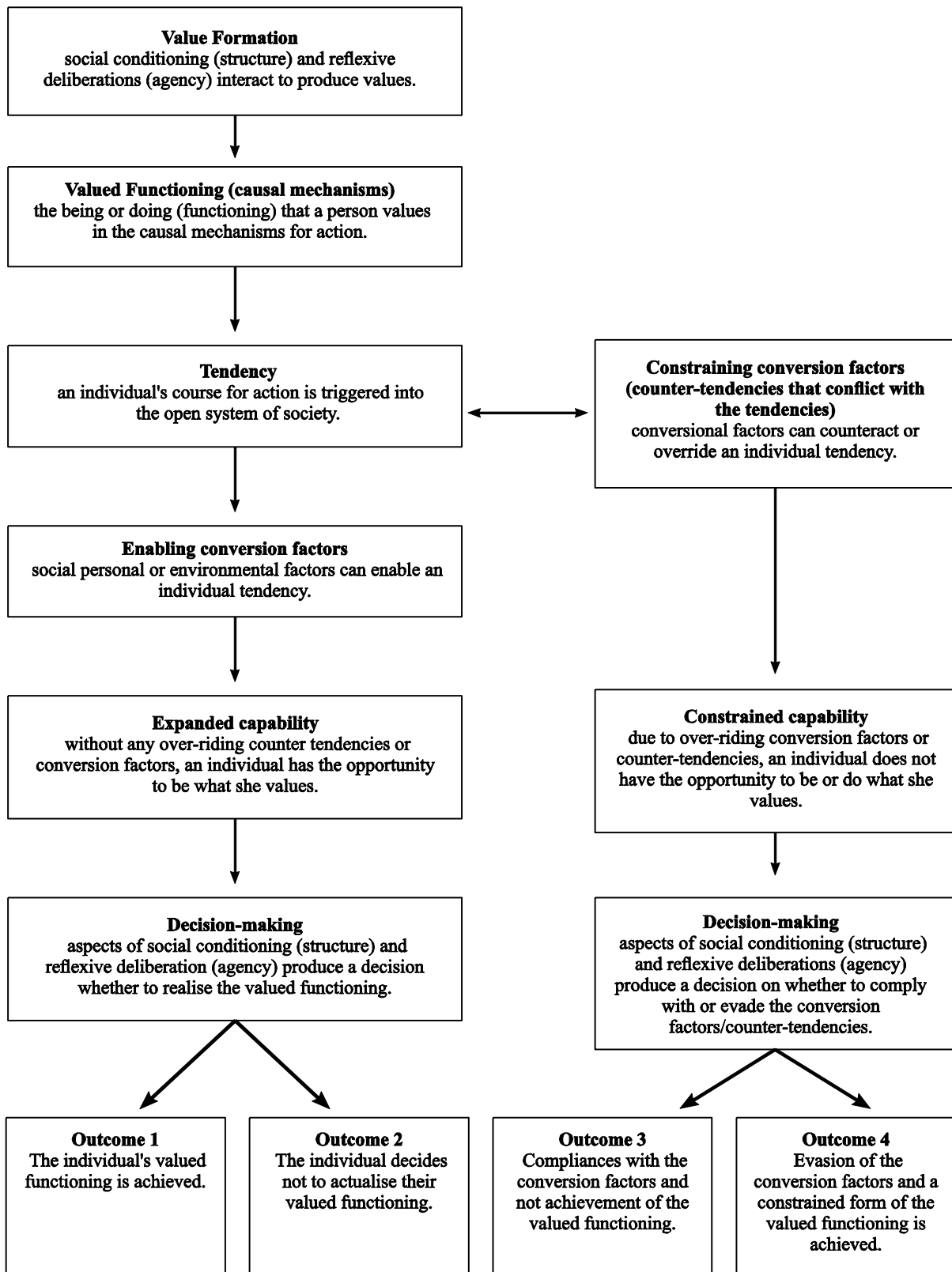


Figure 3.3: Locating capability approach concepts in a Critical Realist Theory of causation (Tao, 2013a:9)

This framework has been the most significant tool used in this study to argue for the use of capability approach and critical realism. The framework has been used for analysis to gain an in-depth understanding on the teachers' valued beings and doings in the PLC related to biodiversity teaching (see Chapter Five). To unpack this framework, at the level of the real, the structures and agency can interact to develop a functioning that an individual values (Tao, 2012). These are the individual's causal mechanisms (in the case of the study this could be the Life Sciences teachers' motivation for participating in the PLC activities) that triggers an individual's tendency of action (ibid.). This happens in an open system (Collier, 2005). Within the open system (in the case of the study, the open systems are the PLCs in the wider education and social system) are conversion factors (environmental, social and personal) which can either enable or constrain the Life Sciences teachers' capabilities to achieve their valued functionings (Tao, 2012). If the conversion factors are enabling, the individual Life Sciences teachers' capabilities are expanded (Robeyns, 2005a). This results in an individual Life Sciences teacher's functionings being achieved and the individual decides whether to actualise the functioning (outcome 1) or not (outcome 2) (Tao, 2012). If the conversion factors are constraining the individual Life Sciences teacher, capabilities are constrained and the individual valued functionings will not be achieved (Robeyns, 2005a). This may result in an individual Life Sciences teacher complying with the constraint (outcome 3), or being content with the counter-tendencies that could result in a constrained version of the valued functioning (outcome 4) (Tao, 2012). This brief discussion clarifies how such a framework can be helpful to identify causal mechanisms in the PLC, identify the conversion factors and explore how the agents (i.e. Life Sciences teachers) can deliberate on whether to realise their achieved outcomes in the PLCs or not.

To further motivate the use of social structure and agency in the study, it is necessary to discuss these concepts drawing on Margret Archer's (1995; 1996; 2007) perspectives, as she provides a sophisticated analysis of the structure and agency debate in her social realist work. "Many critical realists have critiqued the conflation of human action with social structures, as well as conflation of human action with agency only, and see the formation of reasons and subsequent decision making as a result of dialectical process between structure and agency" (Tao, 2013a: 9). This agential ability for teachers to reflexively deliberate on social structures explains why teachers do not respond in the same way under the same circumstances.

Agency refers to the reflexive, creative, innovative, and purposeful actions of people (Archer 1995). It refers to the choices that people make in their daily lives which either reinforce existing structures and cultures or transform them (ibid.). People are not passive beings whose actions are automatically triggered by the forces of structure. According to Archer (1995), even though structural and cultural systems impose constraints on the actions of people, it is important to

understand that people are reflexive actors. People such as Life Sciences teachers have the capacity to choose what they like and dislike, and what they agree with and disagree with, what they prefer and do not prefer, whether to be loyal, to be chauvinists, etc. (ibid.). The actions of people therefore can be different from the socio-cultural system imposed upon them. Archer (1995) therefore maintained that the actions of people do not mirror the cultural system but can show a significant degree of independent variation. Such deviations are crucial because they account for change or stability of structure and culture (ibid.). People therefore have their own emergent powers which cannot be reduced to those of structure and culture (ibid.). Their agency is thus *real* because it has power to shape society, often in unintended ways, and it exists independently of our wishes for what society should be like (ibid.).

Reflecting on Archer's broad commitment to reflexivity and choice as key elements of agency, I drew on Crocker and Robeyns (2010) concepts of self-determination, reason orientation and deliberation, action and impact on the world, to analyse teachers' agency in the PLCs:

- *Self-determination* – the person reflexively decides for himself or herself rather than someone or something else making the decision to do X.
- *Reason orientation and deliberation* – the person bases his or her decisions on reasons, such as pursuit of goals (showing reflexivity and choice).
- *Action* – the person performs or has a role in performing X (providing the situatedness necessary for reflexivity and agency).
- *Impact on the world* – the person thereby brings about (or contributes to bringing about) change in the world. (Crocker & Robeyns, 2010:80)

Crocker and Robeyns (2010) argued that the more fully an agent acts on each of the four conditions, the more fully developed is that person's act of agency. This supports the idea of Reich (2002:93) that "agency is a matter of degree rather than "an 'on/off' capacity or condition". My understanding of the concept of 'degree' is offered via qualitative explanations linked to Life Sciences teachers' agency in the PLCs (see Chapter Seven). Archer's notion of "ultimate concern" (Archer, 2007) is also related to Sen's (1999; 2009) concepts of a person's valued beings and doings as motives for agentive action or agency.

This study was located in critical realist theory of causation. Smith and Seward (2009) observed that the notion of causality that x generates y (in the context of c) can be applied to understanding capabilities at two points. A capability is the combination of an individual's capacity to do something combined with the context of particular enabling (or disabling) mechanisms (Smith & Seward, 2009). The realisation of a capability (i.e. the functioning) will be modulated by the particular configuration of contextual mechanisms that shapes the capability (Smith & Seward, 2009). In the literature, the idea of contextual mechanisms can be related to the notion of conversion

factors. A central argument by Sen for the importance of capabilities over commodities as an evaluation space is the fact that people have different conversion functions for the same commodities (Goerne, 2010). Commodities will only be converted to a particular outcome under the relevant contextual factors and with relevant contextual mechanisms at play (Smith & Seward, 2009). We can also consider what this implies for specific interventions such as Fundisa for Change. An intervention will only generate particular outcomes (such as increased Life Sciences teachers' capabilities) where the relevant contextual mechanisms exist that are generative of the outcome via a process of emergence involving reflexive agency. In this sense, outcomes associated with the intervention are always a result of influence from contextual conversion factors (Smith & Seward, 2009). Thus, considering Fundisa for Change as a national intervention programme, it is arguable that its implementation will be determined by different contextual factors and mechanisms in different provinces. Similarly, even though teachers participating in Fundisa for Change activities might be receiving the same resources, different contextual factors and mechanisms will determine how teachers can or will convert them into new functionings. Hence the argument by Robeyns (2005a) that, even though teachers may receive the same resources, the outcomes will be different.

Critical realism argued that there are two kinds of relation among entities: necessary and contingent (Easton, 2010). Necessary relations mean one cannot exist without the other. Change in one body leads to change in another body with which it has necessary relations. For example, organisations cannot exist without people but people can exist without organisations or a person cannot be a slave without a master, an example given by Sayer (1992). A contingent relation occurs when "it is neither necessary nor impossible that they stand in any particular relation" (Sayer, 1992:89). Therefore entities can have some "relations (necessary) that will affect one another and some (contingent) that may affect one another" (Easton, 2010:121). Whether contingency or not, results may or may not occur, and thus may or may not result in emergence. The framework (Figure 3.3 by Tao (2013a) allows a researcher like me to identify the outcomes (both intended and unintended outcomes). In doing so, it is also significant to use the concept of contingencies and necessity (Sayer, 2000; Easton, 2010; Shipway, 2011) to analyse the relationships between the different outcomes (see Chapter Eight).

3.8 Conclusion

This chapter has discussed the theoretical frameworks in the study. The capability approach has been introduced and elaborated as the substantive theory of the study. In response to the critiques of the capability approach it has been underlaboured by critical realist theory of causation in this study. The chapter argues for critical realism as an underlabourer of the capability approach and provides

an analytic framework for use in this study. In the next chapter the methodology of the study is discussed.

Chapter 4: Research design and methodology

4.1 Introduction

The previous chapter provided theoretical perspectives that are used to provide a more nuanced understanding of the conversion factors, functionings, agency and structures in Life Sciences teacher PLCs. In this chapter I examine the research design and methodology of the study. The chapter discusses the research methodology and the methods used to generate data to answer the research questions and related conversion factors, functionings, agency and structures of Science teachers' PLCs. The chapter further discuss the strengths and limitations of the chosen methods, participants who provided the data that answered the research questions posed in the study and how they were selected. Moreover, this chapter discusses how the data was managed and analysed, the position of the researcher in the study and how that might have affected the participants and the data collected. Finally, the chapter discusses the ethical issues that were considered throughout the research process.

4.2 Implications of critical realism and capability approach for research design

According to critical realism there is an independent reality which is not always readily observable (Danermark et al., 2002). The capability approach demonstrates the implicit critical realism ontology which focuses on concepts such as capabilities, functionings and conversion factors, which in most cases are non-observable and underlying components that affect human agency and social practices (Smith & Seward, 2009). Therefore, both critical realism and the capability approach implicitly reject positivism and the notion that knowledge of reality can be 'objectively' determined. The capability approach places value in listening to people's subjective voices, values and experiences, particularly through inter-subjective dialogue and discussions (Sen, 1999), which in critical realism would be recognition of the hermeneutic nature of experience at the empirical level and Bhaskar's 'epistemic relativity'. As explained in Chapter Three, critical realism underlabours epistemic relativity (transitive reality) or hermeneutics with a realist ontology (intransitive reality).

Critical realism talks of extensive and intensive research designs (Sayer, 2002). "Extensive research shows us mainly how extensive a certain phenomenon and patterns are in a population, while intensive research is primarily concerned with what makes things happen in specific cases" (Sayer, 2000:20). An intensive approach often uses qualitative research approaches as these are helpful in the detection of causal mechanisms while also making use of thick description of empirical experiences (Danermark et al., 2002). In this study, I was mostly concerned with understanding

structures as generative mechanisms influencing the valued beings and doings of Science teachers in the PLCs as this relates to the teaching and learning of biodiversity, and thus I used an intrinsic research design, using qualitative research approaches.

Qualitative research stresses the socially constructed nature of empirical experiences, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry (Sayer, 2000; Denzin & Lincoln, 2011). Researchers seek answers to the questions that stress “*how* social experience is created and given meaning” (ibid.:8). Critical realism believes that “knowledge about the world is socially constructed (but not that the world is socially constructed). Society is made up of feeling, thinking human beings, and their interpretations of the world must be studied” (Danermark et al., 2002:200). Critical realists further believe that “scientific work must go beyond statements of regularity to the analysis of the mechanisms, processes, and structures that accounts for the patterns that are observed” (p.11). The study therefore used qualitative approaches to explore the Science teachers’ valued beings and doings in the PLCs and conversion factors that lie within the real and actual domains of reality. This understanding sought to provide explanations that can inform teachers’ professional growth. Critical realists believe that there are no definite criteria to judge the ‘truth’ of a particular version; they rely on research to provide data that help distinguish among alternative explanations through thorough debates (Maxwell, 2012).

4.3 Case study

In a review of environmental education research by Hart and Nolan (1999), they observed that researchers use case studies as a research tool, as a method or as a methodological approach. Motivated by Lotz-Sisitka and Raven (2004) who argue for the significance of case study methodology for environmental education research, this study uses a case study design. Case study methodology emphasises context-dependent knowledge (Flyvbjerg, 2006) and addresses problems of interest to the researcher’s professional practice (Stake, 1995). This is significant for learning about environmental learning (Lotz-Sisitka & Raven, 2004) as it allows for researchers like me to research environmental education issues in context such as biodiversity, and allows improving professional practice such as my practices as a Life Sciences teacher and a teacher educator. Case study research is also suited to an intrinsic critical realism research design (Sayer, 2000). For an in-depth understanding on the conversion factors, agency and structures in the Science teachers PLCs, the study is constituted as a case study. This was further motivated by Corcoran, Walker and Wals (2004) and Flyvbjerg (2006) who observed that the use of case study is that it allows for freedom to explore the richness, depth and uniqueness of the phenomenon being studied using multiple sources of data. Case study research is more suited to answer *how* and *why* questions, thus is explanatory in nature (Yin, 2014). Easton (2010) argued, however, that case study research lacks philosophical

validation i.e. ontological and epistemological underpinning. Using critical realism in this study provides such underpinnings. In critical realist research, Collier (2005) suggested that causal mechanisms influence events and empirical experiences in open systems like PLCs. “Case study seeks to engage with and report the complexity of social activity in order to represent the meanings that individual social actors bring to those settings and manufacture in them” (Stark & Torrance, 2005:33). They also recognised that, relevant to case studies, critical realism can bring an understanding that the outcomes of the activation of mechanisms always depend on specific contexts. This may mean that different cases of Science PLCs will bring different understandings about Science teachers’ learning on biodiversity. This will depend on the intrinsic conditions of a particular case and how these mechanisms work through participants’ perceptions and choices (Sayer, 2000). With a critical realist understanding of society as emergent, open-ended and contingent (ibid.), it would be necessary to acknowledge that any number of different events and actions might arise from similar contexts and mechanisms. Applying a critical realist approach to this case study research ensured a better understanding of these complex realities.

This study can be described as a nested case study which, according to Lotz-Sisitka and Raven (2004), refers to “situating of a range of different case studies within a broader case” (p.72). In this case there are individual teachers within the Science PLCs and three case studies (which I have termed PLCs) of Life Sciences teachers working together on the topic of biodiversity within the broader case of the Fundisa for Change professional development programme. The three PLC studies were: the Idutywa PLC, Grahamstown PLC and the Cape Town PLC. As discussed in Section 4.4, the three PLCs were purposively and conveniently selected. The Idutywa PLC had six teachers who participated in the study, the Grahamstown PLC had five teachers and the Cape Town PLC had four teachers.

4.3.1 Case study 1: Idutywa PLC

Idutywa falls under the Mbhashe Municipality of the Amathole District in the Eastern Cape (Ncanywa, 2014). The majority of the population lives in the surrounding rural neighbourhood and in poverty (ibid.). This area is characterised by poverty, unemployment, poor infrastructure as a result of having no access to basic needs such as water, sanitation and electricity (Ncanywa, 2014). As discussed in Section 1.8.1, in terms of demarcation, Idutywa is part of cluster B. Cluster B has many schools situated in villages from the former Transkei and Ciskei (ibid.). A large number of schools have very poor infrastructures and are built with mud, inadequate or prefabricated building structures (ibid.).

The Idutywa PLC training took place¹⁴ (three days for each session) on 19-21 August 2014. The first session was attended by ten teachers, three females and seven males. All ten teachers were teaching Life Sciences grade 10 to 12 in rural schools in the Idutywa district. The second session took place on 13-15 November 2014 and was attended by seven teachers, two females and five males. Three teachers could not attend. One teacher was a foreigner and had to sort out his work permit. The second teacher was not allowed by her principal to attend because she had been absent from school caring for her sick father a week prior to the second session. The third teacher did not attend because of personal reasons. As indicated in Chapter One (Section 1.5), Fundisa for Change is a partnership programme. Different partners contribute to the facilitation of the PLC activities. In the Idutywa PLC, the facilitators were Fundisa for Change partners, one from an NGO and one from the Department of Basic Education. The Fundisa for Change coordinator and one of the Fundisa for Change researchers were observers and participated in the first session. The second session was facilitated by the same facilitators. The Idutywa district subject advisor participated in both sessions of the PLC activities. I was a facilitator and a researcher in both sessions.

4.3.2 Case study 2: Grahamstown PLC

Grahamstown falls under the Makana Municipality in the Eastern Cape province (Hamann & Tuinder, 2012). The town was established in the 1830s (ibid.). Grahamstown is a leading education centre, known for its excellent secondary education institutions, and is home to Rhodes University (where I had enrolled for this study) (ibid.). As discussed in Section 1.8.1, the Eastern Cape is divided into three clusters. Grahamstown is in Cluster C (Ncanywa, 2014). Grahamstown was selected as the research site for convenience and accessibility reasons and because it has diverse secondary schools broadly representing the full continuum of the kinds of schools in South Africa (Wilmot & Irwin, 2015). Grahamstown schools are broadly reflective of urban schools in South Africa as a whole. The schools fall into two broad categories classified according to their geographical location. Group A in Grahamstown east are 'township' schools, and Group B consists of schools located in central and west Grahamstown (ibid.). Grahamstown has no rural schools (Ncanywa, 2014).

The PLC activities happened in three sessions (three days, two days, one day) in the Grahamstown PLC. The first session (19-21 September 2014) was attended by ten teachers, all females. These teachers were teaching Life Sciences grade 10-12 in Grahamstown, Peddie and Port Alfred. Six teachers attended the second session on 17-18 October 2014 and five teachers attended the third session on 11 April 2015. Some teachers could not attend some of the sessions because of

¹⁴ These are training sessions, which are referred to as PLC activities in this study. In Chapters Five, Six, Seven and Eight some participants refers to it as training, courses or simply Fundisa for Change.

bereavement and graduation. One teacher relocated to work in another province thus did not attend session two and session three. All three sessions were facilitated by three Fundisa for Change partners from higher education institutions including the Fundisa for Change coordinator. Other participants present at the sessions were two postgraduate scholars (one was a Fundisa for Change researcher) who also assisted with the facilitation of the PLC activities. One Department of Basic Education official participated in the first and second sessions. I was both a researcher and facilitator in all three sessions.

4.3.3 Case study 3: Cape Town PLC

Cape Town is located in the Western Cape province of South Africa (City of Cape Town, 2014). Cape Town is the third biggest city in South Africa (after Johannesburg and Durban) (City of Cape Town, 2010). It forms part of the City of Cape Town metropolitan municipality (ibid.). There are both public and private primary and secondary schools in Cape Town (Baxen, 2008). Cape Town is split into four school districts: Metro Central, Metro East, Metro North and Metro South (City of Cape Town, 2014). The schools within these districts include both fee charging and ‘no fee’ schools (ibid.). Standards vary considerably between different schools and, while preference is given to children from within each school’s catchment area, it is possible to enrol in a school in a different area (ibid.).

The PLC activities happened in two sessions (two days each session) in the Cape Town PLC. The sessions happened over two consecutive weekends (27-28 February and 6-7 March 2015). Both sessions were attended by twenty three teachers. One teacher missed half of the second session because he had to tutor grade 12 Physical Sciences learners that particular Saturday. The teachers were teaching different subjects and phases, mainly in the Cape Town township schools. Twenty-one of the teachers were enrolled for an Advanced Certificate in Education course at the University of Cape Town. They attended the PLC activities as part of the course. The PLC activities were facilitated by two Fundisa for Change partners, one from an institution of higher education and one from an NGO. Six postgraduate scholars from the University of Cape Town Biological Sciences department gave presentations during the first session, which the Fundisa for Change coordinator attended. I was a researcher in both sessions.

Table 4.1: Summary of the participants in the PLC activities

Case	PLC activity	Attendance	Roles
Idutywa	Session 1 19-21/08/2014	<ul style="list-style-type: none"> • Fundisa for Change coordinator • Two Fundisa for Change researchers • Fundisa for Change NGO partner • Two Fundisa for Change Department of Basic Education partners (subject advisors) 	<ul style="list-style-type: none"> • Observer • One facilitator and researcher, one observer • Facilitator • One facilitator, one participant

		<ul style="list-style-type: none"> • 10 teachers 	<ul style="list-style-type: none"> • Participants
	Session 2 13-15/11/2014	<ul style="list-style-type: none"> • Fundisa for Change researcher • Fundisa for Change NGO partner • Two Fundisa for Change Department of Basic Education partners (subject advisors) • Seven teachers 	<ul style="list-style-type: none"> • Facilitator and researcher • Facilitator • One facilitator, one participant • Participants
Grahamstown	Session 1 19-21/09/2014	<ul style="list-style-type: none"> • Fundisa for Change coordinator • Two Fundisa for Change researchers • Fundisa for Change university partner • Department of Basic Education official (subject advisor) • 10 teachers 	<ul style="list-style-type: none"> • Facilitator • One facilitator and researcher, one facilitator • Facilitator • Participant • Participants
	Session 2 17-18/10/2014	<ul style="list-style-type: none"> • Fundisa for Change coordinator • Two Fundisa for Change researchers • Three Fundisa for Change university partners • Department of Basic Education official (subject advisor) • Six teachers 	<ul style="list-style-type: none"> • Facilitator • One facilitator and researcher, one facilitator • Two facilitators, one participant • Participant • Participants
	Session 3 11/04/2015	<ul style="list-style-type: none"> • Fundisa for Change coordinator • Two Fundisa for Change researchers • Five teachers 	<ul style="list-style-type: none"> • Facilitator • One facilitators and researcher, One facilitator • Participants
Cape Town	Session 1 27-28/02/2015	<ul style="list-style-type: none"> • Fundisa for Change coordinator • Fundisa for Change researcher • Fundisa for Change NGO partner • Fundisa for Change university partners • Six Biological Sciences postgraduate students • 23 teachers 	<ul style="list-style-type: none"> • Observer • Researcher • Facilitator • Facilitator • Subject specialists • Participants
	Session 2 6-7/03/2015	<ul style="list-style-type: none"> • Fundisa for Change researcher • Fundisa for Change NGO partner • Fundisa for Change university partner • 23 teachers 	<ul style="list-style-type: none"> • Researcher • Facilitator • Facilitator • Participants

4.4 Selection of case studies and participants

Careful selection of case studies is important in case study research (Yin, 2009; 2012; 2014). Maxwell (2012) wrote that the two guiding principles in selecting settings and participants in qualitative research is “first to identify the groups, settings or individuals that best exhibit the characteristics or phenomena of interest and second is to select those that are more accessible and conducive to gaining the understanding you seek” (p.94). The first principle is often called purposive sampling and the second principle is convenience sampling (ibid.). According to Palys (2008) purposive sampling is the selection of where, when and from whom the data will be collected. This type of sampling is “virtually synonymous with qualitative research, and that decision about whom and what to include should be based on what you want to accomplish and what you want to know” (ibid.: 697). As mentioned earlier, three teachers PLCs participated in this

study; all three had a focus on biodiversity in the Life Sciences CAPS curriculum. Both purposive and convenient samplings were used to select the PLCs. Because of convenience I intended to work with four PLCs of FET Life Sciences teachers in the Eastern Cape province with a biodiversity focus. But as the study unfolded four PLCs with a biodiversity focus could not be identified in the Eastern Cape. Only two PLCs from the Eastern Cape province were found and participated in the study (the Grahamstown and the Idutywa PLCs) and one PLC in the Western Cape province (Cape Town) participated in the study. The Western Cape PLC was selected because of accessibility and its unique biodiversity which was the focus of the PLC activities. The Idutywa PLC focused on 'Teaching Marine Biodiversity'. Like Cape Town, the Grahamstown PLC focus was on 'Teaching Biodiversity'. Three PLCs provided adequate data for the study and my supervisor agreed that a fourth case would not be needed.

As mentioned in Section 4.2, the study is situated in the Fundisa for Change programme. This means all the PLCs that participated in the study had received support from the Fundisa for Change programme. The Fundisa for Change PLC model works with subject specific and grade specific teachers. Depending on the phase and the subject, the focus is usually on one chosen environmental theme i.e. water, biodiversity, climate change, life and living indigenous knowledge. In this study I worked only with teachers who were teaching Life Sciences at FET phase (grade 10-12) and who attended PLC activities focusing on the theme of biodiversity. In the Idutywa and Grahamstown PLCs, all teachers were potential participants in the study. This is because they were teaching Life Sciences at FET phase. In the Cape Town PLC, only six teachers were teaching Life Sciences FET phase, thus were potential participants in this study. However due to accessibility, fifteen teachers participated in the study (six from the Idutywa PLC, five from the Grahamstown PLC and four from the Cape Town PLC) (see Table 4.4 in this chapter).

In addition, twelve Fundisa for Change partners also participated in the study (see Table 4.4 in this chapter). Five were from institutions of higher education, two from NGOs, one from a parastatal and four from the Department of Basic Education. The selection of the Fundisa for Change partners was done purposively (Palys, 2008). Nine Fundisa for Change partners (including the coordinator) were chosen because they had directly supported the PLCs chosen for the study. They had insights into the teachers' valued functionings in the PLCs in relation to biodiversity; they were able to reflect on the conversion factors that enabled and/or constrained teachers from achieving their valued functionings in the PLCs. Three of the Fundisa for Change partners had participated in the programme since its conceptualisation. Their participation was thus important to understand the functionings, structures and agency in the Fundisa for Change programme, and how they were associated with the conversion factors, structures, agency and functionings in Science teachers

PLCs. One Fundisa for Change partner was from the Department of Basic Education at a national level; thus in addition to her insights on the programme, she had an understanding on the emerging policy on PLCs. To further understand the South African policy on the call for the establishment of PLCs, the Director of the Continuing Professional Teacher Development directorate, also participated in the study.

4.5 Data generation methods

Critical realism research aims to answer the question “what caused the events associated with the phenomenon to happen?” (Easton, 2010: 123). To understand a social phenomenon, the researcher needs to record and analyse the associated events taking place as a result of actors acting (ibid.). The events can be recorded live or exist in records of the past (ibid.). It is in this context that to understand how (if at all) the teachers’ valued beings and doings of Science teachers related to biodiversity teaching were achieved in the PLCs, multiple methods were used to generate data (Maxwell, 2012; Harland, 2014). These included semi-structured questionnaires, semi-structured interviews with teachers and with the Fundisa for Change partners, PLC observations and documents analysis. The multiple uses of data collection methods allowed me to compare and contrast interpretations. The data collection process was iterative. The teachers’ questionnaires were completed first, and then the interviews, observations and document analysis were conducted in no specific order. Before providing details on how the different methods were used to collect data, I will provide a brief discussion on the contextual profile that was conducted in 2013 during the conceptualisation phase of the study, as this was significant for working out how I might do the research.

4.5.1 Contextual profiling

As mentioned in Section 4.4, Yin (2009; 2014) has noted that careful selection of data-rich cases is a very important aspect of case study research. In 2013 when I was busy developing a proposal for this study, I conducted a detailed contextual profile through a semi-structured questionnaire with Science teachers and the Fundisa for Change partners. I had by then already established that such PLC type activities did exist, and were linked to some of the Fundisa for Change activities (e.g. in the Eastern Cape, Western Cape and in Gauteng provinces) but I needed to do a more systematic analysis of where such PLCs were operating and how. This was also done to explore PLCs that had participated in the Fundisa for Change programme on biodiversity, to help establish what constitutes PLCs and what was happening in terms of PLCs in South Africa. In addition to the questionnaires, I observed one of the biodiversity PLC activities in the Eastern Cape as a participant observer. This was to gain insights into how PLC activities happen to help frame the research questions. I also read through the Fundisa for Change implementation plan to help frame the study.

The contextual profile further helped inform my decisions regarding which PLCs to work with for this study and to profile the PLCs that participated in the study. The initial analysis of the ISPFTED was also done during the contextual profile on the concept of PLC. The data from the Fundisa for Change partners' questionnaires, Fundisa for Change documents and the ISPFTED were analysed and created a base for Chapter Five of this study. The data from the teachers' questionnaires used in the contextual profiling phase were not used in this study, because the participants were not part of the PLCs selected for this study.

Before discussing the different data generation methods, I present Table 4.2 to show that the teachers participated in different methods.

Table 4.2: Teachers' participation in the study

	Number of teachers who completed questionnaires	Number of teachers interviewed	Number of teachers who completed reflection tools	Number of teachers who submitted portfolios	Number of teachers who completed evaluation
Idutywa (out of 6)	6	6	6	1	6
Grahamstown (out of 5)	5	5	4	0	4
Cape Town (out of 4)	2	4	3	4	3

Table 4.2 shows that all the teachers participated in the interviews but only thirteen completed the questionnaires, reflection tools and evaluation forms. This was simply because some teachers were not present when, for example, evaluation forms were completed or when the reflection tools and questionnaires were administered. Five portfolios of evidence were submitted, none of them from the Grahamstown PLC. The lack of participation of teachers in, for example, completing questionnaires or evaluation forms did not particularly affect the data as most of the questions were covered by the interview schedule which was used as the main data source. Other sources were mainly for triangulation purposes.

4.5.2 Semi-structured questionnaires

During the first session of the PLCs activities, teachers voluntarily completed a double page semi-structured questionnaire. The questionnaires were primarily meant to identify teachers who participated in the study and to establish their profiles. These consisted of questions on where and what they were teaching, qualifications and experiences (see Appendix 2). However, even teachers

who did not initially complete a questionnaire were willing to participate in the study through other methods. The questionnaires were used to establish the teachers' participation in the PLC activities and what their valued beings and doings were in relation to the learning and teaching of biodiversity. In the questionnaires teachers revealed if (or not) some of their valued functionings were achieved in the first session and the enablers and constraints to achieving their valued functionings in that session. Even though teachers were given the questionnaires on the first day of the session, they rushed through completing them on the last day of the session which might have resulted in superficial data. However, upon triangulating with the interviews it was clear what teachers real functionings were, related to the teaching and learning of biodiversity. Even though most teachers in the PLCs completed the questionnaires, the only data used in the study were for the teachers who were interviewed. Of the fifteen teachers who participated in the study, thirteen completed the questionnaire.

4.5.3 Document analysis

A systematic review of purposefully selected documents was done throughout the data generation process (Bowen, 2009). The initial analysis of documents served as a frame to inform the interview schedules and the observation guides. After the interviews and the PLC observations, the documents were analysed as a means of reference on what was observed and said during the interviews. The documents that were analysed during the study include the national policies (i.e. ISPFTED) on PLCs and teachers professional development, programmes of PLC activities, Fundisa for Change progress reports, Fundisa for Change implementation plan, the Life Sciences CAPS document, materials used in the PLCs on biodiversity including Fundisa for Change materials (*Methods and Processes to Support Change-Oriented Learning, Introductory Core Text, Framing Active Teaching and Learning in CAPS*, newsletters, *Teaching Biodiversity* booklet and *Teaching Marine Biodiversity* booklet) (see Table 4.3 for all documents analysed for the study).

I viewed documents as empirical knowledge as they provide accounts of what the Department of Basic Education and the Fundisa for Change programme had done or had planned to do to establish and support PLCs for teachers' professional development. The analysis of documents was guided by the research questions and involved extracting the relevant text and analysing it. I used the concepts of functionings, capabilities, conversion factors, agency and structures provided by Tao's (2012; 2013a; 2013b; 2015) analytic framework to analyse the texts extracted from the documents (see Figure 3.3).

While using documents in the study, because of the details they contained on the PLC activities and conversion factors related to those, I was alert to McMillan and Schumacher's (2006) point on

being able to reflexively engage with authors of the documents. Triangulation helped solve the problem of subjectivity of authorship in the study. Table 4.3 provides a summary of the documents analysed were and shows the index code to identify them.

Table 4.3: Summary of documents reviewed and rationale for choosing them

Code	Document ¹⁵	Reason why it was chosen
D1	Curriculum and Assessment Policy Statement (2011). Life Sciences, Further Education and Training Phase Grade10-12	Provides information on the components of biodiversity in the formal grade 10-12 Life Sciences curriculum.
D2	Integrated Strategic Planning Framework for Teachers Education and Development in South Africa (2011-2025) full version (South Africa. DHET & DBE, 2011a)	Makes explicit the need for support systems that promote PLCs in South Africa
D3	Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011-2025) technical report (South Africa. DHET & DBE, 2011b)	Provided background information leading to the call for PLCs in South Africa
D4	Draft report on a colloquium on PLCs held at the Department of Basic Education, Pretoria 18-19 September 2014	Provides the outcomes of the colloquium that was held to discuss progress on the establishment, development and functioning of PLCs in South Africa
D5	Fundisa for Change Implementation Plan (2013-2016)	Maps out the activities of the Fundisa for Change programme for 2013-2016
D6	Fundisa for Change Programme (2013) <i>Introductory Core Text</i>	Provides an overview and orientation of the Fundisa for Change programme and the Fundisa for Change model
D7	Fundisa for Change <i>Methods and Processes to Support Change-Oriented Learning</i>	Maps out the teaching strategies for environmentally oriented learning (i.e. biodiversity education)
D8	Fundisa for Change (2013) <i>Framing Active Teaching and Learning CAPS</i>	Makes links between CAPS knowledge, teaching and assessment in socio-ecological content of learning to change
D9	<i>Teaching Biodiversity / Life Sciences</i> grade 10-12 teacher education resource text	Developed by the Fundisa for Change programme to expand teachers' expertise in teaching biodiversity in CAPS Life Sciences grade 10 to grade 12
D10	<i>Teaching Marine Biodiversity / Life Sciences</i> grade 10-12 teacher education resource text	Developed by the Fundisa for Change programme to expand teachers' knowledge and expertise in teaching marine biodiversity in CAPS Life Sciences for grade 10 to 12
D11	Fundisa for Change newsletters a,b,c and d	Quarterly newsletter with updates on Fundisa for Change activities
D12	Fundisa for Change progress reports	Reports – key programme activities and events
D13	The Fundisa for Change programme facilitators guide	To guide the Fundisa for Change facilitators on the facilitation of PLC activities

¹⁵ Documents D6-D10 are included on the CD-ROM that accompanies this thesis as they are the foundation materials used in the Fundisa for Change biodiversity PLC.

D14	<i>Professional Learning Communities: A guideline for South African schools</i> (South Africa. DBE, 2015)	Draft document developed by the Department of Basic Education to stimulate and support provincial education departments and other stakeholders to set up, maintain and ensure that PLCs work effectively
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4.5.4 In-depth interviews

McMillan and Schumacher (2006) regarded an interview as a purposeful interaction, usually between two people, focusing on one person trying to get information from the other person. Interviews allow the researcher to investigate and prompt things that one cannot observe (Leedy & Ormrod, 2005). Through semi-structured interviews one can probe an interviewee's thoughts, values, prejudices, perceptions, views, feelings and perspectives (ibid.). In critical realist studies, people's accounts are critical for exploring the level of the real (Maxwell, 2012). It was in this context that one on one semi-structured interviews were conducted with thirteen Fundisa for Change partners and fifteen teachers.

4.5.4.1 Interviews with the Fundisa for Change partners

The first person to be interviewed in the study was the Fundisa for Change coordinator. The coordinator was interviewed to provide an overview of the Fundisa for Change programme and its role in PLCs. In-depth interviews were then conducted with purposively selected Fundisa for Change partners (see Section 4.4) and particularly the official from the Department of Basic Education, National office. This was to probe what support they offer the PLCs on biodiversity to help establish the conversion factors of Fundisa for Change programme associated with the PLC activities. It is, however, worth noting that Fundisa for Change partners' participation in the study was not to represent their institutions or organisations. Their participation was to give their personal experiences of working with teachers in the PLCs and/or their experiences in the Fundisa for Change programme. The Fundisa for Change partners who facilitated the PLC activities were interviewed before the PLC activities. Follow up interviews were conducted after the PLC activities to give them an opportunity to reflect on the PLC activities. The reflective interviews also gave me the opportunity to further probe the research questions to develop insights omitted in the first interviews and to gain clarity on the issues observed during the PLC activities. The reflective interviews happened at different times; this might have been both a strength and limitation in the study (see Section 4.6.1).

The facilitators of the Idutywa PLCs were interviewed within two weeks of the last PLC session, which might have been a strength as they could remember most of the PLC activities. In contrast, the Cape Town and the Grahamstown PLCs facilitators were interviewed about five months after the PLC activities; they might have forgotten some of the events that happened in the PLCs.

However a strength could be that they were able to provide insights into further support given to teachers and comment on the teachers' submission (or not) of portfolios of evidence as well as their realisation of their achieved functionings.

It is, however, worth noting that even though the study focus was on Life Sciences teachers PLCs and biodiversity, the Fundisa for Change partners' also drew from their experiences of participating in other PLCs outside the study. This provided insights to the fifth research question: how can and does a continuing professional development programme act as a conversion factor that expands and/or constrains the conversion factors and functionings in teachers' PLCs related to the teaching of biodiversity? The Fundisa for Change coordinator was the only person who has participated in all three PLCs used in this study (see Table 4.1); thus she was the last person I interviewed. This was to give her an opportunity to reflect on the three PLC activities and to allow her to provide any new information that might be significant to the study.

4.5.4.2 Interviews with the teachers

The interviews with teachers happened at different times (see Table 4.4 in this chapter). This was determined by the PLC activities and the teachers' availability. One advantage of semi-structured interviews is that they are highly flexible (Easton, 2010). I left it up to the teachers to decide when and where they wanted to be interviewed. All the teachers in the Idutywa PLC were willing to be interviewed at the end of the second PLC session (which happened about two months after the first session). The Grahamstown PLC teachers were available for interviews at different times. One teacher was interviewed a week after the first PLC session, another teacher was interviewed during the third session and the other three teachers were only available for the interviews two months after the third session. All the Cape Town teachers were interviewed two months after the PLC activities. The different times of teachers' availability might have been a benefit for the study as it provided teachers' data at different stages of the PLC sessions. However, the times of the interviews might also have been a limitation to the study, especially in the Idutywa PLC where probing was not possible following the realisation of their achieved functionings in the second session. However, this was reflected in one teacher's portfolio of evidence that was submitted about three months after the second session. Because of teachers' preferences, three teachers (two from Grahamstown and one from Cape Town) were interviewed telephonically.

During the interviews, I sought to elicit the details on teachers' valued functionings in relation to the teaching and learning of biodiversity. This was to establish the individual teachers' value functionings related to biodiversity and whether they had been achieved in the PLCs. I further sought insight into the conversion factors that enabled and/or constrained teachers to achieve their valued functionings in the PLCs, and to establish if PLCs were conversion factors for teachers'

professional development on biodiversity. PLCs acknowledge collaboration among teachers (Stoll et al., 2006). Therefore, in addition to the individual interviews, I planned to conduct focus group interviews with teachers in PLCs. This was with the intention of gaining teachers' shared views on their valued beings and doings, conversion factors that enable or constrain achievement of these, and whether Fundisa for Change was a conversion factor that expanded and/or constrained their functionings related to the teaching and learning of biodiversity. Teachers however opted to be interviewed as individuals not as a group. Thus no focus group discussions were conducted.

To guide the interviews, three interview schedules were developed. One was for the teachers (see Appendix 3), one for the Fundisa for Change partners (see Appendix 4) and one for the reflective interviews with the Fundisa for Change partners (see Appendix 5). Drawing on Maxwell's (2012) advice, interview schedules were pilot tested with two teachers and one Fundisa for Change partner. This was to help focus and revise the interview schedules where necessary and to help determine the type of information the data was providing. As recommended by Yin (2009; 2014), I sought permission from all the teachers and Fundisa for Change partners to record the interviews. This was to capture their unique expressions as well as to provide accurate data for transcriptions of the interviews and to avoid losing data. McMillan and Schumacher (2006) and Yin (2014) noted that interview responses may be limited because of the interviewee's inaccuracies due to poor recall or because of interviewees seeking to provide what the interviewer wants. Despite this shortcoming, I found using interviews valuable, particularly because of the semi-structured format that enabled me to get detailed explanations and personal views from the teachers and Fundisa for Change partners. Semi-structured interviews also allowed me to gain detailed and first-hand account descriptions of actions and events that took place in the past or which I could not observe and provided access to information that I might have missed out during the PLC observations. All interviews happened over a period of eighteen months (see Table 4.4), and were transcribed and indexed as outlined in Section 4.6.1.

4.5.5 Observations of PLC activities

Maxwell (2012:106) noted:

While interviewing is often an efficient and valid way of understanding someone's perspectives, observations can enable you to draw inferences about this perspective that you could not obtain by relying exclusively on interview data. This is particularly important for getting at tacit understandings and 'theory-in-use', as well as aspects of the participants' perspectives that they are reluctant to directly state in interviews.

It is in this context that I sought permission from the participants and facilitators in the PLCs to observe the PLC activities. The primary focus of the observations was to develop a deeper understanding of the teachers' beings and doings in the PLCs and how they related to teachers'

functionings on biodiversity teaching. Drawing on Maxwell's (2012) advice, I used an observation guide to list features that needed to be addressed in the study (see Appendix 6). This included the date of activities, site of observation, facilitators of the PLC sessions, participants in the PLC and their positions, and the teaching and learning support materials used in the PLC activities. The observations also focused on the sequence of activities and events that were happening in the PLCs, and the interaction among people in the PLCs. I took note of all written work on the chalkboard and transparencies as well as all worksheets and activities done in the PLCs. I also observed specific factors that influence the PLC activities, for example, time spent on tasks to provide further perspectives on the conversion factors that enable and/or constrain the functionings in Life Science teachers' PLCs.

Observing PLC activities enabled me to generate data about the reality at the level of the actual which I further used to explore the underlying mechanisms responsible for the beings and doings in the PLCs (see Chapters Five, Six and Seven). Simpson and Tuson (2003) noted that observation is susceptible to subjectivity, which might occur either because the observer records what he or she thought occurred rather than what actually took place, or because of the observer's lack of attention to significant events. I found observing the PLC activities useful as observations provided insights into contextual issues related to teachers' beings and doings in the PLC and how these might have enabled or constrained the achieving of their valued functionings related to biodiversity teaching. To take account of subjectivity I undertook observations in conjunction with informal follow-up discussions with teachers and reflective interviews with facilitators of PLCs in order to give them a chance to clarify issues that arose during the PLC observations and to check my interpretation of observations. In addition to field notes, I took video clips and pictures of PLC activities to help capture as much as possible of what was happening in the PLCs. This helped me to review the processes when activities were happening too fast for me to capture them all in field notes. Video clips and pictures also helped remind me of what took place in the PLCs during the analysis. The duration of the observations were determined by the duration of the PLC sessions.

4.5.6 Portfolios of evidence, reflections and evaluations

As part of the PLC activities, teachers were expected to complete and submit a portfolio of evidence (see Appendix 7). Therefore the study also analysed the teachers' portfolios of evidence. This was to help establish teachers' realisation of the achieved functionings in the PLCs related to biodiversity. In the PLCs, teachers were given a reflection tool to complete (see Appendix 8). The tool allowed teachers to reflect on their learning in the PLCs related to biodiversity. This was specifically in relation to the content, pedagogical practices and assessment practices. The reflection tool also provided space for teachers to make links between the content learned and the CAPS

curriculum; as well as for teachers to note down the biodiversity related concepts for which they still needed assistance. In the Cape Town PLC, the reflections were also done in the form of a quiz. The quiz helped establish what teachers had learned from the PLC in terms of content, pedagogical and assessment practices related to biodiversity. The reflection tools were analysed to help establish the teachers' achieved functionings related to biodiversity.

Teachers completed evaluations at the end of the PLC activities. Even though the evaluations were not specifically designed for the purpose of the study, but rather for the evaluation of the Fundisa for Change programme, I found using them for the study relevant. This was because some of the information provided was related to teachers' valued functionings in the PLC, the achieved functionings in the PLC, the conversion factors that enabled them to achieve their valued functionings as well as new valued functionings. The limitations to the evaluations were that they were completed at the end of the sessions which might have led to superficial answers as teachers were rushing to leave. Triangulation helped alleviate this.

4.6 Data analysis

The previous section discussed how the data was generated. The raw data was stored in retrieval forms i.e. field notes, interview transcripts and documents. Partially processed data such as write-ups, transcriptions and reflective remarks, coded data and analytical materials were also stored in retrieval forms (McMillan & Schumacher, 2006). The data were stored under specific files on my personal computer and hard drive. Some data were printed and filed as hard copies. Questionnaires, evaluation forms and reflection tools were all stored as hard copies. For future retrieval, the data have been saved in various ways, including scanning all the data and saving them on the compact disc, and also saving the data on Dropbox (an online service that keeps files safe, synced, and easy to share).

4.6.1 Index coding

For systematic representation of data, index coding of participants and data sources was done. All the teachers and Fundisa for Change partners were given index codes to ensure that real names of participants do not appear in the thesis as negotiated (see Section 4.9 in this chapter).

The index codes of teachers comprised of the site where the teachers were from (the PLC), a 'T' which represented teacher, a reference number and the data source (interview, questionnaire, portfolio of evidence, reflection and evaluation). For the data sources the first letter is used in the teacher index code (I - Interview; Q - Questionnaire; R - Reflection; P -Portfolio of evidence; E - Evaluation). Thus a teacher with an index code **CT4I** means:

- C - from the Cape Town PLC

- T - teacher
- 4 - reference number
- I - from the interview

An index code **DT3E**:

- D - from the Idutywa PLC
- T - teacher
- 3 - reference number
- E - from the evaluations

The index codes of the Fundisa for Change partners represented their institution or organisation (N - NGO; U - University/higher education institution; P - Parastatal, D - the Department of Education), a 'P' for partner and a reference number. The Fundisa for Change partners who reflected on the PLC activities had an 'R' added to their index codes. Thus a Fundisa for Change partner with an index code **UP2** means:

- U - from the university/higher institution of education
- P - Fundisa for Change partner
- 2 - reference number

With an index code **NP1R**

- N - from Non-Governmental Organisation
- P - Fundisa for Change partner
- 1 - reference number
- R - from the reflection

Table 4.4: Summary of all research participants

Participant	Organisation/ Institution	Gender	Position in Fundisa for Change	Date of interview	Participated in
1. UP1	HEI ¹⁶	F	Coordinator	16/04/2014 11/09/2015	Interview Reflection
2. NP1	NGO	F	Partner	31/05/2014 02/12/2014	Interview Reflection
3. NP2	NGO	F	Researcher	18/07/2014	Interview
4. UP2	HEI	M	Researcher	27/09/2014 11/09/2015	Interview Reflection
5. UP3	HEI	M	Partner	26/10/2014	Interview
6. UP4	HEI	M	Partner	26/10/2014 7/09/2015	Interview Reflection

¹⁶ Higher Education Institution

7. UP5	HEI	F	Partner	15/08/2014	Interview
8. UP6	HEI	F	Partner	17/10/2014	Interview
9. PP	Parastatal	M	Partner	15/05/2015	Interview
10. DP1	DBE ¹⁷	M	Partner	15/04/2015	Interview
11. DP2	DBE	F	Partner	22/08/2014 23/11/2014	Interview Reflection
12. DP3	DBE	M	Partner	22/08/2014	Interview
13. DP4	DBE	M	Partner	27/08/2014	Interview
14. UP7	HEI	M	Partner	-	Facilitators
15. UP8	HEI	F	Partner	-	Facilitator
16. UP9	HEI	M	Partner	-	Facilitator
17. NP3	NGO	F	Partner	-	Facilitators
18. The Director of the Continuing Professional Teacher Development directorate	DBE	M	Partner	14/10/2015	Interview
19. DT1	DBE	F	Teacher	15/11/2014	Questionnaire, interview, reflection, evaluation, portfolio of evidence
20. DT2	DBE	F	Teacher	16/11/2014	Questionnaire, interview, reflection, evaluation, portfolio of evidence
21. DT3	DBE	M	Teacher	15/11/2014	Questionnaire, interview, reflection, evaluation,
22. DT4	DBE	M	Teacher	16/11/2014	Questionnaire, interview, reflection, evaluation,
23. DT5	DBE	M	Teacher	16/11/2014	Questionnaire, interview, reflection,

¹⁷ Department of Basic Education

					evaluation,
24. DT6	DBE	M	Teacher	15/11/2014	Questionnaire, interview, reflection, evaluation,
25. GT1	DBE	F	Teacher	23/11/2014	Questionnaire, interview, reflection, evaluation,
26. GT2	DBE	F	Teacher	11/04/2015	Questionnaire, interview, reflection, evaluation,
27. GT3	DBE	F	Teacher	27/06/2015	Questionnaire, interview, reflection, evaluation,
28. GT4	DBE	F	Teacher	22/06/2015	Questionnaire, interview, reflection, evaluation,
29. GT5	DBE	F	Teacher	11/06/2015	Questionnaire, interview,
30. CT1	DBE	M	Teacher	14/05/2015	Questionnaire, interview, reflection, evaluation, portfolio of evidence
31. CT2	DBE	M	Teacher	23/05/2015	Interview, reflection, portfolio of evidence
32. CT3	DBE	F	Teacher	23/05/2015	Questionnaire, interview, reflection, evaluation,
33. CT4	DBE	F	Teacher	26/05/2015	Questionnaire, interview, reflection, evaluation, portfolio of evidence
Total participants	28	(15 teachers and 13 Fundisa for Change partners)			

Dates provided for teachers were for interviews only, all evaluations happened on the last day of PLC activities (see Table 4.1), questionnaires were completed during the first PLC session (see Table 4.1), and reflections took place throughout the sessions (see Table 4.1). All portfolios of evidence came in after the interviews except for DT1 whose portfolio was presented during the second session (data given in the study are thus from the presentation of work in progress). UP5, UP7, UP8, UP9 and NP3 only participated in the study as facilitators of the PLCs used in the study (thus index codes were given for the purpose of field notes).

The study captured the PLC activities in the form of field notes. Thus for systematic review, the field notes were also given index codes. The codes of the field notes were given per session. In the Idutywa and Cape Town the PLC activities happened in two sessions, thus two index codes were given, one for session one, and another for the second session. Three sessions happened in Grahamstown; these were given three index codes. The index code represents the site of PLC, and an 'O' for observation of PLC activities and session number. For example an index code **DO2** means:

- D - Idutywa
- O - observation of PLC activities
- 2 - second session

All PLC activities had training programmes that were also given index codes. The codes of the training programmes were given per session. Thus as above, the Idutywa and Cape Town PLCs had two index codes, and in Grahamstown three index codes. The index code represents the site of the PLC, 'C' for programme of PLC activities and a session number. For example an index code **CPI** means:

- C - Cape Town
- P - programme of PLC activities
- 1 - first session

4.6.2 Analysis of data

After index coding of all the data sources, inductive and/ or abductive coding processes were done (see Appendix 9 for an example of coded interview transcripts, one for teachers and one for the Fundisa for Change partner). This allowed for entry into the judgement and interpretations of the data. I adhered to suggested ways in which to enhance transparency and rigour whilst coding. Hennink, Hutter and Baily (2011) claimed that codes must earn their way into analysis; this may be through being repeated across interviews or by being highlighted by the participants as important issues. Hennick et al. (2011) further suggested a range of strategies for reading data to identify inductive codes, such as looking for topic changes in discussion, reading beyond the words to

consider subtext and considering what is present but also what is missing. They advised that for reliability, multiple researchers' coding can be used. The use of multiple researchers' coding of data was not logistically possible in this research. However, reflexivity, triangulation and having the opportunity to re-examine the data and codes several times after the first coding process enhanced trustworthiness of the analysis. Re-examining of the data provided opportunities for me to refine the codes from the initial broad codes, so as to have a few looks at the constructs, categories and interpretations. This analysis was done in two phases.

Phase 1: Chapter Five provides a full account of the teachers' valued beings and doings in the PLCs activities. The intention was to provide a descriptive account of the teachers' beings and doings in the PLC to help explain if and how they enabled teachers to achieve their valued beings and doings in the PLCs. For the first phase of data of analysis, five key themes were identified inductively. These were:

- Subject content knowledge
- Pedagogical practices
- Assessment practices
- Teaching and learning resources
- Other valued functionings

These broad themes were then used to guide presentation and discussion of the data in Chapter Five. In Chapter Six the conversion factors that enabled or constrained teachers' capabilities were presented. These were clustered via abductive analysis under the three types of conversion factors identified by Robeyns (2005a): social, personal and environmental conversion factors. In Chapter Seven, the full account of teachers' achieved, realised and achieved functionings are presented.

During the first phase analysis sub-themes were identified and analysed under each of the three broad themes. The sub-themes were used to frame the Chapters Five, Six and Seven. Phase one analysis was primarily inductive but also used abduction and thick descriptions (mainly in the form of quotes) to present and discuss the teachers' valued beings and doings and associated conversion factors in the PLCs.

Phase 2: This phase of analysis was abductive. The process involved using the reduced data in Chapters Five, Six and Seven and the theoretical perspectives provided in Chapters One, Two and Three to provide an in-depth analysis of the main research questions. The in-depth analysis is also provided in Chapter Five, Six and Seven and synthesised in Chapter Nine, which has the main findings of the study. In Chapter Eight, an analysis of valued beings and doings, conversion factors

and achieved functionings are explained, drawing on the critical realist theory of causation, as discussed in Section 3.7.

4.6.3 Modes of inference

Critical realism uses four modes of inference: deduction, induction, abduction and retroduction. These modes of inference are complementary (Danermark et al., 2002). In this study I used inductive, abductive and retroductive modes of inference. According to critical realist research studies, any combination of these three modes of analysis is valid. Abduction and retroduction provide methodological approaches that allow explaining events and processes in critical realism research (ibid.). Induction takes place at the empirical level of critical realism (Danermark et al., 2002). This mode of inference attempts to “draw conclusions about an entire population from studies of a sample of investigated units (such as people, organizations and tests); or from studies at a particular point of time, draw conclusions about other points of time” (Danermark et al., 2002:86). The limitations of the inductive mode of inference are that it can never be either analytically or empirically certain and it is restricted to conclusions at the empirical level (ibid.). Induction in this study happened through generation of themes and sub-themes from the data (primarily used in Chapters Five, Six and Seven). However, as much as the inductive method is a valid mode of inference, it does not give guidance on how knowledge of the underlying structures is to be inferred from the observable characteristics (Danermark et al., 2002). Induction is therefore not able to go beyond the empirical level of critical realism. Therefore, it was necessary in this study to use abductive and retroductive modes of inference to find answers to some of the research questions. According to Danermark et al. (2002), abduction and retroduction are the most important forms of inference when the aim of the research is to *explain* events and processes. This is because:

... to explain something implies (from the perspective of critical realism) first describing and conceptualizing the properties and causal mechanisms generating and enabling events, making things happen ... and then describing how different mechanisms manifest themselves under specific conditions. (p.74)

The fundamental structure of abduction is “to interpret and recontextualise individual phenomena within a conceptual framework or a set of ideas”; this is to understand them “in a way by observing and interpreting this something in a new conceptual framework” (Danermark et al., 2002:80). Abduction therefore allows one to gain new knowledge on the existing phenomena. In the case of this study, I used an analytical conceptual framework from critical realism and capabilities (see Chapter Three) to look at the data in the new way. The concepts of structure, agency, functionings, capabilities, and conversion factors were used to look at the data in a new way. Tao’s (2013a) analytic framework (Figure 3.3) was used to analyse the causal mechanisms (for example, Life Sciences teachers’ motivation to participate) in PLCs, their tendencies, and how these tendencies

operate within the social system (the PLCs) among counter-tendencies. As discussed in Section 3.7, Tao's (2013a) framework that combined the concepts of capability, issues of structure and agency and underlying mechanisms and tendencies were used to shape the analytic tools for the study (Figure 3.3). As noted in Chapter Three, Tao's framework was suited for the study, as it has potential to identify the relationships between the conversion factors of Science PLCs and the conversion factors in the Fundisa for Change programme, and how those conversion factors act as enablers or constrainers for teachers' capabilities. These were able to inform the Fundisa for Change programme on what support to offer to Life Sciences teachers in the PLCs related to biodiversity. I analysed how these counter tendencies act as enablers or constraints, and how they relate to causal mechanisms affecting teachers' knowledge, for example, on biodiversity. I further analysed how the social structures from both the Science teachers PLCs and Fundisa for Change contribute to that, by being enablers or constraints. I then analysed the decisions teachers make as part of their reflective deliberations and how those decisions result in chosen outcomes (structure and agency dialectic process develop and define the causal mechanisms possessed by an individual). This study was also recontextualised with the existing understanding of the concepts of professional development, particularly the PLCs in the context of teachers' biodiversity knowledge provided in Chapters One, Two and Three of the study.

“The fundamental tenet of critical realism is that we can use causal language to describe the world” (Easton, 2010:119). The most fundamental aim of critical realism is to explain answers to the question: “what caused those events to happen?” (Easton, 2010:121). The explanatory power of the substantive theory and theoretical perspective given in Chapters One, Two and Three were used to provide a language of re-describing what the teachers and the Fundisa for Change partners said in the interviews, as well as what I read in the teachers evaluations, reflections, questionnaires, portfolios of evidence, other documents and what I observed in the PLCs. To construct explanatory accounts, critical realist research uses retrodution as a method of inference through which the generative mechanisms are most likely to be identified. This contrasts with induction which aims to reach a reliable generalisation (Reed, 2009). Deploying retroductive logic as its main method of inference, this study aimed at providing a theoretical explanation of how Science PLCs function in the context of teachers' continuing professional development in South Africa. The strength of using retrodution in research such as this is that “it provides knowledge of transfactual conditions, mechanisms that cannot be directly observed in the domain of the empirical” (Danermark et al., 2002: 80). Retrodution facilitated the identification of causal mechanisms which expanded and/ or constrained teachers' functionings within the PLC. Data on institutionalisation of PLCs of Life Sciences teachers in South Africa was analysed by means of a retroductive mode of inference,

which is a thought operation that enables the understanding of social reality beyond what is empirically observable or experienced (Danermark et al., 2002).

I was further interested in the relationship that exists between the conversion factors, agency, structures and functionings of continuing professional development programmes with associated conversion factors, structures, agency and functionings in Life Sciences teachers' PLCs. The study thus required analytical and explanatory processes that took account of causality (not to produce correlational forms of causality, but rather *explanatory* analyses of causality within a critical realist framework). This is the focus of Chapter Eight: to make explicit the relationship between continuing professional development with teachers in PLCs functionings as they specifically relate to the teaching and learning of biodiversity. Finally I drew from the critical realism concept of contingencies (Sayer, 2000) to analyse the relationships between the conversion factors of continuing professional development programmes with the associated conversion factors in the Science teachers' PLCs.

4.7 Validity, trustworthiness and generalisation

There have been debates about the use of the term 'validity' in qualitative research and justification for using the term in critical realism research is still thin (Maxwell, 2012). Drawing from Maxwell (2012) to ensure validity in this study, I considered the three types of validity: descriptive validity, interpretive validity and theoretical validity.

Descriptive validity is the factual accuracy of the account of researchers, that "they are not making up or distorting the things they saw and heard" (Maxwell, 2012:134). If a participant made a particular statement in an interview this should not be "misheard, mistranscribed or misremembered". For descriptive validity, I paid attention to "issues of omission as well as commission" acknowledging that "no account can include everything" (Maxwell, 1992:287). I tried to ensure that constructs were accurate and portrayed as they had been presented by participants. My interpretation of interviews relied as much as possible on the participants' own words and concepts (interpretive data). Based on this understanding, the information which I reported in Chapters Five, Six, Seven and Eight, were as true to the intended meanings of the participants as possible. As mentioned earlier in Section 4.5.5, the audio recorder and field notes were used to capture the data and reflect on what had been interpreted. Through careful transcription, thick description was made possible to ensure that I was realistically interpreting the meaning of the participants. Using follow-up discussions, reflective interviews after the observations of the PLC activities and member checking (Shenton, 2004; Cohen, Manion, & Morrison, 2011) of interview transcripts I was able to share the interpretations with participants in order to corroborate the data.

In some cases, participants did not return transcripts for member checking thus in cases where I felt it was necessary, I only forwarded extracts from the transcripts that I needed them to verify and that strategy seemed to have contributed to validity of the study.

Interpretive validity can be described as “appropriate primarily because this aspect of understanding is most central to interpretive research, which seeks to comprehend phenomena not on the basis of the researcher’s perspective and categories, but from those of the participants in the situations studied” (Maxwell, 2012:138). Unlike descriptive validity which can either be etic or emic, interpretive validity “pertains to aspects of an account for which the terms are emic. This is because, while accounts of physical and behavioural phenomena can be constructed from a variety of perspectives, accounts of meaning must be based initially on the conceptual framework of the people whose meaning is in question” (ibid.:138). To ensure interpretive validity I tried to comprehend the values of the teachers and Fundisa for Change partners not on the basis of my perspective but those of the participants and the situations of the study area. The use of member checking and use of thick descriptions helped to avoid misinterpretations.

Theoretical validity refers “to an account’s validity as theory of some phenomenon” (Maxwell, 2012:140). A theory includes the concepts or categories that the theory employs and the relationship thought to exist between the concepts (ibid.). Theoretical validity was ensured in the study through in-depth reading into key concepts used in the study i.e. functionings, capabilities, conversion factors, PLCs, continuing professional development processes and biodiversity. The broader views and context of PLCs were engaged with throughout the study in relation to the research questions. The theoretical frameworks and methodologies chosen for the study were consistently used and clear arguments were made throughout the study to ensure rigour. Rather than being concerned with the purpose, rigour and application alone of different procedures during the study, I also considered the actual conclusions drawn.

Another way of ensuring validity and trustworthiness in the study was through *triangulation* (Patton, 2002; Shenton, 2004; Cohen et al., 2011; Maxwell, 2012; Yin, 2012; 2014). While the use of one data collection method suffers from some common methodological shortcomings, their distinct characteristics also result in individual strengths (Yin, 2014). The use of different data collection methods (see Section 4.5) helped to triangulate and to build on each type of data collection method while at the same time compensating for potential weaknesses in any single approach (Patton, 2002; Yin, 2014). Triangulation allowed for a broader and more secure understanding of science teachers’ valued functionings related to the teaching and learning of biodiversity and conversion factors that enable and/or constrain those functionings (Maxwell, 2012). Even though observations provided a direct and powerful way of learning about teachers’

valued beings and doings and the PLC context in which it happened, interviews were valuable in providing descriptions of the teachers' beings and doings in the PLCs and other valuable information related to the research questions that I could not observe. Interviews were further used to check for accuracy of observations (Maxwell, 2012). It was useful to use both observations and interviews to gain a more complete account of how continuing professional development programmes provide conversion factors that expand and/or constrain the functionings, agency and structures in science teachers PLCs than either could alone provide. According to Shenton (2004) triangulation also happens through the use of diverse informants and through a range of documents. As discussed in Section 4.4, fifteen teachers and thirteen Fundisa for Change partners participated in the study to allow for individual viewpoints and experiences which were used to construct a rich picture for scrutiny. Triangulation helped me to verify and look for consistency, patterns and discontinuities in the data generated (Cohen, Manion & Morrison, 2007).

Sagor (2000) observed that research results have been shared electronically over the years. He argued that to improve the quality and validity, we need to share our research while it is still in progress. This allows for critique from the research community that will help improve the quality of the final outcome of the research (ibid.). It is with these perspectives that during the research process, different platforms were used to share different aspects of the research to receive comments and feedback from peers and academics. The initial ideas of the research were presented at the Namibian Environmental Education Network conference in Namibia, April 2013. The concept of PLCs was presented at the Education Association of South Africa conference in January 2014, Free State, South Africa. Some key findings of the research were presented at the Rhodes University postgraduate conference in October 2014, and at the National Environmental Skills Summit in March 2015, Pretoria, South Africa. The National Environmental Skills Summit was a particularly important platform to share the research as the audiences were Fundisa for Change partners, some of whom were participants in the study. This was thus not only useful to share some of the research findings but also to get critical feedback on the interpretations of the initial study findings.

The Rhodes University faculty of education (where the study was registered) hosts doctoral weeks three times a year. These weeks provide opportunities for PhD students to present progress on their research. It was thus important for me throughout the research process to use those weeks to share aspects of the research, particularly the aspects I was grappling with. The first doctoral week in 2015 provided an opportunity to share the study with an international audience as several Swedish scholars were part of the week. Weekly departmental seminars were also useful platforms, not only to share progress on the research, but also to critique literature. This helped to strengthen the

theoretical perspectives and methodological approaches of the study. The faculty of education offers research design courses two to three times a year. Participating in these courses has been particularly important in strengthening this chapter of the study. The perspectives provided by different people at the above mentioned platforms challenged the assumptions I had made as a researcher whose closeness to the study frequently inhibited my ability to view it with real detachment (Shenton, 2004). Questions and comments enabled the refinement of methods, and I was able to develop a greater explanation of the research design and strengthen the arguments in the light of the comments made. The research was a reflexive process, and involved constantly seeking for more information and interaction between the researcher, the subjects and the topic in question and contextualising findings (Maxwell, 2012).

Some researchers have identified research *generalisability* as an element for research validity (Easton, 2010). Generalisability “refers to the extent to which one can extend the account given of a particular situation or population to other persons, times, or settings than those directly studied” (Maxwell, 2012:141). Generalisation in qualitative research usually takes place through the development of a theory that not only makes sense of the particular persons or situation studied, but also shows how the same process, in different situations, can lead to different results (Maxwell, 1992; 2012; Hammersley, 2012; Yin, 2012; 2014).

The goal of most qualitative studies is not to generalise a claim that difference exists between settings, groups or categories of individuals that a relationship exists between specific variables for some population. Instead it is to understand the processes, meanings, and local contextual influences involved in the phenomena of interest for the specific settings or individuals studied. (Maxwell, 2012:94)

I worked with ‘fuzzy’ generalisations (Bassey, 2001) in this study. Critical realism argues against absolute truth, claiming that our knowledge is fallible thus subject to change (see Chapter Three). To acknowledge the fallibility of my knowledge, I have used fuzzy statements such as: *maybe, unlikely, likely, in the case of this study*, to leave space for other possibilities. Bhaskar (1978) argued, however, that generality in Social Sciences cannot exist at the level of the empirical but it can be established at the level of ‘deep structures of reality’. Fundisa for Change is a national programme thus drawing expertise from all over South Africa. The Fundisa for Change partners interviewed in this study drew from their experiences beyond the PLCs in the study. However, this is not adequate to claim for generality in this study on how continuing professional development programmes act as conversion factors that expand and/or constrain the functionings for Life Sciences teachers’ PLCs in South Africa. Chapters Six, Seven and Eight will provide evidence that PLCs are context dependent (Lotz-Sisitka & Raven, 2004; Flyvbjerg, 2006). This implies that among other factors, the Life Sciences teachers’ functionings, capabilities and agency will be

influenced by the context in which the PLC is situated. This implies that the use of PLCs in different contexts may yield different findings. The findings in this study are thus only applicable to the three PLCs used in the study. However, the information given on the concept of PLCs and its potential for teachers' biodiversity knowledge can be used as a base to mirror how PLCs may look like in other cases outside the study, as can insights on the deep structures of reality influencing the cases.

Maxwell (2012) noted that researchers are inescapably part of the social world they are researching. They bring their own biographies to the situation they are researching and participants may behave in a particular way in their presence (ibid.). During the time of this research I played a role in the Fundisa for Change programme. It is thus necessary for me to explain in the next section how I used reflexivity to maintain and distinguish between my role as a researcher and as a participant in the Fundisa for Change programme.

4.8 Researcher position and reflexivity

According to Hammersley and Atkinson (2007) "we are part of the social world we study" (p.21), and we

... must therefore understand how we influence and are influenced by this world. This mutual influence is both a necessary aspect and facilitator of data collection, and a potential validity threat to your conclusion. The major factor in this reflexivity is the personal characteristics that you bring to the research – the prior experiences, beliefs, purposes, values, and subjective qualities that shape how you conceptualise the study and engage in it. (Maxwell, 2012:96)

Implied in the above quotes is that my personal characteristics as a researcher played a major role in the process of conducting this study, and that it was through my subjectivity, that I able to tell a story about teachers' valued doings and beings in PLCs and if they were achieved.

4.8.1 Researcher stance

My status as a black, Namibian, Science teacher and female PhD student who was an active participant in the Fundisa for Change programme played an important role in this study. My experiences of being in South Africa during my Masters studies in 2011 and the time after this exposed me to the issues around teacher professional development in the country. Working with South African teachers as part of the Sustainable Seas Trust project (described in Chapter One), I immersed myself in the position of improving my practice and the practices of the teachers through eventually being an active participant in the Fundisa for Change programme as from 2013. Being in this position often brought frustrations and prompted me to bring the experiences of the teachers to the fore with the aim to contribute to the practices of teachers related to biodiversity and policy on PLCs. Being a Namibian, I reflected on how my educational experiences in Namibia could affect my interpretation of the South African teachers and professional development activities. I became

conscious of reflecting on the constraints and enablers of teacher professional development in Namibia and how these might not necessarily be the same in South Africa. Chapters Six, Seven and Eight in this study will expose those factors in the South African context.

My participation in the Fundisa for Change programme involved attending the training of trainers' workshops, attending the Fundisa for Change conference, compiling Fundisa for Change newsletters, representing Fundisa for Change at conferences, co-facilitating the teachers' PLC activities and being a researcher on the programme. I was one of the co-facilitators in the Idutywa and Grahamstown PLCs (see Table 4.1). I have also co-authored the *Teaching Marine Biodiversity* Fundisa booklet for FET Life Sciences which was the focus of the Idutywa PLC activities. I therefore had considerable insight into and in-depth understanding of the Fundisa for Change programme. I also had good relationships with some of the Fundisa for Change partners who participated in the study. This involvement helped to shape the study and the conclusions drawn. To ensure rigour, the research process had to be a reflexive process.

4.8.2 Reflexivity

"Reflexivity is a broad concept that includes rigorous examination of one's personal and theoretical commitments to see how they serve as resources for selecting a qualitative research approach, framing the research problem, generating particular data, relating to participants, and developing specific interpretations" (McMillan & Schumacher, 2006:327). Pillow (2003) suggests four validated strategies of reflexivity:

1. Reflexivity as recognition of self – personal self-awareness
2. Reflexivity as recognition of the other – capturing the essence of the informant, or "let them speak for themselves"
3. Reflexivity as truth gathering – the researcher's insistence on getting it right or being accurate
4. Reflexivity as transcendence – the aim of the researcher, through transcending her own subjectivity and cultural context, can be released from the weight of (mis) representation for accuracy in reporting

The above strategies were considered in the study; however reflexivity in this study is discussed according to the strategies suggested by McMillan and Schumacher (2006):

Peer briefer: Throughout the research period, I shared an office with the Fundisa for Change coordinator. The Fundisa for Change coordinator was not only a very good friend but also a critical friend. I often engaged with her in conversations related to the logical analysis of data and interpretation. She would frequently pose questions that made me understand my own position and its role in the inquiry (McMillan & Schumacher, 2006).

Field log: A field log was kept with fieldwork information such as dates, time spent in the field, places and persons involved, activities that happened and gaining access to the informants and to the PLC activities. The field log helped to me to be reflexive about the decisions made on the fieldwork process and allowed to me revisit information when I needed to follow up with the teachers and /or Fundisa for Change. The field log further ensured that I was able to retrieve information on the fieldwork for the write-up of the study.

Reflexive journal: The critical realist perspective requires researchers “to take account of the actual beliefs, values and dispositions that they bring to the study, which can serve as valuable resources, as well as possible sources of distortion or lack of comprehension” (Maxwell, 2012:97). The researcher’s personal motives, beliefs and theories have important consequences for the validity of their conclusions. Thus, as advised by Maxwell (2005), recognising how my beliefs and prior experiences might have influenced this study, I kept a reflective journal. In this journal I recorded all the decisions I made during the emerging design and rationale of the study including judgements of data validity, recorded ethical dilemmas and actions and self-reflections. The reflexive journal allowed for justification based on the available information at the time, and it traced my ideas and personal reactions throughout the study. The reflexive journal allowed me to continuously reflect on and examine the purpose, assumptions and personal values and feelings and how they could potentially influence the study (Shenton, 2004; Maxwell, 2005). This allowed me to bracket my experiences and perspectives throughout the research process (Maxwell, 2012). I sometimes would ask participants to reflect on my observations, not only to test the accuracy of my statements but also to re-examine my perceptions and conclusions drawn. I captured and kept all descriptions and vignettes to reflect on what had been interpreted (Yin, 2009; 2012).

Ethical considerations recorded: As mentioned by the National Research Council (2003), the issue of ethics is important in research. To deal with the issues of ethics I recorded all the ethical concerns that helped to justify choices in data collection analysis. I recorded evidence of ethical dilemmas experienced during the research process such as dealing with issues of anonymity and confidentiality in the research. I recorded all the decisions made and actions taken during the research process. Those include the discussions I had with my supervisor as to how I could negotiate or alert the Fundisa for Change partners about the possibility of revealing their names (because of their positions which were seen as conversion factors to the PLCs) but without exposing them to any potential harm. Ethical considerations are discussed further in Section 4.9.

Audibility: This was considered throughout the research process (McMillan & Schumacher, 2006) not only to manage the data and the research process but also to ensure that a ‘decision trail’ was

recorded (codes, categories, themes used in description and interpretation as well as draft work) and kept for inspection of outside reviews should they be interested in such information.

Critical reflexivity: As a researcher, I engaged in critical reflexivity (McMillan & Schumacher, 2006) that allowed self-critique by asking difficult questions. “Reflexivity also involves discomfort, as the researchers seek to minimise predispositions through self-questioning” (McMillan & Schumacher, 2006: 327). Drawing on Patton (2002) throughout the study I asked myself the following questions: What do I know? How do I know what I know? What shapes and has shaped my perspectives? With what voice do I share my perspectives? What do I do with what I found? I also questioned what the participants knew, what shaped their worldviews, how they perceived me and why and how I perceived them. My participants were from diverse backgrounds thus I was aware of their cultures, age, gender, class, social status, education and how those could influence the research (Patton, 2002).

It was also important for me to continuously draw boundaries between my position as a researcher and my participation in the Fundisa for Change programme. I had participated in other teachers’ PLC activities which were outside the scope of this study. I thus had to ensure through critical examination of my assumptions and reflexivity that I treated the cases separately: the ones that were used for the study and the ones that were not. Recognising my position as a researcher allowed me to be transparent throughout the research process, open with my participants and myself and conscious of how my subjectivity might shape the interpretations being made.

Reflexivity was important for someone as close to the project as I was as a participant observer. During observations and interviews with teachers I could be described as a ‘participant observer’ which Patton (2002) described as an observer who is herself immersed in the process that is being researched. Patton noted that participation is something that can be described in degrees.

4.9 Ethical consideration

Careful attention was given to ethical issues that confront the researcher. This includes policies regarding informed consent, safety, deception, confidentiality, anonymity, privacy and caring (National Research Council, 2003; McMillan & Schumacher 2006). To conduct the research, I gained ethical clearance from Rhodes University (where the study was registered) indicating that the proposal to conduct research, the provisional title of the research and the research process had gone through the university’s ethical clearance process (see Appendix 10). As discussed in Sections 1.8 and Section 4.3.2, the PLCs studied were in the Western Cape and Eastern Cape provinces. Therefore, before conducting the study, I first had to seek permission from the Eastern Cape and Western Cape Education Departments. These departments had guidelines on research with and on

teachers. The guidelines were different in the two provinces; this required me to follow the respective ethical processes as outlined in the two provinces. The process required completing the Eastern Cape and Western Cape Department of Basic Education forms. Even though I anticipated working with about eight teachers in each province, I requested 15 teachers to allow for the possibility of teachers withdrawing from the study. The two provinces granted permission to conduct research (see Appendix 10 for permission letters to conduct research in the two provinces). Finally I worked with four teachers in the Western Cape province and eleven in the Eastern Cape province (as justified in Section 4.4 of this chapter).

After gaining access from the provincial education department, permission letters to conduct research were submitted to the local district offices to inform them of the research goals, aims and process. I then informed all the teachers in the PLCs on the process and purpose of the research (see Appendix 11). This was done during the first day of the first PLC sessions in all the three PLCs. This was particularly important because I needed to observe the PLC activities from the beginning and I needed teachers who agreed to participate in the study, to understand what they were agreeing to. A consent letter with a full introduction of who I was, the study purpose and goals, was thus given to the teachers to gain written consent from all those who were willing to voluntarily participate in the study. I assured all participants orally and in writing that the data collected would be dealt with confidentially. The names of participants would not be revealed; pseudonyms were used (as shown in Chapters Five, Six, Seven, Eight and Nine). Since different types of methods were used to collect data from the teachers, the ethical consent form provided clear options for teachers to choose from if they wanted to participate i.e. fill in questionnaire, focus group, interview, reflection tool, observation (Appendix 11). Teachers were happy with all options but none chose focus groups, so no focus groups were conducted despite the original intention. I told all the teachers explicitly that I would be observing the PLC activities, and would be focusing on the activities and events. And for the observations I would not necessarily only focus on the teachers who agreed to participate in the study as that would be difficult to capture because of the pace of the activities and the different elements that I was observing in the PLC (see Section 4.5.5 of this chapter). It is therefore worth noting that the accounts given of teachers' beings and doings in the PLCs in Chapters Five, Six and Eight were not only for the 15 teachers who participated in this study but rather for all the teachers in the PLC. For ethical reasons, teachers who did not directly participate in the study were told about that. None of the teachers objected to participating in the study when they were given consent letters, but due to logistics and amount of data gathered, they could not all participate ultimately. In the Cape Town PLC, some teachers in the PLC were not Life Sciences teachers and thus were not the focus of the study (see Section 4.3.3 and Section 4.4).

Permission was also sought from the Fundisa for Change partners to participate in the study. They were also briefed on the purpose, goals and process of the study (see Appendix 12) and offered written consent to participate voluntarily in the study. In cases where I was not able to preserve anonymity of the participants' names, for example, the Fundisa for Change coordinator, I negotiated to reveal their names in the study if necessary. In the consent letters signed by the participants, they were informed about their rights to withdraw from the study at any time should they feel that this was necessary (Shenton, 2004). I guaranteed all participants of their full rights to verify the data and use of data.

Setati (2005) noted that most researchers use teachers for their own benefit; I was, however, both a participant and facilitator in the Idutywa and Grahamstown PLCs, and I believe teachers have learned through interactions in the PLCs. I am also a co-author of the Fundisa *Teaching Marine Biodiversity* booklet which teachers in the Idutywa PLC received. Because of this, teachers viewed me as a researcher but also as an expert in the topic of discussion, and they thus sought assistance to clarify content. Both the Western Cape and Eastern Cape provinces' permission letters to conduct research included conditions to publish the thesis on their websites (see Appendix 13 and Appendix 14). It is my hope that the two provincial departments of education will engage with the research findings to improve and support PLCs in their provinces. I intended to provide feedback to teachers and to the Fundisa for Change partners who participated in the study; this was not only for respondent validity but also to gain respect and trust (Bassegy, 1999). Pictures and videos were taken during the PLC activities for the purpose of analysis but have not been used in this thesis as no permission was sought from participants to include them in the actual thesis.

4.10 Conclusion

In this chapter I have examined the research design and methodology of the study. The chapter discussed the methods used to generate data to answer the research questions related to conversion factors, functionings, agency and structures of Science teachers PLCs in relation to biodiversity. Furthermore, this chapter has discussed the strengths and limitations of the methods chosen to generate data. In addition, the chapter has provided information on who provided the data that answered the research questions posed in the study, how they were selected, and how the data was managed and analysed. Finally the chapter has discussed the position of the researcher in the study, how the position of the researcher might have affected the participants and the data collected, as well as the ethical issues that were considered throughout the research process. The next chapter discusses the teachers' valued beings and doings as they relate to the teaching of biodiversity.

Chapter 5: Valued beings and doings of teachers related to the teaching of biodiversity

5.1 Introduction

The previous chapter discussed the methods used to elicit what the Life Sciences teachers valued beings and doings (also referred to as valued functionings) were in the PLCs. This chapter answers the first research question on what beings and doings were evident amongst the Life Sciences teachers in the PLCs, if and how they were valued in biodiversity teaching. The chapter will discuss what the teachers in the three PLCs (Idutywa, Grahamstown and Cape Town) noted as their valued functionings in the PLCs in relation to biodiversity. Because of the similarities across the three PLCs, the teachers' valued beings and doings will not be described and discussed as separate cases.

5.2 Teachers' valued beings and doings related to biodiversity teaching

As discussed in Section 1.7, the 2014 action plan *Towards the realisation of Schooling 2025 of South Africa* highlighted that teachers should be confident, well trained and continually be improving their capabilities (South Africa. DBE, 2011b). The ISPFTED (2011-2025) aims at improving the professionalism, teaching skills, subject knowledge and computer literacy of teachers throughout their teaching careers (South Africa. DHET & DBE, 2011a). These policy documents imply the role of teacher education in South Africa. It is thus worth arguing that teachers' participation in the PLCs were to achieve these valued functionings that are regarded as important in the South African policy documents. However, the capability approach argues that people have the freedom to lead the kind of lives they want to lead (Robeyns, 2005a). This implies that teachers in the PLCs could have different valued functionings depending on what they have reason to value. Cundill et al. (2014) asserted that at the outset of any learning process, it is necessary to have a good idea of the participants' intended or expected outcomes of the learning process. This helps to be responsive to participants' individual valued functionings. Thus to explore the teachers' valued functionings in the Idutywa PLC, at the beginning of the first session they were asked what their valued beings and doings were in relation to the teaching of biodiversity. The teachers wrote down their valued beings and doings on a white board and this has been transcribed into Table 5.1 below.

Table 5.1: Teachers' valued beings and doings related to biodiversity teaching (from the PLC¹⁸)

- | |
|--|
| <ul style="list-style-type: none">• Better understanding of teaching marine biodiversity, concepts used and to be able to develop awareness about conserving nature.• Learn more about marine biodiversity to be able to impart knowledge acquired to learners, to share ideas on the topic with colleagues and to get learning and |
|--|

¹⁸ The valued beings and doings in this PLC are direct quotes from teachers but unlike in Table 5.2, I could not reference the individual teachers as they were randomly written on the white board without names of teachers.

teaching support materials.

- To learn more about marine biodiversity and to be assisted in finding areas or topics in which marine biodiversity fits in the curriculum.
- To have more information about biodiversity and to know why it is important to conserve species that we have.
- To learn how to do practical tasks in Life Sciences, how to use different ways in making my learners understand the subject and how to assess learners in different ways that are challenging not just recalling.
- A better understanding of marine biodiversity, easy and better ways to teach this topic and make learners understand and to observe and identify some marine organisms in their natural habitats.
- To be a better Life Sciences teacher and to be equipped with experiments.
- I hope I would have a better understanding on biodiversity and in the process I can get tips on how to get learners interested in biodiversity.
- To have a better understanding of marine biodiversity, learn better ways of teaching marine biodiversity and to study further on the said if I get the chance and to educate the community.
- To improve my knowledge and skills and as well as build my confidence to accurately teach the topic involved.
- To gain more knowledge on how to teach and address the learners on the ecosystems
- Better understanding of teaching biodiversity to raise awareness among colleagues at school on biodiversity and teach learners conservation practices on marine biodiversity.
- Why marine biodiversity is important to high school learners.
- How can I study further on marine biodiversity?

Evident in Table 5.1 is that in the Idutywa PLC teachers' core valued beings and doings were to gain confidence in their teaching of biodiversity; to expand their own biodiversity knowledge; to improve their teaching practice; to be supported with teaching and learning support materials; to expand their curriculum knowledge; and to gain knowledge to educate their community on the importance and conservation of biodiversity.

Commenting on the approach used by the facilitators in Idutywa to explore the teachers' valued beings and doings, the Fundisa for Change coordinator expressed:

In Idutywa, what stood out for me, the first day was asking the participants, what would you like to achieve at the end of this training? For them to actually set up the agenda, in terms of saying, at the end, this is what I am hoping to get out of this training. Sometimes there is a tendency that people bring their programme and say these are the objectives, this is what we want to achieve. Forgetting that when people are trained is not about the person who brings the programme, it is about the recipients of the programme ...Yes it is good to have a structure in terms of this is what we are trying to achieve but at the same time also responding to what the

participants are saying ... there must be flexibility in terms of this is what the participants need, then cover that, even if it means some of what you had planned as a facilitator might not get covered but as long as you respond to the particular context in which you find yourself. (UP1R)

Demonstrated in the quote above is the emphasis on allowing teachers to define the training programmes based on their individual valued functionings. In South Africa, most programmes have not made an impact on teachers' professional development as they do not take into account teachers' valued functionings (D3; D4). The quote from the Fundisa for Change coordinator above further demonstrates the need for teachers' agency in relation to their individual beings and doings (D2; D3; D4; D14).

Teachers in Cape Town and Grahamstown did have the opportunity to share their valued beings and doings at the beginning of the PLC activities as in Idutywa. However, throughout the PLC activities they were given opportunities to reflect on what their valued beings and doings were as they relate to the teaching of biodiversity. It was however evident in the questionnaires and interviews that their valued doings and beings were similar to the Idutywa teachers' valued beings and doings. Table 5.2 shows Grahamstown and Cape Town teachers' valued beings and doings.

Table 5.2: Teachers' valued beings and doings related to biodiversity teaching (from Grahamstown and Cape Town PLCs)

Teacher	Valued beings and doings related to biodiversity teaching
Grahamstown PLC	
GT1	<ul style="list-style-type: none"> • Need to learn more so that I can teach my learners with confidence • To change my teaching practices for better
GT2	<ul style="list-style-type: none"> • Want to be helped with my subject knowledge and new teaching methods
GT3	<ul style="list-style-type: none"> • To gain more knowledge on biodiversity and how to do fieldwork • To assist me with more information so that I can use it in the classrooms, even videos
GT4	<ul style="list-style-type: none"> • To help bridge content gaps and understand new ways of approaching biodiversity • To get assisted with how to approach the difficult concepts
DT5	<ul style="list-style-type: none"> • To better my understanding and approach to CAPS, not just environmental content in Life Sciences CAPS
Cape Town PLC	
CT1	<ul style="list-style-type: none"> • I want to know more about biodiversity and I also want something for my Curriculum Vitae. But I enjoy teaching things with the biology component, so that is why I came • Help me better my knowledge on this section of my subject and share ideas
CT2	<ul style="list-style-type: none"> • I want better information on biodiversity as I feel I lack the proper background information
CT3	<ul style="list-style-type: none"> • Empowerment to successfully bring information across to learners • I wanted to expand my knowledge and find better ways of presenting my lessons
CT4	<ul style="list-style-type: none"> • I expected them to identify the gap in content and assist with that

Evident in Table 5.1 and 5.2 are the teachers' valued beings and doings in the three PLCs. The teachers' valued functionings were to expand their capabilities to teach biodiversity. This was

mainly through expanding their subject content knowledge, pedagogical and assessment practices to teach the biodiversity content in the Life Sciences CAPS curriculum confidently. In line with teachers' valued functionings, Fundisa for Change aims to expand teachers' foundational concepts on environmental learning (D6; D13; Lotz-Sisitka, 2011).

The Fundisa for Change programme seeks to support teachers' understanding of and capacity for teaching environmental content and concerns as found within the national curriculum subjects, and their cognate disciplines. It broadens knowledge of teachers to engage with social-ecological concepts, issues and solutions and wider sustainability practices. It further seeks to strengthen disciplinary knowledge, pedagogical content knowledge, situational knowledge and fundamental learning. It does this through supporting critically reflective and applied practice in which new concepts and approaches are tried out and reflected on in classrooms. (D13:2)

The valued functionings to be achieved by the Fundisa for Change programme are:

- *Subject knowledge and learning* (theory): Show improved understanding of environment and sustainability subject knowledge in the context of a specific subject and phase;
- *Pedagogical knowledge and learning* (practice): Show ability to use appropriate teaching and assessment approaches for a specified subject knowledge, skills and values;
- *Situated knowledge and learning* (context): Relate subject specific environment and sustainability content knowledge broader issues and contexts; and
- *Practical knowledge and experience* (work experience): Design, develop, implement and reflectively review a lesson plan/sequence of lesson plans relevant to an environmental and sustainability content focus in a particular subject and phase/ grade. (D13:2-3)

The valued functionings of the Fundisa for Change programme are integrated in and through the Fundisa for Change professional development framework mentioned in Chapter One (know your subject, improve your teaching practice and improve your assessment practices) (D5; D6; D11a; D13). The Fundisa for Change model was confirmed by all the Fundisa for Change partners interviewed. As two of the partners noted:

Fundisa for Change offers curriculum support looking at three things: Firstly is improving the teacher content knowledge, in other words that science of the environment. Second is the methodologies, which methodology is applicable for that particular type of content and lastly is the assessment ... We are talking about high order questions. Beginning to build the capacity of teachers so that when they do assessment, the assessment should produce creative, innovative and critical thinkers - moving away from the system where learners learn by rote learning ... of course that is happening in line with what the curriculum has prescribed should happen. (PP)

Our programme primarily focuses on content knowledge, improving teaching practices and improving assessment, which means therefore that if we are focusing on content this need to be relevant, up-to-date, cutting edge content. We are working with partners who are in the field, particularly in the environmental field who have the relevant and up to date content; it

means therefore that our teachers will be working with the relevant content knowledge, up to date. We also have partners from higher institutions of learning-teacher educators who know the pedagogy; they have different pedagogies because when we talk of teacher educators, it's academics who are in the field, who are constantly doing research. Teacher educators also know the current trends and these they can be modelled to the teachers ... (UP1)

As shown in Table 5.1 and 5.2, the Fundisa for Change framework is in line with the teachers' valued beings and doings. As evidence of successful completion of the PLC activities, teachers are expected to submit an assignment. The assignment is in the form of portfolio of evidence (see Appendix 7). The assignment has been designed to provide evidence on the following aspects:

- Evidence of some acquisition of new knowledge relevant to a subject;
- Evidence of being able to use a new teaching approach and assessment method (e.g. designing higher order questions for assessment);
- Evidence of developing a lesson plan that integrates new knowledge, teaching approach and assessment strategies in the subject concerned in a relevant social-ecological and educational context; and
- Evidence of having taught the lesson with critical reflective comments on the processes. (D13:5)

In addition to valuing subject content knowledge, pedagogical and assessment practices, it is evident in Tables 5.1 and 5.2 that teachers valued being resourceful. They noted lack of teaching and learning support materials for biodiversity teaching. They valued being supported with teaching and learning support materials in the PLCs. The teachers further valued gaining confidence for teaching Life Sciences as a subject. Some of their valued beings and doings were to achieve their other valued functionings such as having 'good looking' Curriculum Vitae, exploring further study opportunities, and to raise awareness in their community for biodiversity conservation. The teachers' valued functionings are discussed below in line with the Fundisa for Change framework under the sub-headings: i) Subject content knowledge; ii) Pedagogical practices; and iii) Assessment practices. In accordance with teachers' valued functionings, Fundisa for Change aims to expand teachers' capabilities for teaching biodiversity through supporting teachers with teaching and learning resources. Therefore the teaching and learning resources will be discussed as one of the valued functionings under the sub-heading of 'teaching and learning resources'. Any other valued functionings will be discussed under the sub-heading of 'other valued functionings'. The next section is thus a discussion of the teachers' valued functionings under the five aforementioned sub-headings.

5.2.1 Subject content knowledge

In analysing the curriculum, it was evident that the Life Sciences CAPS curriculum covers a considerable amount of biodiversity knowledge related aspects (D1; D6; see Appendix 1). This is mainly under the two Knowledge Strands: Diversity, change and continuity; and Environmental

studies (D1). Most of this environmental content is described as new knowledge that is contested and ever changing (D1; D6). “The teachers are thus faced with a triple challenge of teaching environmental knowledge to learners: what we know, content and concepts; that what we know can be questioned and changed; and that we don’t know everything about these issues” (D6:8). It is because of challenges that teachers’ valued functionings were to expand their capabilities for subject content knowledge as noted in Tables 5.1 and 5.2. There is a certain amount of foundational knowledge needed in Life Sciences (D1; D6).

Without a sound understanding of certain core concepts and processes, it is unlikely that an environmental issue will be adequately understood. This problem can be addressed by focusing on the teaching of core concepts and processes in various subjects that provide the foundational knowledge necessary to understand a range of environmental issues and possible solutions. The core content includes: the earth as a system; key life supporting processes; and how ecosystems function to support the diversity of life. (D6:8)

The quote from the Fundisa for Change document above emphasises the importance of foundational knowledge. Foundational knowledge requires all Life Sciences teachers to teach the core content of biodiversity (the earth as a system; key life supporting processes; and how ecosystems function to support the diversity of life) adequately in order to expand learners’ knowledge on issues of biodiversity and biodiversity loss. In line with the Fundisa for Change document, it was evident in the interviews (GT31; GT51; CT1I - CT3I; DT1I-DT6I), that teachers recognise biodiversity knowledge as important, new and ever changing. Two Grahamstown teachers said:

Biodiversity is a less understood area of work and challenging as well. And if you don’t understand it as a teacher, you end up not teaching it the way it should be taught, motivating the learners to participate in the activities. A lot of teachers are not knowledgeable on it, it is content that was not there and have just been recently brought in the curriculum. So as much as you might have dealt with it ten years ago, you still need to revisit what is new. (GT5I)

If you look at grade 11 or 12 syllabuses, you will find that our syllabus change[s] every year. Whenever it changes, there are new topics added, just like evolution and genetics. Those topics are very difficult. We used to have monohybrid crossing in genetics now we have dihybrid crossing, and that dihybrid crossing is very difficult for me. Then it is very difficult to teach learners something that is very difficult for you to understand. Even evolution, most of the times I ask the subject advisors to come teach it for me. We did not get enough workshops or professional development on that ... (GT3I)

The above extracts reveal what some other teachers mentioned in their interviews (GT31; GT51; CT1I - CT3I; DT1I - DT6I). Some of these teachers (GT31; GT51; CT3I; DT3I - DT6I) revealed that the South African ‘changing’ curricula introduced new biodiversity concepts that they are not familiar with or supported to teach. The Life Sciences curriculum document does acknowledge this, by noting that scientific knowledge does change over time as new things are discovered and people get better understandings with changed views on the world around them; this is because scientists

continue to explore the unknown (D1). Teachers (GT3I - GT5I; DT3I; DT4I) commented that most professional development support they received was when 'new' curricula were introduced. Echoing other teachers (GT3I- GT5I; DT3I; DT4I), one Idutywa teacher said "I have attended workshops, conducted by the department, specifically the CAPS. CAPS were introduced a year ago in grade 12 which is the only support I got; I attended a workshop for Grade 11 for CAPS" (DT3I). While one Grahamstown teacher said:

The only professional development I received is, since the syllabus is changing every two or three years the curriculums are changing, from OBE to NCS to CAPS...every time they were going to change the syllabus, we attended workshops and those are the only professional development I received. (GT3I)

The South African curriculum reforms have been discussed in Chapter One (see Section 1.4). The CAPS curriculum was phased in over three years in terms of its implementation. The mandatory training started in 2011 for teachers of the grades that were targeted for the first implementation in 2012. The cascade model was used to provide CAPS orientation to teachers of specific subjects and grades over two or three day workshops (De Clercq & Shalem, 2014). One teacher in Idutywa confirmed this "I have attended CAPS workshops starting from last of last year that is 2011; another one in 2012 and I attended the last one in 2013 that was focusing on grade 12 curriculum" (DT4I). While like DT3I, he noted that the workshops were effective in understanding the difference between the Revised National Curriculum Statement and the CAPS curriculum, three teachers in the Grahamstown (GT1I; GT3I; GT5I) revealed that facilitators of the trainings lacked capabilities to engage with the 'new' curriculum and its subject content knowledge. One teacher from Idutywa said "the CAPS workshops helped me to know and to understand better this national curriculum statement, how it is supposed to be done in this education system" (DT4I). While one teacher from Grahamstown expressed:

Those people who are conducting the workshops, they do not have knowledge about what they are workshoping us. So you will find that there is nothing you have learned from them, you have to learn yourself from the pamphlets ... you will ask questions from those people conducting workshops and they don't know anything about OBE or CAPS. (GT3I)

It is evident in the extract above that teachers' personal conversion factors (see Section 3.3.2.3) enables them to expand their capabilities for teaching the 'new' curricula. Only one teacher (from Cape Town) had received formal training to teach biodiversity. He was a new graduate with less than one year of teaching experience (see Table 6.1 in Chapter Six). He maintained "I studied it in my first year at university and then for three years I did no biodiversity. So I do not feel properly prepared to teach it. There are gaps in the information I know" (CT1I). From this, it is evident that pre-service teacher education in some teacher training institutions does not enable teachers to teach the biodiversity content in the curriculum. There were different facilitators in the PLCs (see Table

4.1). Some of the facilitators (UP1; UP4; NP1; DP2) confirmed teachers' lack of subject content knowledge for biodiversity teaching. This was evident in the interview with one of the Grahamstown PLC facilitators who was working at an institution of higher education, as she reflected:

In my experience and what I am seeing in my students' research is that there still seem to be a tendency in South African schools to focus on definitions, definitions. From some of the observations of my students' research I can see a whole lesson dedicated to learning definitions. And it worries me that with the complexities of environmental issues and the higher order critical thinking skills that we are trying to develop, this is a huge conceptual leap, for teachers whose training has emphasised these definitions not necessarily understanding of concepts. To define doesn't illustrate understanding. (UP6)

It is evident in the above quote that initial teacher education in some teacher training institutions has not capacitated teachers adequately to engage with the in-depth knowledge on biodiversity required for critical thinking. As a result some teachers' capabilities for biodiversity teaching were only about definitions of concepts. Given the complexity of biodiversity knowledge, this is inadequate (see Section 2.3.1). Thus teachers' valued functionings were to expand their capabilities to go beyond teaching definitions of biodiversity concepts. Arguably, this is what teachers valued as they noted in Table 5.1 and 5.2 that one of their valued functionings is to "gain more knowledge on biodiversity" (GT3). To support teachers to achieve their valuing of subject content knowledge, the PLC activities started with exploring key concepts in biodiversity. This is fundamental knowledge required by teachers for biodiversity teaching (D1; D6; D9; D10).

It is important to develop a foundation for a progressive understanding of biodiversity. This includes understanding the levels of biodiversity and the associated terminologies. The concepts of biodiversity are based upon the principle of hierarchies and the basic building block is the species. (D9:12)

Thus to engage with biodiversity concepts requires defining it first, and explaining the key terms associated with it (D9; D10). This enables teachers to develop the necessary vocabulary for understanding the topic of biodiversity (D9; D10). In line with the Fundisa for Change documents, it was observed that to expand teachers' subject content knowledge, many biodiversity concepts and content were discussed in the PLCs. The content covered was structured under the three main units of the Teaching Marine Biodiversity¹⁹ or Teaching Biodiversity modules²⁰ (D9; D10) as shown in Table 5.3 below:

¹⁹ This was the one of the key Fundisa for Change booklets used to inform the Idutywa PLC activities.

²⁰ This was the key Fundisa for Change booklet that informed the Grahamstown PLCs and was used in the Cape Town PLC.

Table 5.3: The learning units in the biodiversity booklets

	Teaching Biodiversity	Teaching Marine Biodiversity
Unit 1	What is biodiversity?	What is marine biodiversity?
Unit 2	The roles of biodiversity	The roles of marine biodiversity
Unit 3	Causes of biodiversity loss and emerging human responses to biodiversity loss	Causes of marine biodiversity loss and emerging responses

In line with learning unit one (D9; D10; see Table 5.3), a number of key concepts relevant to biodiversity were explored in the PLCs, including biodiversity, species, population, genus, community, habitat, ecological niche, ecosystems, trophic energy levels, taxonomic classifications (naming and grouping organisms in a hierarchical ordered system that reveals their natural or evolutionary relationships), South African biomes or eco-regions, relationships between organisms, adaptation of species to the environment and competitions (DO1; DO2; CO1; CO2; GO1-GO3). This content knowledge was aligned to the curriculum topics (see Appendix 1).

It was observed that teachers were knowledgeable to some extent on some of the biodiversity concepts but lacked in-depth understanding of most concepts (DO1; DO2; CO1; CO2; GO1;-GO3). For example in the Idutywa PLC, the teachers were not fully able to define the concept of marine species (DO1). They referred to marine species as species found in water. This was confirmed by two teachers who noted in his interview “I did not know that it will focus on marine biodiversity, which is more challenging. I only noticed that it is challenging after we have dealt with it ... Before the training I just knew that marine is the sea with fish, I thought the ecosystem was only in water” (DT4I). “It is very difficult to teach about marine species that you do not know” (DT61). Through discussions, it was agreed that marine species include species that are not found in water but rely on species found in the water (DO1). Teachers were however familiar with some of the marine species i.e. mussels, jellyfish, seaweeds, sponges, crabs, snails, fish and abalone (DO1). In the Grahamtown PLC, teachers defined biodiversity as “the variety of plants and animal species”. Through discussions in all three PLCs, biodiversity was thus defined as ‘the variety of life’. This definition of biodiversity resonates with that presented in the Fundisa for Change materials. “Biodiversity refers to life on Earth in all aspects of its varieties” (D9:12). Further discussions happened in the PLCs to expand on the definition of biodiversity (see Section 1.8.7).

Emerging from the observations and some reflection tools, it was evident that in all three PLCs there were teachers who needed assistance with the concepts of biomes, taxonomic classification, taxonomic keys and the three levels of biodiversity (species diversity, genetic diversity, and ecological diversity) (DO1; DO2; CO1; CO2; GO1; GO2; GT1R-GT4R; CT1R; DT1R- DT3R; see Chapter Seven). To confirm what these teachers noted in their reflection tools, one teacher in the

Grahamstown PLC revealed “that is why I don’t like teaching grade 11 taxonomy because I don’t understand it” (GO2). To expand teachers’ capabilities to teach the concepts of biomes, taxonomic classification, taxonomic keys and the levels of biodiversity, the four concepts were dealt with in great detail in the PLCs. In Idutywa an activity was done using round and square shapes to unpack the concept of taxonomy and taxonomic keys (D10:28) (DO1). In Grahamstown, to expand teachers’ knowledge on the concepts of taxonomy and classification, they did activities using pictures of species, bugs, moths, butterflies and plant specimens to construct dichotomous keys, to distinguish between moth and butterflies, and between vertebrates and invertebrates (GO1). To further expand teachers’ knowledge on the concept of dichotomous key and classification, in a different activity, teachers used various plant leaves (spinach, beetroots and cabbage leaves) to construct a dichotomous key (GO1). In Cape Town, to expand teachers’ knowledge on the concept of classification, an activity was set up at the University of Cape Town Biological Science department (CO1). For the activity plant specimens were used for classifications. This required teachers to observe with a naked eye (and with the microscopes) the different seed cones, fruits, pollen cones, flowers to differentiate between (and classify) angiosperms and gymnosperms (CO1).

To expand the teachers’ capabilities on the three levels of biodiversity: in Grahamstown teachers engaged with three different case studies with the support of the facilitators to unpack the concepts of species diversity, genetic diversity, and ecological diversity (GO2). The three case studies focused on animal diversity in compost gardening, plant diversity in kitchen garden, and changing patterns of food production (GO2). In Cape Town, to support teachers with the levels of biodiversity a picture collage method was employed (CO1). This allowed teachers to sort pictures of species and ecosystems into the levels of biodiversity. The pictures were then used as examples to discuss the levels of biodiversity. In Idutywa discussions happened on the levels of biodiversity. Prior to the discussion, one teacher was able to define genetic diversity as “characteristics within the species caused by the genes” (DO1). This teacher used examples of interbreeding in cattle and sheep to explain the concept of genetic diversity (DO1).

To expand teachers’ capabilities on the concept of biomes: in Grahamstown teachers were asked which biomes are found in the Eastern Cape (GO2). They mentioned: Fynbos, Valley thicket and Karoo biomes. However when asked how they were teaching biomes they were hesitant to share. One teacher eventually revealed “I teach one out of the seven, and then I give learners homework to find out about the other biomes” (GO2). Another teacher noted “it is difficult to teach it” (GO2). A discussion was then done based on the CAPS document on the expectations of CAPS and the concept of biomes (D1). To expand teachers’ knowledge on the concept of biomes, they watched video clips (GO2). For the video clips teachers completed worksheets. They had to choose one

biome and explain *what* it is, *where* it is found, *who* (plants and animals) is found there, and *how* (adaptations) (GO2). In addition, they had to write down concepts related to biodiversity mentioned in the video clip and their brief explanations. Teachers noted concepts such as genetic diversity, relationships between organisms (mutualism, parasitic, symbiosis), species, ecosystems, pollution, biomes (tropical, desert, forests, rainforests), ecological niche, greenhouse effects, conservation and biogeochemical cycles (GO2). While watching video clips (one video clip was taken in Wales), teachers noted the importance of using locally relevant video clips for meaningful learning; this implied the importance of situational learning.

In Idutywa, teachers were not sure what biomes were found in their own context (DO1). After a discussion and engaging with maps on the six marine biomes (also called eco-regions) in South Africa (D10), all teachers agreed that they were in the Natal biome. The Cape Town teachers did an activity on South African biomes (CO1). The activities allowed them to use provided material resources to locate the three biomes (Fynbos, Forest and Succulent Karoo), to determine their average temperatures, rainfall and to explain how the vegetation is adapted to the different biomes (CO1). Teachers were unable to use plant leaves provided to explain the plant adaptations to the three biomes (CO1). Through discussions, they were then able to conclude that the leaves in the succulent Karoo are thick and hairy to reduce transpiration and store water to survive the high temperatures and little rainfall. The leaves in the forest are big and flat because the forest receives a lot of rainfall (CO1).

The above examples demonstrate how the different types of knowledge were engaged with in the PLCs. The examples further demonstrate the level of subject content knowledge on some of the biodiversity concepts. In the Idutywa PLC, through discussion teachers engaged further with concepts of genus, marine ecosystems, food chains and food webs (DO1). Teachers were also engaged with the concepts of ecological niche (DO1). Examples of an ecological niche of a fiddler crab, fly and a turtle were given to explain the concept of ecological niche (D10:13-14) (DO1). The facilitator emphasised that ecological niche refers “to the role that a particular species plays; and the space that the species occupies in an ecosystem” (DO1). In the Cape Town PLC, through presentations and discussions concepts of genus and species, habitat, population, ecosystems and community were also engaged with in the PLC (CP1; CO1). In Grahamstown, concepts of climate regulation, ecosystems, mass extinction, genetic modified organisms, monoculture and species richness were discussed (GO1).

Interestingly, during the first sessions when teachers were asked if and how they taught biodiversity concepts, only a few teachers in Idutywa and Grahamstown noted that they were teaching biodiversity concepts (DO1; GO1). In Idutywa, some teachers taught concepts of extinction,

endangered species, indigenous species, habitats, population and biodiversity hotspots (DO1). These concepts are key to biodiversity (D9; D10). It was however worrying to hear some teachers say they did not teach biodiversity concepts, despite the explicit links and amount of biodiversity content in the curriculum (DO1; GO1; D1; D9; D10). It however became evident as the PLC activities unfolded that some teachers were teaching concepts linked to biodiversity. This was evident in their reflection tools and some of their comments in the interviews (these are reflected in Chapter Seven). It became evident that those teachers who noted that they were not teaching biodiversity concepts in the first session, appeared to lack the confidence and capabilities to make links between the CAPS concepts and biodiversity (which were among some of their valued functionings) (O'Donoghue, 2015).

One of the principles of the Life Sciences curriculum is progression: “content and context of each grade shows progression from simple to complex” (D1:4; see example of concepts and progression in Appendix 1). Progression happens within and across grades (grades 10, 11 and 12). Life Sciences teachers are expected to know how to make the conceptual links in the curriculum (D1). This is, for example, evident in the *Specific Aim 1* of the Life Sciences curriculum given below:

Specific Aim 1: relates to knowing the subject content (theory); this includes acquiring of knowledge, understanding and making connections between ideas and concepts to make meaning of Life Sciences, applying knowledge on Life Sciences in unfamiliar contexts and analysing, evaluating and synthesis of scientific knowledge, concepts and ideas. (D1: 13)

In line with the concept of progression, the Fundisa for Change materials noted:

Another issue that needs attention is knowledge progression and quality. Research shows that teachers are ‘under-teaching’ learners ... Enough attention is not paid to the level and quality of the knowledge taught to the learners, nor is sufficient attention paid to progression, or how to build on knowledge year by year. (D6: 9)

To confirm the above extract, teachers’ valued beings and doings included assistance to find links between biodiversity and the Life Sciences curriculum (see Table 5.1 and 5.2). To enable teachers to achieve their functionings on how marine biodiversity concepts are linked to CAPS, a presentation on biodiversity and CAPS was given (DP1). In three groups, teachers were given an activity to analyse CAPS for marine biodiversity related concepts. Group 1 had to analyse CAPS grade 10 (term 1 and 2); group 2 (grade 10, terms 3 and 4) and group 3 (grade 11). The activity led to the introduction of the concept of progression as outlined by the Life Sciences CAPS curriculum document. Teachers were expected to find explicit and implicit links between the concepts identified and marine biodiversity (conceptual progression) and to justify how the concepts they chose were related to marine biodiversity. It was observed that teachers struggled to find implicit links (DO1). One teacher said “we are confused, is this implicit or explicit”? Teachers then reported

back their CAPS analysis results on the flip charts. Once all groups have presented their charts, as a whole group they did a grade 12 CAPS analysis for marine biodiversity related concepts. Teachers then looked across the three charts (across grades) to see how the concepts on the three charts are linked explicitly or implicitly, this was to look at conceptual progression across grades. Group 3 note that there are many topics in grade 11 explicitly linked to marine biodiversity. For example, in term 1, biodiversity of microorganisms, biodiversity in plants, reproduction in plants, biodiversity of animals; in term 2, animal nutrition; in term 3, pollution ecology and in term 4, human impacts on the environment. They had a long debate as to whether photosynthesis in term 2 is implicitly linked to marine biodiversity or not. The teachers found it difficult to identify links between grade 12 concepts and marine biodiversity. There was considerable discussion on whether Deoxyribonucleic Acid and forms of life, meiosis, reproduction in vertebrates, human reproductions, genetics and inheritance are related to biodiversity or not. The activity was allocated an hour but took over two hours to complete (DO1).

An activity on conceptual progression was also done in Grahamstown. Teachers were given an overnight task to review the Fundisa for Change *Teaching Biodiversity* booklet (GO2). Teachers had to list the key concepts presented in the booklet, and to highlight page numbers in the CAPS documents where identified concepts were covered. Teachers further had to describe how the core knowledge (identified concepts) was related to biodiversity and how they progress with the CAPS curriculum document. Some of the concepts identified in the Fundisa for Change *Teaching Biodiversity* booklet and in the CAPS document included: biodiversity, taxonomy, roles of biodiversity, mass extinction, human interactions with the environment, climate change and biodiversity loss. Teachers were unable to make links between the concepts identified (GO2). With the help of the DP4 and the facilitators they were introduced to the concept of progression in CAPS (p.10). Like in Idutywa, it emerged that teachers in Grahamstown were also not familiar with the concept of progression (D6; see also Chapter Seven).

Table 5.1 shows that teachers in Idutywa also valued being knowledgeable about the importance of conserving marine biodiversity. To enable these teachers to achieve their valued functioning, like in Grahamstown and Cape Town, the roles of biodiversity were discussed in detail (DO1; CO2; GO2). The discussions on the roles of biodiversity were aligned to the Fundisa for Change learning unit two of the *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets (D9; D10).

The roles of biodiversity include ecosystems services and contributing to human well-being. Ecosystem services are the various benefits that ecosystems provide. Biodiversity plays an important role in the provision of various ecosystem services necessary for sustaining human life on Earth. In CAPS, ecosystems services and human well-being are covered in Grade 10, Term 3 and 1. (D10:38)

To expand teachers' content knowledge on the roles of biodiversity in the Cape Town PLC teachers were given a scenario; they had to view one of the facilitators as a 16-year old who needed convincing that biodiversity is important (CO1). Individual teachers had to write the use of biodiversity on strips of coloured papers. They placed them on the wall under the appropriate heading as shown in Table 5.4 below:

Table 5.4: Uses of biodiversity

Ecological (nature)	Economic (money)	Utilitarian (using every day)	Stewardship (looking after)	Aesthetic (beauty)	Spiritual	Ethical
-Oxygen -Nitrogen -Fertilising the ground	-Tourism -Minerals -Timber -Biofuel	-Food -Shade -Defence -Shelter		-Sculpture -Relaxing -Peace -Paintings	-Worship	-Clothing -Cross breeding

Teachers were not able to categorise most of the uses of biodiversity under the given categories but they managed through discussions (CO1). The discussion also triggered a debate on the ethical issues on the use of bio-fuels and cross-breeding of animals.

Learning unit three of the *Teaching Biodiversity* and *Teaching Marine Biodiversity* booklets focuses on the human impacts on biodiversity and responses to biodiversity loss (D9; D10) in response to the Life Sciences CAPS curriculum. "Human impacts on biodiversity are covered in CAPS in Grade 11, Term 4" (D10:48). In the Grahamstown PLC, to expand teachers' knowledge on the direct and indirect drivers of biodiversity loss, teachers were asked how they were teaching human impact on biodiversity. They were hesitant to share their practice but eventually noted:

Teacher 1: The reason we are not answering is because we teach this topic at the end of the year and there is no time and we do not make those links. But now since we did not teach it yet and we know, we will make links between direct and indirect drivers.

Teacher 2: It is true environmental studies is the last topic in the curriculum, we are rushing to prepare for examinations.

Teacher 3: Sometimes is the attitude, we do not understand and sometimes you have no interest that is my case at least. I have a negative attitude towards that section just like with evolution.

Teacher 4: This topic is difficult, that is why we are always juggling.

Facilitator: The aim of biology is to understand human - nature relationships. Maybe it is important to talk about it throughout the year for example when walking in the garden, ask what happened here, why is it here, how did it happen? Develop the use of language so that by the time you get to that topic at the end of the year to teach it, you have already covered some of the concepts.

The above responses introduce interesting perspectives as to why biodiversity content knowledge was not prioritised in Life Sciences, namely: teachers' attitudes, and the fact that biodiversity topics are taught in the fourth (last) term and get neglected due to examination pressures. The CAPS curriculum does stipulate that the 'Knowledge Strands' or content does not have to be taught in the same sequence as it is represented in the curriculum (D1). Thus teachers could reconcile their work plans to cover the topic earlier in the year. Alternatively as suggested by the facilitator above, through conceptual progression, teachers can teach biodiversity components throughout the year. However, as revealed in Table 5.1, teachers valued assistance with conceptual progression. Related to human impacts on biodiversity, in all the three PLCs the direct and indirect causes of (marine) biodiversity loss were discussed (GP2; GO2; DP1; DO1; CP2; CO2). In Grahamstown the drivers were discussed, in Cape Town, there was a PowerPoint presentation and in Idutywa, the drivers of biodiversity loss were role played. Among the drivers of biodiversity loss were habitat change, pollution, and invasive alien marine species, overexploitation and climate change (D9; D10).

In the Grahamstown and Idutywa PLCs, teachers were able to explain how habitat loss, climate change and invasive alien species contribute to biodiversity loss (DO1; GO2). For example, in Grahamstown one teacher noted that invasive alien species use a lot of water and compete with indigenous species (GO2). Another teacher explained that climate change results in floods, tsunamis and drought which all impact on the environment and species do not adapt quickly to environmental change (GO2). Teachers in Grahamstown observed that the factors affecting biodiversity are linked (GO2). They further noted that the indirect drivers of biodiversity loss can be due to economic, social, political, cultural or religious reasons (GO2).

In Cape Town, figures on South African biodiversity (from the 2011 National Biodiversity Assessment) were shown to discuss how urbanisation, pollution and habitat loss lead to biodiversity loss (CO2). Using posters from the City of Cape Town (showing vegetation and species in Cape Town), teachers completed a worksheet to determine:

1. The different vegetation types that occur in the Cape Town Metropole area;
2. The levels of endemism in the vegetation types (pie charts); and
3. The levels of threatened species in the vegetation types (pie charts).

Responses to biodiversity loss are discussed in the Fundisa for Change *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets (D9; D10). These responses are varied (D9; D10). "However, no singular response is effective on its own. Each response is a continuous learning process and in some instances certain responses can have negative implications. An integrated approach to biodiversity conservation is more feasible" (D10:54). In line with the *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets, in all the three PLCs PowerPoint presentations

were used to describe the emerging responses to biodiversity (DO1; CO2; GO2). Some of the emerging responses to biodiversity (marine) loss include: the proclaimed Marine Protected Areas in South Africa, co-management, South African Sustainable Seafood Initiatives and policy and legislation, Environmental Education and ESD, indigenous conservation species, collaborative management and community-based natural resource management, ex-situ conservation, non-consumptive use of biodiversity, invasive alien control, policy and legislation, international environmental agreements/treaties/conventions and related programmes and the low carbon and green economy (D9; D10). In Idutywa, it was observed that teachers were familiar with some policies on biodiversity conservation (DO1). They noted that policies on mussels limit individuals to harvest 25 mussels a day, but people harvest more than that. They observed that for sustainable harvesting of mussels, people are encouraged to use screwdrivers instead of spades, but they still use spades which kill the surrounding smaller mussels (DO1). In Cape Town, teachers were not familiar with seed and gene banks as responses to biodiversity (CO2). Like in Grahamstown, in Cape Town teachers were not familiar with the different levels of endangered species (CO2; GO2).

5.2.2 Teachers' valued functioning with regard to pedagogical approaches

“Quality education is shaped by pedagogies as much as it is by content” (D6:10). Life Sciences favour investigative methods (D1; D6). As noted in Chapter Two (Section 2.3) and Section 5.2.1 (in this chapter), biodiversity concerns are complex and contested, therefore “it requires learners to engage actively with complex social and ecological concepts, issues and risks relating to local and global contexts” (D6:11). Learners need to be creative and should be able to use their imaginations to develop new and alternative solutions to local and global biodiversity concerns (D6). “Teachers therefore need to develop the capacity to design teaching and learning interactions that encourage critical thinking and analysis of topics at different scales and at different contexts” (D6:11). This implies that for the successful implementation of biodiversity knowledge, teachers should be able to identify appropriate teaching methods. Teachers recognised this process as challenging; they therefore valued support with pedagogical approaches for biodiversity teaching (see Table 5.1 and 5.2). As indicated earlier in this chapter, expanding teachers' capabilities on pedagogical practices for biodiversity teaching is one of the Fundisa for Change programme components. The teaching methods being promoted by the Fundisa for Change programme are aligned to Life Sciences and biodiversity concepts, content and issues as well as the context of learning (D6; D7; D9; D10). “There is little point in using a teaching method in your subject unless it contributes to effective learning. It is vital that teachers give adequate attention to the quality of both teaching and learning” (D6:13). Thus in the PLCs, to expand teachers' capabilities, pedagogical approaches aligned to biodiversity and the Life Sciences CAPS curriculum were engaged with.

Biodiversity is about forms of life systems and is therefore to a large extent a practice-oriented subject. However, this does not imply that theoretical as well as other classroom-based activities are not possible. A mixture of practical action-oriented aspects is in real life contexts as we as classroom-based activities facilitate learning on the topic. These include investigative, experiential, learning by doing and deliberative ... Some activities are suitable for groupwork while some are individual activities. Using a diverse range of teaching and learning approaches creates opportunities for learners to actively engage in the learning process. (D10:30)

The extract above recognises that the Life Sciences curriculum requires both theoretical and practical knowledge. The extract further notes that different types of teaching methods are suitable for the range of learning activities, thus Life Sciences teachers need to be exposed to the different types of methods. The biodiversity topic requires the development of language skills, analytical skills, critical decision-making skills and mathematical development skills (D9; D10). As indicated in Tables 5.1 and 5.2, teachers valued being supported with pedagogical knowledge for biodiversity teaching. Their weak pedagogical knowledge was confirmed by one of the Fundisa for Change partners from the national Department of Basic of Education who noted:

The problem is not only content but methodology and diversity of teaching ... most teachers are still using the talk and chalk, they don't bring in any of the exciting teaching methodologies such as experiential learning, field learning, outside learning, active participatory learning ... even when you talk of simulations, in most cases the simulations are quite artificial in the sense that the examples that are used by the teachers do not really speak to the real world. (DP1)

The above extract was supported by the subject advisor who participated in the Grahamstown PLC activities, as he commented:

Some of our teachers actually do have the knowledge, they know it, and they just don't know how to teach it. Others they know how to teach, but they do not know what to teach. You have a textbook, but you don't have to teach everything in the textbook, so they don't know how to select, to get to the important stuff. You always start at what is known and work towards the complex. So when a teacher says she does not understand we need to find out, what does she not understand? Is it the actual knowledge or the methodology of it that she does not understand? (DP4)

In line with teachers' valued beings and doings, the two extracts demonstrate the lack of teachers' subject content knowledge and pedagogical knowledge. This points to the need for striking a balance between expanding teachers' sound subject knowledge and pedagogical knowledge. The extract from DP1 notes the importance of using 'exciting' methods such as experiential methods for biodiversity learning. This is in line with the teachers' valued functioning of 'easy and better' ways to teach biodiversity. Even though teachers did not explain what they meant by 'easy and better' teaching methods, it became evident in the PLC activities, that 'easy and better' referred to

experiential and participatory approaches (discussed in Chapter Seven). Some teachers (DT2I; GT3I; GT1I) wanted to specifically expand their practical knowledge for conducting practical activities and fieldwork. Some of the teachers in the Idutywa PLC recognised the need for situational knowledge and place-based pedagogies. As one teacher said “a better understanding of marine biodiversity, easy and better ways to teach this topic and make learners understand and to observe and identify some marine organisms in their natural habitats” (DT6Q). The teachers’ valued functionings of place-based learning approaches and situated approaches are encouraged for biodiversity education (D6; D7; D9; D10; see Section 2.3). The CAPS document stipulates that teachers should be able to conduct practical and fieldwork activities (D1). For example, under the topic of ‘biosphere and ecosystems’ teachers are expected to “choose one ecosystem close to the school within a local biome for special study...” (D1:33). Teachers therefore valued being supported with practical and investigative skills (see Tables 5.1 and 5.2). Some teachers (DT2I; GT3I; GT1I) revealed that their pre-service training did not capacitate them on how to conduct practical activities. One teacher in Idutywa maintained:

It is difficult to do practicals, I don’t know how to do it ... at university; we were only taught theory and did not do it in practice. At school when I went there I was just given a textbook. You don’t know whether what you are doing is right, you don’t have enough resources. You will just be manipulating trying to come up with the results, because you know what is expected from you. So I don’t know whether the teaching that I am doing is correct. At least if I can get support on how to do practicals, like we are doing here, this is what you are supposed to be doing in class, how you are supposed to introduce the topic, how you present it, analyse it, and reflect on it, give assessment. (DT2I)

The above quote demonstrates why some teachers (DT2I; GT3I; GT1I; GT5Q) valued being supported to conduct practical activities. The quote further reveals that initial teacher training in certain institutions does not enhance teachers’ capabilities to conduct practical activities, yet they are expected to conduct practical activities for learners in Life Sciences. What is further evident DT2I’s response is that at her school, teachers were not being supported to conduct practical activities. They only receive textbooks and are expected to figure out how they will conduct practical activities. The lack of teachers’ capabilities to conduct practical activities was also confirmed by the subject advisor who was a participant in the Idutywa PLC activities. He revealed:

Teachers have problems with doing practical work. Some teachers never went to universities, so the whole concept of doing practical activities is new to them. When they are expected to do practicals for their learners, some even try to avoid doing practicals, because it is difficult for them and they don’t know how to go about it ... There are a lot of other skills that they don’t know, about hypothesising, how you set a hypothesis testing practical ... (DP3)

Emerging from the subject advisor’s extract is that some teachers had not been to university thus lack the capabilities for conducting practical activities in Life Sciences. However, all the teachers

who participated in this study were qualified to teach (see Table 6.1 in the Chapter Six). Despite their qualifications, some teachers (DT2I; GT3I; GT1I, GT5Q) revealed their lack of capability to conduct practicals in Life Sciences. The subject advisor revealed that some teachers lack scientific skills required by the Life Sciences curriculum. Grahamstown teachers also revealed inadequate training on how to conduct practical activities. They were thus not able to conduct practicals in their schools. However, unlike the Idutywa teachers, they (GT1Q; GT2Q; GT3Q; GT1I; GT2I; GT3I) acknowledged the support they received from the Rhodes University Mobile Lab on conducting practicals and experiments for learners. In addition to their lack of skills on how to conduct practicals, teachers revealed lack of resources as constraints to conducting practical activities. Echoing other teachers (GT1I; GT2I; GT3I), two Grahamstown teachers expressed:

For example we have another support that we get from Mobile Lab Rhodes. They come to our schools with the apparatus and they conduct most of the experiments with our learners. Then when they are gone as a teacher you cannot do those experiments with the learners because there are no apparatus. They were there, you saw what they did, but you cannot do it for the learners because the school has no resources. (GT1I)

The mobile lab unfortunately they did not get a slot. They usually come to my school to do practicals because sometimes we don't have materials. Sometimes you can see this is a microscope but as a teacher, you don't know how to use it, so we seek help from them, so that when we do practicals with learners we are clear. (GT2I)

The extracts from the two Grahamstown teachers provides evidence that even though they do get support with practicals and experiments from the Rhodes University Mobile Lab, it was sometimes difficult for them to conduct similar practicals with the learners because of the lack of resources or their lack of knowledge. In Cape Town, teachers did not express any concern about conducting practicals but they also did not show any evidence of being capable of conducting practical activities. In line with teachers' valued functionings on practical activities, the Life Sciences CAPS curriculum *Specific Aim 2* puts emphasis on practical investigations and a range of skills that are related to doing practical work (D1).

To expand teachers capabilities for different pedagogical approaches to biodiversity teaching, they were introduced to the teaching methods that are recommended for environmental learning (including biodiversity) (D6; D7; D9; D10). These were mainly informed by the Fundisa for Change *Methods and Processes to support Change-Oriented Learning* booklet (D7). The pedagogical approaches (with examples of methods) were discussed under the following categories:

- *Investigative methods*: participatory methods, fieldwork and collaborative research, exploring indigenous ways of knowing and case studies;
- *Deliberative methods*: dialogic cartoons, social learning methods, critical media analysis, story methods, drama and theatre for development, and scenario and backward mapping;

- *Learning by doing methods*: projects and practical actions, action research and community problem solving and stewardship;
- *Experiential methods*: interpretive trails, solitaire, music, poetry, role play, values clarification, working with cameras; and
- *Information transfer methods*: awareness social marketing campaigns, talks and presentations, demonstrations and experiments, guided questioning, fieldtrips, excursions and exchange visits, games and quizzes. (D7)

In the Grahamstown and Idutywa PLCs, the different pedagogical approaches were unpacked and discussed in detail (DP1; DO1; GO2). Their advantages and pitfalls were highlighted (D7). In Cape Town, the teaching methods were merely outlined (CO1; CO2) and teachers were expected to read through the *Methods and Processes to support Change-Oriented Learning* module (D7) to extend their capabilities regarding the different pedagogical approaches.

In all the PLCs, however, most of the teaching methods were modelled. For example, in Idutywa, the scenario planning method was used to demonstrate the reduction in mussel species (DO1). The role play method was used to explain the concept of human impacts on marine biodiversity (DO1). In Cape Town, a role play method was used to demonstrate the complexity of environmental issues (CO2). This role play focused on conservation versus urban development (to develop or to conserve). Teachers in groups assumed different roles i.e. the conservation agency, developers, greenies and the community. Each group presented their points of view. The developers were keen to build houses for economic reasons. The greenies noted the need for oxygen and carbon dioxide. The conservationists argued for protection of the site because of rare and indigenous species discovered in the area. The community asserted that the City of Cape Town only care about foreigners coming for tourism, “why don’t they take the rare species to the already protected sites, we want better houses. If they don’t build houses for us we will toi toi²¹” (CO2). It is thus evident that the role play revealed the complexity of environmental issues and their economic, social, biophysical and political implications. Emphasis was placed on teachers mediating such debates in their classes. As discussed in Section 5.2.1, a picture collage method was used in Cape Town to help unpack the three levels of biodiversity. Teachers noted that sorting skills are required to employ such a method. They further noted that sorting skills is one of the science skills required by CAPS (CO1). The teachers in Grahamstown and Idutywa observed that learners benefit from learning by doing, experiential methods and through discussions (GO2; DO1; DT2P).

²¹ This is a similar expression to protesting.

Table 5.1 shows that teachers valued fieldwork activities. In all the PLCs, there were field activities conducted to expand teachers' capabilities on conducting fieldwork. For example in Idutywa, a fieldwork activity was done to understand marine ecosystems (DO2). Teachers in groups had to do the following as part of the fieldwork activity:

Group 1 - Identify marine species in the marine ecosystems and construct a taxonomic key (this task was given to a group of teachers who were unable to construct a taxonomic key in an activity done prior to the field excursion).

Group 2 - Use appendix 2 of the *Teaching Marine Biodiversity* booklet to identify the different types of marine ecosystems and the species found in those ecosystems.

Group 3 - Use examples on page 18 of the *Teaching Marine Biodiversity* booklet to construct different food chains using what you find on the marine ecosystems.

Group 4 - Use page 18 of the *Teaching Marine Biodiversity* booklet to construct a food web to show indicators of relationships between species found in the marine ecosystems.

In Grahamstown, to expand teachers' capabilities on conducting practical investigations, a fieldtrip was conducted to the wetland. As part of the wetland visit teachers identified organisms and the human impacts on the wetland (GO1). They used identified organisms as indicators to determine the water quality of the wetland. In groups they concluded that the water was clean because of the organisms they found there i.e. whirling beetle, bloodworm and mayfly. They valued the materials used for the activity to enable them to realise the achieved functionings in their actual teaching, but there were not enough materials for everyone. After the wetland study, teachers mind-mapped the importance of wetlands in groups (D9, Activity 9). In Cape Town, to expand their capabilities of conducting fieldwork and to further expand their knowledge on some of the biodiversity concepts, an excursion was conducted in the Kirstenbosch Botanical Garden (CO1). Teachers were given a worksheet to differentiate between terms i.e. biome and biodiversity, endemic and indigenous, community and habitat, ecological niche and ecosystem, genetic diversity and species diversity, genus and species, producer and consumer (CO1). During the excursion, guided questioning was used to engage teachers with these concepts. In pairs, teachers used a taxonomic key to identify plant species. The Cape Town teachers also had an opportunity to expand their investigation skills through engaging in activities in the University of Cape Town Biological Sciences laboratories and exploring the rocky shore marine ecosystem aquarium (CO1). The above examples have demonstrated how different pedagogical approaches were discussed and modelled in the PLCs to expand teachers' capabilities for biodiversity teaching.

5.2.3 Assessment practices

Assessment is a continuous planning process of identifying, gathering, and interpreting information on learners' performance using various forms of assessment. It involves four steps: generating and collecting evidence of achievement, evaluating this evidence, recording the findings and using this information to understand and thereby assist learners' development in order to improve the process of teaching and learning. (D1:66)

The CAPS document provides teachers with clear guidelines and structure for assessment, i.e. topics to be assessed and how many marks to be allocated (D1; D6). Fundisa for Change “supports teachers to develop the insights and skills necessary to ensure high quality and effective assessment practices” for biodiversity content (D6: 15).

Even though CAPS provides very structured guidance on assessment, the teachers still need to think through assessment carefully, and to develop effective assessment strategies. Good assessment practice greatly enhances the quality of teaching practice, especially if assessment is seen as an important part of the learning process. Good quality assessment provides learners with useful feedback on their progress, and helps teachers to get to know learners and to identify the kind of learning support they need. (D6:16)

The Life Sciences CAPS describes three different types of assessments: tests, examinations and project-based (or assignment) assessment. Life Sciences considers both summative and formative assessment (D1; D9; D10). In grade 10 and 11, formal assessment counts for 25 per cent of school-based assessments including the mid-year examination. For grade 12, it counts for the same percentage but including the trial examination. The end of the year examination, in grades 10-12 formal assessment counts for 75 per cent. The formal school-based assessment comprises of tests and/or examinations and practical tasks in each school term. The end of year examination is made up of two written papers and a practical examination. “It is therefore important to include assessment of practical tasks as well as written tasks or tests when planning for assessment” (D10:34). All assessment in CAPS is structured according to Bloom's taxonomy. Weighting of cognitive demands in Life Sciences of content in grade 10, 11 and 12 is shown in Table 5.5:

Table 5.5: Weighting of cognitive demands in grade 10-12 Life Sciences CAPS curriculum

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

The curriculum clearly outlines the proportions of school-based formative assessment and of examination-based assessment, by being explicit in terms of how many tests should be recorded, how many practical activities, examinations and fieldwork (see Table 5.6) are required for school assessment for grade 10 and 11.

Table 5.6: School-based assessment for grade 10 and 11 Life Sciences CAPS curriculum

Formal, recorded, school-based assessment				End of year internal examination (75%)	
Content		Practical		Two written examinations	Practical examination
*Four tests (minimum 50 marks each) *One mid-year examination (150 marks) *One project/assignment (can be done in any term: 100 marks in the fourth term) *Skills are listed under Specific Aims, 1 and 3		A selection of three representative practical tasks which cover range of skills, must be marked and recorded (the marks allocated for a practical task should range from 20 to 40) Specific Aims under skills in described Specific Aim 2		This exam tests knowledge on content, concepts and skills across all topics. Knowledge of practical works as well as some of the skills related to practical work must be assessed in the written examination 80% = 60 marks	This exam tests practical knowledge and skills. This should be set by each teacher taking into account the resources that are available for practical examination 20% = 15 marks
School based assessment (during the year)				75	
Term 1	Term 2	Term 3	Term 4		
*One test *One selected practical task	*One test *One selected practical task *Mid-year examination	*One test *One selected practical task *Environmental studies fieldwork	*One test *One project/assignment		
25%	25%	25%	25%		
Convert to 25%				75%	

Source: D1:67 (for grade 12 assessments see D1:68)

In Life Sciences, two examination papers are written of 150 marks each (D1). The papers to be written, the different topics to be covered and the mark allocation are clearly stipulated in CAPS (D1). For biodiversity, in grade 10, biodiversity and classification taught in term 2 are allocated 10 marks (7 per cent) in paper 2. While in grade 11, paper 2, biodiversity components are allocated 70 marks (47 per cent). Table 5.7 below shows the breakdown of the marks allocated to biodiversity in grade 11. In grade 12, the topic of human impact is assessed in paper 1. The weight for this section in the paper is 25 marks (17 per cent).

Table 5.7: Assessment of biodiversity components in grade 11 (paper 2)

Topic / Term	Weighting	
	%	marks
T1		
*Biodiversity and classification of micro-organisms	20	30 30

*Biodiversity in plants and reproduction	20	
*Biodiversity in animals	13	20
T4		
*Human impact on the environment	47	70

Source: (D1:72)

Emphasis on moderation of assessment is highlighted in the CAPS document. “Moderation refers to the process that ensures tasks are fair, valid, and reliable” (D1: 74). Formal school-based assessment and practical tasks should be moderated by relevant subject specialists at district and if necessary, provincial level, in consultation with moderators at the school in grade 10 and 11 (D1). Grade 12 formal assessment moderation takes place at four levels: school-based moderation, moderation by subject advisors at district level, moderation at provincial level and moderation at the national level (D1).

In the *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets, there are assessment practices linked to the biodiversity content knowledge covered; see an example in Table 5.8 for assessment practices linked to unit one (What is biodiversity? What is marine biodiversity?).

Table 5.8: Linking knowledge to assessment practices (link to unit 1)

Content knowledge section	Section summary	Assessment activity	Key assessment skills (verbs)
Exploring key 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/articles 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)

Source: (D9: 30)

Table 5.8 demonstrates the links that are made in the *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets that teachers received and engaged with in the PLCs. To expand teachers’ capability for assessing biodiversity concepts, the two booklets make direct links between assessment and the content. For example in Table 5.8 it is suggested that to assess key concepts of biodiversity, assessment activities could be based on investigation of a local natural ecosystem. To further expand teachers’ assessment skills, Table 5.8 provides suggestions on the key assessment skills for biodiversity concepts. These are in line with the Life Sciences CAPS curriculum (D1). In the *Teaching Biodiversity* and *Teaching Marine Biodiversity* booklets the assessment methods with linked assessment tools are provided (D9; D10). Among the assessment methods are self-

assessment, peer- assessments, case studies, projects, reports and practical demonstrations. These are linked to assessment tools such as observation checklists, project checklists, report checklists and rubrics (D10; D9). These are to support teachers with compiling and assessing tasks.

Surprisingly, as much as assessment has been reported as one of the critical aspects for quality teaching, it was only a few teachers in Idutywa (DT2I; DT1E) who explicitly noted that they valued being supported on how to expand their capabilities for designing assessment tasks for biodiversity related concepts. This implied a need to be supported with assessment practices that promote high order thinking and critical thinking skills. While one teacher simply noted “I want to learn ... different ways of assessing my learners at school” (DT1E), the other teacher expressed in the interview that she did not know how to allocate marks in assessment tasks, as she said:

There is this thing of allocating marks; I still don't get it right. I hope when I leave this place I will be in a good position to allocate marks when I am setting tests ... now I just take past question papers and cut and paste with already allocated marks. What I do is take a question paper, take this particular question, I know that question 1 is terminologies, question 3 is investigative. That is what I do. But I don't normally count, this particular one falls under knowledge, evaluation, synthesis, comprehension. I do not normally do that, simply because I do not know how to do it. So I am hoping that, at least when I leave this place I will know exactly how to allocate marks ... (DT2I)

The extract from the teacher above emphasised the valued functioning of how to allocate marks. The teacher (DT2I) understood the importance of asking different questions associated with the cognitive levels, but she lacked the competence to analyse and compile the assessment tasks aligned to the cognitive levels. Thus being able to expand her capabilities on allocating marks enhances her ability to design different levels of questions in the assessment tasks. As indicated in Table 5.1, teachers' valued functionings expand their capabilities on developing assessment strategies that will assess learners' high order thinking skills. In the CAPS curriculum this accounts for 15 per cent of assessment tasks (D1). In line with assessment practices, one of the Fundisa for Change partners from the National Department of Basic Education confirmed teachers' lack of capability to compile assessment tasks according to the cognitive levels. She revealed:

Do teachers really understand the difference between formal and informal assessment? Are they able to set their own assessment? We use Bloom's taxonomy across the curriculum. Are they weighting the questions properly in the activities, building the learners up through exams and school based assessment ... We are finding more and more that assessment is a huge challenge for the teachers. PLCs must not ignore those issues. (DP1)

The subject advisor who participated in the Idutywa PLC activities supported her, as he said:

Teachers cannot assess, they just cannot assess properly. So, when you even go and look at their developmental tasks that they do in their schools, they are of very poor quality, you see that they are not developing learners at all ... The type of questions that are asked in the

informal tasks is not a variety of questions that a learner will expect to see in the formal task or examination. So, assessment is very difficult for them, even when you ask them, who will set for us the term test? It is a struggle, when you pick a group of people to set the test, you will struggle to get that task and also with making corrections for the task to be ready, so they really have a problem. So, I think it will help them a lot if Fundisa for Change is able to assist them with assessment. (DP3)

In the Idutywa PLC, the second session focused predominantly on the topic of assessment (DP2; DO2). This was to expand teachers' capabilities on assessing marine biodiversity related concepts in Life Sciences. Assessment discussions were informed by supporting theories like Bloom's taxonomy (D1; D10). The focus was on assessment *for* learning, assessment *of* learning, assessment related to Life Sciences and specifically relating to marine biodiversity concepts (D1; D6). Teachers were not sure how to do assessment *for* learning (DO2). Bloom's taxonomy was used to unpack the cognitive levels to be considered in assessment of Life Sciences: knowledge, comprehension, application, analysis, synthesis and evaluation (D1). Past question papers were analysed to help expand teachers' capabilities on assessment (the different types of questions, knowledge and skills required for each cognitive level). In groups, teachers were given questions from the Life Sciences paper 2, (February/March 2012) to analyse. Focusing on assessment, during the second session there was an excursion to the mangrove forest at the Bashee River estuary. Prior to the excursion, most teachers had not seen a mangrove forest. Teachers did an activity on the excursion (see Appendix 15). For the activity they had to answer the questions, allocate marks, justify what cognitive levels the questions were and develop a marking rubric. Teachers answered the questions but struggled to allocate marks and to compile a marking rubric. Table 5.9 shows the marks allocated by the groups:

Table 5.9: Marks allocated for the assessment activity done by teachers in groups

Question	Group 1	Group 2	Group 3
1	3	4	4
2	2	2	4
3	2	3	7
4	2	1	5
5	5	3	5
6	5	3	4
7	6	6	6
Total	25	22	35

Discussions took place on how and why different marks were allocated by different groups. Emerging from all the groups was that the marks were allocated depending on the amount of time, thinking and information required to answer a specific question. All the groups gave more marks to question seven because it is a synthesis question and requires higher order thinking skills. The marking rubrics were discussed. Emerging from the discussion was that some questions needed to be rephrased. All groups agreed that question three required understanding and application. It also emerged from the discussion that teachers were not sure what CAPS required in terms of allocating marks and designing rubrics.

In Grahamstown, there were also activities focused on expanding teachers' capabilities for assessment practices (GO1). For example, three questions below were discussed. This was to show the type of questions teachers can use to assess learners' understanding of the concepts of genetic diversity and species richness:

1. State two reasons why bio-cultural diversity change has led to a reduction in the genetic diversity in our food. (2)
2. Describe how buying cabbages and spinach has contributed to biodiversity loss. (2)
3. Explain what could be done to reduce the impact of our vegetable foods on the loss of genetic diversity, species richness and natural habitats (biodiversity). (3)

There was a long discussion about the level of questions and the need for rephrasing them (GO2). Teachers did not know the concept of bio-cultural diversity, thus noted that learners would not know it. The questions were then rephrased, for example question one was rephrased to "state two reasons why change in culture has led to reduction in the genetic diversity in the food that we eat"? Teachers shared that learners are usually not able to answer questions that require them to apply their knowledge or that are based on case studies.

In both the Grahamstown and Idutywa PLCs, effective feedback was highlighted as an important component of assessment to motivate and improve learners' performance.

Feedback is a useful component for learning ... in the Fundisa for Change programme we will also consider some examples of 'assessment-in-practice' to work out how to plan for and conduct assessment of environmental learning. We will focus on improving assessment practices in the context of a subject, and its particular environmental topic and content. (D6:18)

It is highlighted in the Life Sciences CAPS document that for both assessment of learning and assessment for learning, regular feedback should be provided (D1). In line with the CAPS curriculum, in Idutywa, emphasis was also made on teachers' self-assessment. The teachers in

Idutywa and Grahamstown recognised that learners struggle with higher order questions, essay questions and the questions on graphs. In Grahamstown, teachers also observed that learners struggle to do calculations in Life Sciences. One teacher said “and I am not a Maths teacher so I struggle with calculations myself” (GT1). Another teacher said, “I also struggle with calculations but I ask Maths teachers for assistance” (GT2). The teachers’ reflections on lack of mathematics skills led to the discussion about teachers inviting mathematics teachers to assist with teaching aspects of biodiversity, especially as they relate to mathematical skills.

5.2.4 Teaching and learning resources

Emerging from the interviews and questionnaires was that some teachers (DT4Q; GT3I; GT1I; GT5I) valued being supported with teaching and learning resources, even in the form of videos. This resonates with D6. This is in line with the Fundisa for Change documents that note that in South Africa there is lack of quality teaching and learning resources for teachers to teach environment and sustainability content (such as biodiversity) (D11a; D11c). The school textbooks generally present information that is unquestioned (D6), while as noted by UNESCO (2014a) environment and sustainability knowledge is still being questioned. The CAPS document also highlights teaching and learning resources as key for effective teaching, thus teachers need to be well resourced; alternatively they should improvise (D1).

In line with teachers’ valued functionings for teaching and learning resources, in the Fundisa for Change programme there are teams of authors who bring together professional teacher education expertise with environmental expertise (D11a). These teams collaborate to develop materials²² with a focus on expanding teachers’ knowledge on the different environmental topics that are in the CAPS curriculum (D11a). In addition to foundational knowledge, pedagogical processes and assessment, the materials also consider progression of learning (D11a). Different modules have been developed. Among them were the ‘generic materials’ that provide a general orientation to assessment and pedagogical practices for environment and sustainability content integrated in various curriculum subjects (D5). The generic materials include three booklets: i) *Introductory Core Text* (D6), ii) *Methods and Processes to Support Change-Oriented Learning* (D7), and iii) *Framing Active Teaching and Learning in CAPS* (D8). Before giving a brief description of these booklets below, it is worth noting that all the individual teachers in the PLCs received a set of these booklets to expand their capabilities for teaching and learning resources, and for content knowledge, pedagogical approaches and assessment practices.

²² These are Teacher Education materials, not classroom teaching and learning support materials but they give teachers access to classroom teaching and learning support materials to be used in conjunction with the textbooks.

5.2.4.1 Introductory Core Text (D6)

Fundisa for Change seeks to support the professional development of knowledgeable and skilled teachers who have the capacity, the will and the interest to teach learners about the world they live in (D6). The Introductory Core Text introduces the Fundisa for Change model consisting of three essential aspects of teaching: i) Knowing your subject; ii) Improving your teaching practice; and iii) Improving your assessment practices (D6; D13).

5.2.4.2 Methods and Processes to Support Change-Oriented Learning (D7)

This booklet “is about methods and processes to support change-oriented learning towards better environmental sustainability practices. The booklet aims to enrich and broaden our methodological frameworks so we can use methods with greater educational intent” (D13:4). The purpose of the booklet is:

- To help broaden the range of methods teachers are comfortable to use;
- To encourage teachers to think more carefully about how to use methods, and the assumptions they hold about learning and teaching; and
- To enrich the methodological framework so that teachers can use different methods with greater educational intent, towards learning and teaching. (D7)

It is indicated in the Fundisa for Change materials that they are not complete; they have to be used in conjunction with other texts for in-depth discussions (D7; D9; D10). The booklet discusses that different learners have different learning needs, thus require different methods for learning (D7). The booklet further notes that a variety of methods are required to address a variety of educational purposes and outcomes (D7). In the booklet, all methods (see Section 5.2.2) are discussed with typical examples, underlying ideas, possibilities, pitfalls, and complementary methods. In addition, references have been given for further reading of each method (D7). It is thus evident that this booklet recognised that teachers need to engage with different teaching methods for teaching biodiversity, and to expand individual learners’ capabilities on biodiversity (see Section 5.2.2).

5.2.4.3 Framing Active Teaching and Learning in CAPS (D8)

The *Framing Active Teaching and Learning in CAPS* booklet has been developed for teacher educators to:

Provide teachers with a simple structure to think through the learning processes associated with a content referenced curriculum. In particular, it suggests that we need to start with literacy of learners, as this helps them to access the content that they are to learn. It also suggests that there is a need for a balanced approach and for knowledgeable teachers to mediate learning. It is therefore a framework that helps us all to think through how to approach a content rich curriculum. It can help teacher educators to orient teachers to the new curriculum and how it is constructed, but more importantly, it aims to share how we teach well within the new curriculum framework. (D8: no page number)

The booklet explains the human social-ecological context and a balanced approach “between an emphasis on teaching to foster knowledge acquisition and learning through participation to construct knowledge” (D8:8 original emphasis; Sfard, 1998). In addition to the generic materials discussed above, the Fundisa for Change programme has produced ‘subject specific’ materials (D11a; D13).

Subject-specific materials provide specific environment and sustainability content knowledge, pedagogical content knowledge and assessment practice as relevant to specific subjects and phases and grades in the South African school system. These are closely aligned and integrated with CAPS frameworks and imperatives. However, the materials work on a CAPS+ approach as they extend the minimum content specified in the CAPS. (D13:3)

The subject specific materials are designed to allow teachers to reflect on the textbooks and their content and to provide teachers with access to additional support materials that they can use to enhance their classroom practices (D13). “Additional materials may be provided where relevant to complement the Fundisa for Change teacher education materials. These may be materials from local environmental organisations” (D13:3). The focus of this study was on the Teaching of Biodiversity (D10) and Marine Biodiversity (D9) for Life Sciences teachers. Thus the only two booklets discussed are the *Teaching Biodiversity* and *Teaching Marine Biodiversity* for Life Sciences FET phase. These two booklets will not be discussed separately as the *Teaching Marine Biodiversity* booklet is based on the *Teaching Biodiversity* booklet and there are many similarities.

5.4.2.4 *Teaching Marine Biodiversity (D9) and Teaching Biodiversity (D10)*

These booklets have been developed to expand teachers’ knowledge and expertise in ways that support teaching the CAPS Life Sciences curriculum for Grade 10-12 (D9; D10). The *Teaching Marine Biodiversity* booklet draws on the *Teaching Biodiversity* booklet but is focused on marine systems (D10). “Marine biodiversity is specific and requires explicit explanations ...” (D10:4). In these booklets “the sections do not follow the sequence of CAPS, instead the progression is from exploring the concepts of biodiversity, the role it plays, the causes of biodiversity loss, and finally, human responses to this loss” (D10:6). The *Teaching Marine Biodiversity* and *Teaching Biodiversity* booklets cover the three main aspects of the Fundisa for Change programme: i) Know your content knowledge; ii) Improve your teaching practice; and iii) Improve your assessment practice (D9; D10; Songqwaru & Shava; in press). The booklets are divided into three learning units (see Table 5.3).

The biodiversity learning units have been developed to support teaching and learning in the Diversity, Change and Continuity knowledge strand of the Life Sciences for Grade 10-12. Most of the content on biodiversity in this Knowledge Strand falls within grade 10 (Terms 3 and 4) and some falls within grade 11 (D9; D10). All the learning units in the booklets cover the content,

teaching strategies as well as assessment strategies for biodiversity (D9) or marine biodiversity (D10). Therefore the Biodiversity booklets aim to:

- Develop and expand content mastery, enabling teachers to gain deep knowledge of the subject, thereby creating confidence in teachers in their ability to teach biodiversity (key concepts, definitions, principles, issues);
- Promote teacher familiarity with the South African Curriculum Assessment Policy Statement (CAPS) for grades 10-12 and its requirements with regard to biodiversity content knowledge and assessment;
- Provide access to other relevant environmental subject content knowledge on biodiversity;
- Expose teachers to possible teaching, learning and assessment approaches associated with biodiversity in order to enable their application in teaching and learning processes;
- Explore biodiversity issues in relation to the local and global context;
- Promote the use of local biodiversity contexts through exploring local biodiversity and engaging the biodiversity knowledge of learners and the local community;
- Raise awareness on environmental issues related to biodiversity; and
- Enable them to develop and re-examine environmental attitudes, values, ethics, practices and educational ends and purposes in relation to biodiversity issues. (Songqwaru & Shava, in press: no page number)

It is thus evident in the description above that the Fundisa for Change teaching and learning resources expand teachers' capabilities and confidence for teaching biodiversity in the Life Sciences CAPS curriculum. This is through expanding their subject content knowledge (with the focus of both local and global biodiversity issues), pedagogical approaches and assessment practices. In addition to the Fundisa for Change teaching and learning support materials, teachers have access to other teaching and learning support materials for biodiversity teaching. Among the teaching and learning resource materials teachers received in the PLCs are Share-Net booklets and field guides and South African National Biodiversity Institute materials (see Section 6.2.2.1).

5.2.5 Other valued functionings

In addition to the new knowledge, teaching methods and assessment practices, teachers valued being confident in their teaching of biodiversity (DT5Q, GT1I, see Table 5.1 and 5.2). They therefore valued gaining confidence in their teaching of biodiversity related concepts. They noted that biodiversity concepts are complex. This is elaborated by two teachers' comments: "the course will effectively improve my knowledge and skills, and as well build my confidence to accurately teach the topic involved" (DT5Q). The other teacher said:

Because really, if you have a problem Sirkka²³ or you are not confident, it becomes difficult for you to go to class. I don't know, but just losing confidence because you know that you are not perfect with what you are going to do. So you add up sitting and not going to class, and you just end up giving learners questions, memos, materials to read something like that, I

²³ My name (the researcher/ interviewer)

know that that is not an effective method, but just because you have nothing else you can do. (DT2I)

It is evident from the data referenced above and in the teacher's interview extract above that lack of teachers' confidence impacts on their teaching of biodiversity. Thus teachers valued being confident by improving their teaching practices related to biodiversity. Teachers also valued being better Life Sciences teachers as shown in Tables 5.1 and 5.2. In line with valued functionings on gaining confidence, the Fundisa for Change partners confirmed that the Fundisa for Change programme valued confident, capable and competent teachers. To make this point, one of the Fundisa for Change partners noted:

The desire is to have confident and competent teachers. Teachers who feel that they can achieve the components of the curriculum ... They don't just read about it from the textbook, that they can feel enthused about the fact that they are capable of teaching that component of the curriculum ... the underlying principle that I enjoy about Fundisa for Change is that the teacher feels confident to achieve the pedagogy, the content involved and also the ability to assess that component. (NP1)

The interview above also indicated that teacher's constrained capabilities can lead to behaviours such as staying away from class to avoid teaching biodiversity components they are not comfortable to teach. This has implications for biodiversity and biodiversity conservation, especially because some of the teachers expressed their valued functioning to conserve biodiversity (see Table 5.1). In Idutywa, teachers' participation in the PLC were also to expand their other capabilities, such as exploring further opportunities to study marine biodiversity. In Cape Town one teacher revealed that his valued being in the PLC was to have a 'good looking curriculum vitae' to maximise his opportunities for employment prospects. This demonstrated that teachers valued beings in the PLC were also to expand their other personal valued functionings.

5.3 Discussion

According to Walker and Unterhalter (2007) people are responsible agents who shape their own learning opportunities. It emerged from this study that in the PLCs, teachers were agents. As agents they were responsible for determining what their valued beings and doings were as they relate to the teaching of biodiversity. This is in line with the policy documents in South Africa (South Africa. DHET & DBE, 2011a; 2011b; South Africa. DBE, 2014; 2015) which note that in professional development activities, teachers should determine their own trajectories. As noted in Chapter One (see Section 1.5) at policy level, this is a shift from professional development models that focus on individual teachers to collaborative learning as a strategy for teachers' professional growth. Many teacher professional development programmes have overlooked teachers' capacity for deliberation and agency; and many do not pay sufficient attention to social structures associated with teacher

professional development (Kennedy, 2011; Steyn, 2013). Such professional development has not made an impact on teachers' teaching practice.

An analysis of the Life Sciences curriculum shows that the biodiversity content is explicitly structured with a specific sequence that needs to be followed (South Africa. DBE, 2011a). The curriculum requires teachers to teach biodiversity content knowledge, values and skills (ibid.). It has emerged that teachers lacked the capability to make links between biodiversity and the content in the Life Sciences curriculum; they therefore valued expanding their capabilities for making those links. The teachers' lack of ability to identify the biodiversity content and concepts in the Life Sciences curriculum was due to their lack of disciplinary knowledge. This was not surprising as most studies in South Africa point to the need to improve teachers' subject content knowledge and pedagogical content knowledge on biodiversity content, skills and values (HSRC, 2010; see Section 1.2; Section 1.4; Section 1.5). These studies found that in South Africa, few teachers fully understand the biodiversity content in the curriculum. Evidence in literature reveals lack of biodiversity knowledge to be a global phenomenon (see Section 2.3.1). This was due to lack of capacity in many teacher education institutions to adequately prepare teachers with sound subject content knowledge and pedagogical approaches for biodiversity teaching (see Section 2.3.1). One of the challenges to reorienting ESD in teacher education institutions is the "lack of or inadequately trained professionals who are knowledgeable about ESD" (UNESCO, 2005:31). This implies a need to build expertise at teacher education institutions for ESD. In some studies this is reflected in students' lack of knowledge on biodiversity (see Section 2.3.1; Chandrasekhar et al., 2012).

Emerging from the study is that the lack of teachers' biodiversity content knowledge is due to lack of or poor teacher education, on-going 'changing' curricula, lack of professional development support and newness of the biodiversity content and concepts. In South Africa, environmental education (encompassing biodiversity knowledge) has been integrated in teacher education programmes (see Section 2.3.1; Le Roux, 2005; Holtman, 2010). These are through postgraduate programmes such as Postgraduate Certificate Courses in Education or as electives in the Bachelor of Honours degree in Education and Master's degree in Education. The integration of environmental education in teachers' pre-service and in-service training courses is to expand teachers' capabilities to work with the environment and sustainability knowledge, such as biodiversity knowledge (Lotz-Sisitka, 2011; O'Donoghue, 2015). As was evident in the teacher interviews, these courses are yet to make an impact on teachers' knowledge, pedagogical approaches and assessment practices for biodiversity teaching, hence the formation of the Fundisa for Change programme and network. This was demonstrated in teachers' lack of competence to work with biodiversity concepts such as biomes, taxonomic keys and the three levels of biodiversity

(species diversity, genetic diversity, and ecological diversity). In international studies, it is evident that the complex interrelationships within the concept of biodiversity have made biodiversity concepts challenging to teach (Navarro-Perez & Tidball, 2012). Many international authors also recognised that the real challenge for biodiversity implementation is that it comprises three levels: genes, species and ecosystems which are not always acknowledged by educators (see Section 2.3.1). Findings from these studies are that biodiversity concepts cannot be reduced to one idea.

As indicated above, failure to capacitate teachers to engage deeply with biodiversity concepts was linked to inadequate training and lack of professional development support. Poor subject matter knowledge and pedagogical content knowledge including assessment practice knowledge among teachers also points to ineffective existing systems such as the Integrated Quality Management System (IQMS) that is aimed at assisting teachers to identify their professional development needs in South Africa. The IQMS has failed to enable teachers to identify their own learning and professional needs and to access opportunities to address these needs (South Africa. DHET & DBE, 2011b). As indicated above, teachers have noted the on-going ‘changing’ curricula (see Section 1.4) as contributing factors to their lack of biodiversity knowledge. The ‘new’ curriculum introduces complex biodiversity concepts that teachers are not trained to teach.

This poses a double challenge for teachers of a) inducting learners into available knowledge/content and concepts (i.e. what we know), and b) teaching learners that knowledge is contested and that the knowledge can change. Environmental content knowledge especially is often contested and in many cases we remain uncertain about the full scope, extent and implications of environmental issues. Environmental content in relation to future sustainability is therefore partially uncertain. (O’Donoghue, 2015: no page number)

It emerged that teacher professional development was often aimed at orientating teachers to ‘new’ curriculum changes such as the CAPS curriculum. This resonates with Reddy (2011) and De Clercq and Shalem (2014) who noted that professional development programmes offered in South Africa are related to curriculum reforms rather than substantive subject knowledge and competence. Teachers in this study acknowledged that CAPS training was done during its implementation phases. A cascading model was used to train teachers on the CAPS curriculum (De Clercq & Shalem, 2014). It is this same cascading model that was used to introduce teachers to Curriculum 2005 (see Section 2.7; Griffin, 1999; Lotz-Sisitka & Janse van Rensburg, 2000). The training was far from adequate, used inappropriate models and methods and focused on introducing complex terminologies in Curriculum 2005 (see Section 2.6; Ono & Ferreira, 2010). The cascading model has thus largely proven to be an ineffective model for professional development; this was also supported by the teachers in this study who described the CAPS training as ineffective as it did not expand their capabilities to meet the curriculum requirements. For teachers in schools to meet the

requirements of the curriculum, professional development activities including pedagogical practices, assessment practices and knowledge need to be examined (South Africa. DBE, 2011b). This was evident in the teachers' valued functionings in this study as represented in Tables 5.1 and 5.2.

Shulman (1986) has proposed seven categories of teacher knowledge: content; pedagogy; curriculum; learners and learning; contexts of schooling; educational philosophies, goals and objectives; and pedagogical content knowledge. In Shulman's theoretical framework, teachers need to master two types of knowledge: content knowledge and knowledge of curriculum development (Shulman, 1986). Content knowledge refers to extensive and in-depth knowledge of the subject matter. According to the *Minimum Requirements of Teacher Education Qualification in South Africa*, teachers need the integrated and applied knowledge that is advocated for good teaching (disciplinary, pedagogical, practical, fundamental and situational) (South Africa. DHET, 2011). The Fundisa for Change programme recognised the different types of knowledge and learning, thus they are core to the programme activities. These are integrated into the Fundisa for Change framework: know your subject, improve your teaching practice and improve your assessment practice (see Section 5.2; Lotz-Sisitka, 2011). In line with integrated and applied knowledge, the Life Sciences CAPS curriculum is associated with the acquisition, integration and application of knowledge (South Africa. DHET, 2011).

It was evident that teachers' valued beings and doings were aligned to the different types of knowledge (disciplinary, pedagogical, practical, fundamental and situational) foregrounded for quality teaching (South Africa. DHET, 2011). For example the teachers' valuing an understanding of biodiversity concepts is evidence of disciplinary knowledge or knowledge about subject matter. The teachers' valuing of links between marine biodiversity and the Life Sciences CAPS curriculum is evidence of valuing practical knowledge. Teachers' valuing different teaching resource materials such as videos suggests the valuing of fundamental knowledge. The simple desire expressed by teachers to 'improve knowledge and skills' (see Table 5.1) implies teachers valued integrated and applied knowledge. It is thus evident that in the PLCs teachers valued the different types of learning and knowledge required for good teaching (South Africa. DHET, 2011).

In the PLC activities, the different types of knowledge and learning were worked with in an integrated way. Thus both subject matter knowledge and pedagogical content knowledge (including assessment practices) were brought into the PLCs (South Africa. DBE, 2015). As indicated above, teachers in the PLCs valued expanding their capabilities to work with the different forms of knowledge in both a theoretical and applied way. As is evident in this chapter, the activities in the PLCs were structured to explore and investigate the core concepts of biodiversity, what teachers did

not know, how they taught what was not known on biodiversity, and how they might work with it in their actual teaching. Teachers showed a great deal of competence in working with some of the biodiversity concepts, especially at the level of definitions, but lacked an in-depth understanding of the concepts. For example, when they defined biodiversity they referred to plant and animal species only, but biodiversity is more than animal and plant species (as reported in Section 5.2.1; see Section 2.3.1; UN Convention on Biological Diversity, 1992).

It is widely accepted that biodiversity education is shaped by pedagogies as much as it is by content (see Section 2.3.1). New on the global education agenda is Education 2030, in which it is stated that “Education 2030 will ensure that all individuals acquire a solid foundation of knowledge, develop creative and critical thinking and collaborative skills, and build curiosity, courage and resilience” (UNESCO, 2015b:2). Biodiversity education is not exempt from this quote. As argued in Chapter Two (see Section 2.3.1), in terms of biodiversity to meet the vision for Education 2030, teachers’ valued functionings highlighted in this chapter need to be translated into capabilities. From the capability approach perspective, for individual teachers to achieve the mentioned valued functionings requires different types of resources. Sen (1999; 2009) argued that individuals differ in their ability to convert resources into doings or beings, thus providing equal resources does not equate to equal opportunities (Walker & Unterhalter, 2007). Thus even though the teachers in this study had similar capability sets, they needed different resources to achieve their same valued functionings (discussed in detail in Chapters Six and Seven).

In line with teachers’ valued functionings related to pedagogical approaches, it is noted that biodiversity education requires learners to engage with local and global biodiversity issues and associated risks (O’Donoghue, 2015). Biodiversity education is also oriented towards socio-ecological change processes; thus learners are often actively involved in conceptualising and preparing themselves for action or engaging in action oriented processes which require particular kinds of pedagogical practices (see Section 2.3.1; Rosenberg et al., 2008; Lotz-Sisitka, 2011; Schudel, 2012; O’Donoghue, 2015). Engaging with active learning approaches requires teachers to engage learners in activities that will allow them to investigate local biodiversity issues and develop an understanding of the global biodiversity context. It has also been argued in Chapter Two (see Section 2.3.1) that biodiversity issues are complex and contested thus require learners to critically engage with them. The challenge for teachers as revealed in this study is to design activities that allow for critical engagement with contested and complex concepts of biodiversity. O’Donoghue (2015) argued that this requires inter-disciplinary approaches to teaching and learning. This explains why the teachers in this study valued expanding their capabilities on pedagogical approaches for teaching biodiversity.

To enable teachers to achieve their valued functionings, as demonstrated in this chapter, the PLC activities examined the range of teaching methods that are recommended for biodiversity knowledge. Among the explored pedagogical approaches were information transfer methods, experiential methods, investigative methods, learning by doing and deliberative methods (Rosenberg et al., 2008). To expand teachers' capabilities, most of these pedagogical approaches were modelled in the PLCs. The focus was on reflecting on methods that are most appropriate to Life Sciences and to the biodiversity concepts, content and context of learning. Therefore as argued in Chapter Two (see Section 2.3.1), the use of active learning, place-based, situated, creative and critical learning approaches were explored. Thus in line with O'Donoghue (2015), the teaching processes in the PLCs looked at an array of different types of pedagogy or teaching methodology. It was evident in the study that the challenge of working with the biodiversity concepts is their economic, political, social and biophysical dimensions (this was, for example, demonstrated in the role play in the Cape Town PLC on how to conserve biodiversity or to build houses; see Section 5.2.2). This resonates with Navarro-Perez and Tidball (2012) who observed that the other challenge for teachers on biodiversity is that biodiversity is surrounded by complex ethical, economic and social issues. The complexities pose problems for teachers (and for the learners they work with) (ibid.). "This implies that in order for people to understand what biodiversity is, they may need to understand what biodiversity means ecologically, culturally, socially or economically and how its loss affects all of these dimensions" (Navarro-Perez & Tidball, 2012:20). It thus emerged that even though teachers in this study were able to identify the drivers of biodiversity loss, they lacked in-depth understanding of the human impacts on the biodiversity loss.

As it has been argued that biodiversity knowledge requires active, critical and creative and situated approaches, environmental education researchers have also argued for assessment practices that will assess learners' high order thinking skills, problem solving skills and critical thinking skills (O'Donoghue, 2015). In line with this statement, it emerged that teachers in the PLCs valued expanding their capabilities for assessing biodiversity content in the Life Sciences curriculum. The valued assessment strategies were those that would enable them to assess and expand learners' high order thinking skills (see Table 5.1). Therefore the PLC activities, especially in Idutywa and Grahamstown, examined and explored different assessment practices that would expand teachers' capabilities for developing tasks that would expand learners' capabilities for higher order thinking skills. Teachers were not clear on what types of assessment would best assess biodiversity concepts and what type of feedback was useful for biodiversity learning.

Mbuyazwe (2011) and Songqwaru (2012) found that Life Sciences teachers struggled to see the relationship between teaching and assessing. Their assessment of learners was not clear, it was

limited to content presented and did not extend to feedback (ibid.). Effective feedback is a critically important dimension of assessment and learning (Fundisa for Change, 2013). Life Sciences CAPS explicitly notes that assessment should cater for a range of cognitive level and abilities of learners. Assessment tasks should be designed to cover the different cognitive levels (see Section 5.2.3). Dalton (2003) suggested that Bloom's taxonomy was useful for the field of ESD in order to ensure that learners have an opportunity to not merely understand and evaluate something but also to be able to create concepts, principles and procedures that will benefit others. It was a concern that teachers did not express their valued functionings for assessment practices with the same interest as with the valued beings for content knowledge and pedagogical approaches, especially when the South African diagnostic report showed that learners were unable to answer middle and high order questions (South Africa. DBE, 2013b). With this type of evidence, teachers need to take seriously their lack of capabilities to assess biodiversity aspects in the curriculum. The assessment practices should expand learners' capabilities to answer higher order thinking skills and promote critical and problem solving skills. Otherwise emancipation and transformation will not happen (see Section 2.3.1).

In South Africa, teachers have indicated that there was a need for teaching and learning resources to enable their teaching of biodiversity aspects in the curriculum (Lotz-Sisitka, 2011; Mbuyazwe, 2011; Isaacs, 2015). This was evident in the teachers' valued functionings (see Tables 5.1 and 5.2). As discussed in Section 5.2.4, the Fundisa for Change programme provides teachers with high quality teacher education resources to help teachers improve their teaching practices and become confident and knowledgeable teachers. The teaching and learning resources consider the different types of knowledge required for competent teaching (disciplinary, pedagogical, practical, fundamental and situational) (South Africa. DHET, 2011). The materials are aligned with the teacher education policy and critically engage with the "complex dynamics of the curriculum knowledge brought forth by the changing nature of knowledge and the associated social-ecological conditions which produce the needs for engaging with such forms of knowledge" (Lotz-Sisitka, 2011:55). Teachers thus engaged with these materials and with the classroom based teaching and learning support materials they were exposed to in the PLCs to enable them achieve their valued being knowledgeable for biodiversity teaching. This is in line with the capability approach: resources are means, but not intrinsic ends, of human well-being (Walker & Unterhalter, 2007).

It is evident that teachers valued being educated, which is a capability (Sen, 1999). However Sen also acknowledged that education is a capability that can expand other capabilities (ibid.). To support this, it emerged in the study that some of the teachers' capabilities to be educated on biodiversity were of instrumental value. Teachers valued being educated and this also fulfilled an

instrumental role to help achieve their other valued functionings such as expanding learners' capabilities and the community's knowledge on biodiversity. Teachers' capability to be educated was also part of expanding their personal valued functionings such as having 'good looking' curriculum vitae and their valuing of being better and more confident teachers.

5.4 Conclusion

The aim of this chapter was to discuss the teachers' valued beings and doings that were found in the PLCs as they relate to biodiversity teaching. It emerged that teachers' valued beings and doings were to expand their capabilities for biodiversity teaching. Their valued functionings indicated a need to expand both their theoretical and practical knowledge which are in line with the Specific Aims of the Life Sciences curriculum. It was also evident that the teachers' valued beings and doings were in line with the Fundisa for Change framework that aims to improve teachers' content knowledge, pedagogical practices and assessment practices. These were engaged with in the PLCs to allow teachers to achieve their valued beings and doings. However, even though the teachers had similar capability sets, as individuals they required different inputs to shape their learning opportunities to achieve their desired comes in the PLCs. The next chapter will therefore discuss the conversion factors in the PLCs that allowed teachers to achieve their valued functionings related to the teaching of biodiversity.

Chapter 6: Conversion factors associated with teachers' valued beings and doings

6.1 Introduction

The previous chapter discussed the teachers' valued beings and doings as they relate to their teaching of biodiversity. This chapter answers the research questions on what conversion factors, structures and agencies were associated with the functionings in the PLCs for teachers' professional development. The chapter discusses how the identified conversion factors enabled or constrained teachers' capabilities to achieve their valued beings and doings in the PLCs. The conversion factors discussed in this chapter are analysed in line with the Fundisa for Change teacher education programme. The chapter thus also starts to answer the research question on how can, and does, a continuing professional development programme act as a conversion factor that expands and/or constrains the functionings in the PLCs.

6.2 Conversion factors

The capability approach sees resources as the means but not the intrinsic ends of human well-being (Walker & Unterhalter, 2007). This means that the capability approach looks at the relationship between what people have and what they can do with what they have. Individuals differ in their ability to convert resources into beings and doings (Sen, 1999; 2009). Thus providing equal resources does not equate to equal opportunities (ibid.). The conversion factors dictate how much use a person can get out of the resource (Robeyns, 2005a; Walker & Unterhalter, 2007). To echo the capability approach here, even if the teachers in the three PLCs had similar valued beings and doings (as discussed in Chapter Five), in order to achieve those valued beings and doings, they needed different support to achieve their valued functionings. As observed, it was confirmed in the teachers' interviews and evaluations that in the PLCs there were personal, environmental and social conversion factors (Robeyns, 2005a) that allowed teachers to achieve their valued functionings. The Fundisa for Change programme was a conversion factor in itself that provided further conversion factors that enabled teachers to achieve their valued beings and doings in the PLCs. Some of the conversion factors in the Fundisa for Change programme are captured in the quote below:

The Fundisa for Change programme is a carefully designed, facilitator led, interactive professional development programme that has a strong structure but with opportunities for teacher participation, practical and reflective engagement with concepts, approaches and ideas, informed by teacher professional development research and best practices. (D13:2)

Evident in the quote from the Fundisa for Change document above is that the programme provides a structured programme which is carefully designed and facilitated in an interactive way. The

programme provides opportunities for teachers to participate and engage practically and reflectively with the concepts and approaches informed by teacher professional development ideals. The emphasis on research informed ideals is in line with the documents from the Departments of Basic Education on PLCs that maintains that PLC activities should be based on teaching and learning based research (D2; D4; D14). The good facilitation, support structures, interactive activities, and collaborative spaces were revealed by teachers as some of the conversion factors that allowed them to achieve disciplinary knowledge and to acquire new skills and pedagogical approaches for effective teaching of biodiversity. The conversion factors that allowed teachers to convert the available resources into valued functionings will be discussed below.

6.2.1 Personal conversion factors

6.2.1.1 Individual teachers' profiles

As mentioned in Chapter Four, there were 15 teachers who participated in the study. These teachers had different qualifications and experiences, as listed in Table 6.1 below:

Table 6.1: Teachers' qualifications and experiences

Teacher	Qualifications	Years of experience
PLC 1		
DT1	Secondary Teaching Diploma, Diploma in Educational Management, Bachelor of Education	5
DT2	Bachelor degree in Agriculture and Economics and Postgraduate Certificate in Education	1
DT3	Bachelor of Education	4
DT4	Bachelor of Science in Biological Science	5
DT5	Bachelor of Education	20
DT6	Senior Teaching Diploma, Bachelor of Arts and Bachelor of Education Honours in Educational Management	20
PLC 2		
GT1	Secondary Teachers Diploma, Advanced Certificate in Education, completing Bachelor of Education, Honours in Education	6
GT2	Secondary Teachers Diploma, Bachelor of Education	20
GT3	Secondary Teachers Diploma, Advanced Certificate in Education, Short computer course, Bachelor of Education in Information Communication and Technology	8
GT4	Secondary Teachers Diploma, Advanced Certificate in Life Orientation, enrolled for Bachelor of Education in Life Orientation	28
GT5	Bachelor of Science, Postgraduate Diploma Certificate in Education, Bachelor of Education Honours, busy completing a Masters in Environmental Education	7
PLC 3		
CT1	Bachelor of Science (Human Life Science) and a Postgraduate Certificate in Education	Less than a year
CT2	Bachelor of Science (Botany and Zoology), Higher Diploma in Education, enrolled for an Advanced Certificate in Education	12
CT3	Higher Diploma in Education, enrolled for Advanced Certificate in Education	28

CT4	Bachelor of Technology in Education, enrolled for Advanced Certificate in Education	9,5
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According to the Life Sciences CAPS curriculum document and the ISPFTED (2011-2025), teachers should be qualified to teach (D1; D2). It is evident in Table 6.1 that the teachers in this study were qualified. Even though in some cases, the teachers only mentioned the general qualifications and not the specialisation (which would determine whether they were all specifically qualified to teach Life Sciences), it is evident that except for one teacher (DT4), the teachers had at least one or more qualifications in the field of education. The qualifications varied from a Senior Secondary Teaching Diploma in Education to a Bachelor of Education Honours degree. Teachers had different specialisations i.e. Information Communication and Technology, Education Management and Life Orientation. Some teachers had Bachelor of Science degrees with majors in Biological Sciences, Agriculture and Economics and Human Life Sciences. As is evident in Table 6.1, at the time of the research, some of the teachers were still studying. In the Grahamstown PLC, one teacher was enrolled for a Bachelor of Education degree and another was busy completing her Master's degree in Environmental Education at Rhodes University. In the Cape Town PLC, three teachers were in their second (final) year of the Advanced Certificate in Education course at the University of Cape Town. None of the teachers in the Idutywa PLC were studying, but as mentioned in Table 5.1, two of the teachers' valued functioning was to explore opportunities to study further in marine biodiversity.

Evident in Table 6.1 is that most teachers were very experienced. Of the 15 teachers, 13 teachers had five years of teaching experience or more, with five teachers having 20 or more years of teaching experience. There was a good balance between the very experienced teachers and the less experienced teachers in the three PLCs. This allowed for new teachers to learn from the experiences of the experienced, for example, on the effectiveness of tried and tested teaching resources (D14).

One Grahamstown teacher said:

What we did there, we looked at the textbooks we are using in our schools, so that the other teachers can say, I am using textbook series, and *Focus* is good when you are teaching an eye. And the other teachers will say I am using *Understanding* and questions in *Understanding* there are very good questions for the learners. So we interchange our textbooks also. (GT1I)

The experienced teachers learned from novice teachers' new ideas and pedagogies that they may not have been exposed to in their initial training (D14). It was observed that three teachers brought enthusiasm and understandings of the use of Information and Communication Technologies into the PLCs (GT3I; DT5I; D14). Thus, having a combination of experienced and inexperienced teachers

in the PLCs were personal conversion factors that enabled teachers to achieve their valued functionings.

As mentioned in Chapter Four (see Section 4.4), the interest of the study was Life Sciences teachers thus as indicated in the interviews, all the 15 teachers were teaching Life Sciences. Most of the teachers were also teaching Natural Sciences; a few were teaching other subjects such as Physical Sciences (CT2I) and Isixhosa (GT4I). For Life Sciences, most teachers were teaching grades 10 to 12 (GT2I-GT5I; DTII - DT6I; CT3I; CT1I; CT4I). A few exceptions were teaching either grade 10, 11, 12 or a combination of any of the two grades (GT1I; DT6I; CT2I). Some teachers (CT1I-CT3I; DT1I; GT5I) explicitly noted that they were passionate about Life Sciences. It is the passion and enthusiasm that informed their participation in the PLC activities, and their interests in expanding their capabilities for teaching and in achieving their valued functionings of supporting and developing learners with an interest in Life Sciences and particularly in biodiversity (see Table 5.1).

Two teachers from Cape Town said:

Life Sciences, especially this biodiversity type of thing, this is my first love of all time, this is where my qualification is, I mean I did BSc even though I am teaching Physical Sciences. I did Botany and Zoology majors, which means I am qualified as a Life Sciences teacher. But because of the need ... I started teaching Physical Sciences as well. Now I am trying to get back in the Life Sciences because I want to do that. (CT2I)

I have been teaching for about 28 years, in the same field – Life Sciences and Natural Sciences, which I really enjoy because that is where my passion really lies. I am qualified to teach in that field ... I always make sure that I know a little bit more about the learners so that I can excite them about the things that we do. So I am willing to make sacrifices, I could go home and go sleep, but I choose not to. (CT3I)

As shown in CT3I's extract above, it was evident in some teachers' interviews (DT3I; DT4I; DT6I; GT1I; GT2I; GT5I; CT4I) that participating in the PLC activities involved personal sacrifices. The choice of participating in the PLC activities was prioritised above other valued doings such as going home to sleep. "If you want to achieve something you need to make sacrifices ... because you are benefiting from the activities ... you get an opportunity to share teaching approaches and to see that you were not doing it right" (GT2I).

As discussed earlier, teachers indicated in the interviews that their individual experiences were personal conversion factors that either enabled or constrained their capabilities in the PLCs. The teachers who had fewer years of teaching experience acknowledged their lack of subject content knowledge as constraints to their full participation in the PLC activities. For example, one teacher in the Idutywa PLC had one year of teaching experience. She noted her lack of experience as a personal conversion factor that constrained her understanding of some of the biodiversity concepts.

She thus acknowledged the experiences of the more experienced teachers as conversion factors that enabled her to enhance her pedagogical content knowledge related to biodiversity teaching. She expressed:

Especially for me, I am new in teaching. Some of the things, I have never heard about them at school or at university. So I didn't know how to deal with them, even practicals ... some of the things are just very difficult for me to deal with. I did Agriculture and Economics. But in PGCE, you are obliged to do Agriculture and Life Sciences, which I was not that familiar with. I wanted to take Agriculture and Economics ... there are difficult concepts in Life Sciences that it becomes difficult to present when you don't understand them. So there were colleagues helping me or showing me what the concepts mean and how to teach them it then it becomes easier to understand them. (DT2I)

The above clearly demonstrates how one teacher (DT2I) admitted her lack of knowledge for scientific concepts. The extract further demonstrates how the structure of the education system contributes to teachers' lack of disciplinary knowledge. The *Minimum Requirements for Teacher Education Qualification* outlines the subject combinations that teachers can specialise in for different qualifications in Education (South Africa. DHET, 2011). The extract from the Idutywa teacher above also reveals that individual teachers were able to acknowledge the experiences of other teachers as personal conversion factors that enabled them to achieve their valued beings and doings. Three teachers in Grahamstown (GT2I; GT4I; GT5I) also revealed in their interviews that as individuals they drew on their experiences to contribute to the PLC activities: "there were certain sections where I was strong and I could contribute. And it was not only me who was participating, there was somebody else obviously knowing a certain aspect more than me ..." (GT5I). "We were discussing our problems ... in one part of the syllabus I am strong; in the other topic I am poor" (GT4I). "I shared my ideas and benefited by receiving ideas from the other teachers because we were talking about our experiences ... how you deal with different kids, the learners these days don't want to learn, that is our main problem" (GT2I). While one teacher in Cape Town said "I was sharing what I know and learning new things from others. This equips me with knowledge on how to teach the topic and how to approach it" (CT4I). The other Cape Town teacher noted:

I am quite willing to help and if I was not in that group, I just give them whatever notes I had or experiences I have. In Fundisa for Change only three of us were teaching Life Sciences. At some schools the principals did not go to the science teacher. At my school, my principal brought it to me; he knew that I was involved with biodiversity. One teacher was panicking because she knows nothing; she is not in science ... always messaging me. (CT3I)

The above quotes confirm what was observed in the PLCs: due to the different experiences and qualifications, the levels of pedagogical content knowledge were different. As teachers who were teaching FET Life Sciences, they needed to have an in-depth understanding of the Life Sciences syllabus for conceptual progression (D1). However, it was observed that in all the three PLCs, some

of the teachers were not familiar with the grade 10 subject content, especially if they were only teaching grade 12 (DO1; DO2; CO1; CO2; GO1-GO3). This was confirmed by the two facilitators in the Idutywa PLC, as they reflected:

In as far as knowledge of the teachers is concerned, I think they came at different levels ... And what I observed was that, not all of them actually knew what the content was for the grade 10. As teachers who are teaching Life Sciences I feel that, they need to know exactly what is happening in the syllabus of the Life Science so that they are able to see the links between the content in the three grades as well as the progression of content from one grade to another ... what is taught in grade 10 lays the foundation for understanding what is taught in grade 11. (DP2R)

I might be judging everybody on the few, but there were definitely some who were battling ... but it makes a difference when people have that feeling that they are enabled to say, I do not understand ... people were able to express themselves ... it could be because of the community of practice, it could be because they were not threatened by their subject advisor, it could be because of the way we presented, let's all have a part in this ... that in itself made a difference were everybody was contributing. I did hear one of the teachers saying, we all participated. I did try to make sure that we don't have dominance ... at the end everybody had a voice somewhere along the line. Everybody has given an indication of how they will move forward. (NP1R)

It is evident in the extract above (NP1R) that even though teachers had different capabilities and understandings of biodiversity knowledge, the PLC was characterised by inclusivity where all teachers were able to comfortably express their challenges and difficulties (D14). Inclusive membership is one of the attributes of effective PLCs (D14). This resonates with what was observed in the PLCs: that teachers were treated equally and their opinions were respected. This was evidenced by one Fundisa for Change partner who noted “we as facilitators we still stress that element of us being colleagues, we are in the same situation as teachers and we don't want them to look at us as knowledgeable because there are also things that they know that we don't know so we learn from them” (UP2R).

Apart from their differences in qualifications and experiences, the teachers in the PLCs were of mixed genders (except in Grahamstown where all teachers were females but there were male facilitators and the subject advisor who attended was male). Teachers in the PLCs also differed in terms of their age groups, positions and cultural backgrounds. The facilitators ensured that all perspectives were valued by creating a conducive environment for all to share their opinions and views (D14; see extract from NP1R and UP2R above). A good example was in the Idutywa district, one teacher was a principal (DT6) but his position was not prioritised above the other teachers. He had equal opportunities to share and raise his opinions (DO1; DO2). The same applied to the subject advisors who participated in the PLC activities (DO1; DO2; GO1-GO3). Their opinions

were not necessarily more valued than the teachers' opinions, thus inclusivity provided an enabling environment for all teachers to participate in the activities. What was also observed to be a real enabler (as signalled in the extracts from NP1R and UP2R above) were the facilitators' constant reminders that all were learners and the PLCs were a space for sharing.

6.2.1.2 Effective facilitation skills

Effective facilitation is critical in PLCs (D2; D13; D14). This requires someone who is experienced and who is trained to facilitate the PLC activities (D2; D14). The Fundisa for Change programme is based on a partnership model (D5; D11a; D13) and includes partners from the department of education, the environmental sector and the institutions of higher education facilitating the PLC activities (D11a). "We think it is a successful model as it combines professional teacher education expertise with environmental sector expertise and provincial/district level of Department of Basic Education expertise. This allows us to combine the best of our expertise in ways that bring quality training to our teachers" (D11a:2). As indicated in Chapter Four (see Table 4.1), there were different facilitators in the PLCs. In the Idutywa PLC, the facilitators were from the environmental sector, Department of Basic Education and institution of higher education. In the Cape Town PLC, the facilitators were from the environmental sector and the institution of higher education. In the Grahamstown PLC, the facilitators were from the institution of higher education but there was a subject advisor who was a participant. All the Fundisa for Change partners confirmed that the facilitators had participated in the Fundisa for Change training of trainers' workshop where the facilitators were taught to facilitate the PLC activities (D5; D13).

In the interviews and evaluations, teachers (DT41; DT3I; DT3E; DT4E; DT6E; CT3E; CT1I; GT1I; GT2I) described the facilitators as knowledgeable, well trained, very helpful, accommodating and very supportive. Some teachers, for example, noted "the facilitator helped in elaborating or explaining what assessment is and the different forms of assessment, she emphasised that knowledge is not the only thing that learners need to acquire, this will have an impact on my teaching" (DT3E). "The facilitators were good; the activities were well presented and extremely useful. Relevant issues and topics were raised" (CT3E). "I think the way the facilitators deliver the lesson, everything was good for me, and I really enjoyed the training" (GT4I). "The facilitators were all really welcoming, well trained and helpful" (CT1I). These teachers thus noted good facilitation as a personal conversion factor that enabled them to achieve their valued functionings in the PLCs. Teachers (GT1I; GT2I; GT3I; CT1E; DT1I; DT4I) also valued the level of confidence in the facilitators and were keen to realise this in their own teaching. One Grahamstown teacher revealed in an interview:

The way the facilitators presented, I want to be like them presenting that topic, so I had to try it, so that it drives me also... as a team, each and every facilitator; they just stand up boldly

and do. Usually when we go to other workshops, the facilitator is just fumbling, he does not know but you guys, you stand there, each and every one when he or she stand up to present something it just becomes clear. So even with us, when we listen and look at you we just have that thing that I am going to try that. Even if you have some hiccups to do that, so that really motivates us, the way the facilitators were presenting. (GT1I)

The extract from the Grahamstown teacher above, reflects good facilitation as exemplary for the teacher's own teaching of biodiversity. The Fundisa for Change partners (NP1; NP2; UP1; UP2; UP4; DP3; DP4) also praised the good facilitation in the PLCs. They noted that the facilitators had good facilitation skills; they were experienced, knowledgeable, passionate, and enthusiastic and open to criticism. Thus, the Fundisa for Change partners noted the role of the facilitator as enabling in the PLCs. One partner, for example, noted:

So the facilitation obviously has come out as being a very important aspect of the Fundisa for Change course. That the choice of the facilitator and ensuring that one choses them carefully as well, that there are people who have expertise of working with teachers and do that in the kind manner, and who can model different methods even in how they facilitate. That is also very important. (NP2)

Echoing the teachers, the facilitators (NP1; UP1; UP2; DP2) noted that they saw themselves as lifelong learners who were willing to learn and share their experiences. One of the Fundisa for Change partners who recognised his role as a facilitator in one of the PLCs commented:

Having facilitators that are knowledgeable about what they do, I think that is one aspect. Even from the teachers' comments, they were very vocal about having those facilitators that seemed to know their stuff ... I did a session on biomes and I brought in an element of using technology which I think schools that are struggling when it comes to funding can use to bring reality to the classroom. (UP2R)

The extract from the Fundisa for Change partner above introduces the importance of using technology in the teaching of biodiversity. Teachers in Grahamstown and Idutywa were excited about the use of video clips (GO2; DO2). They noted video clips had been social conversion factors that expanded not only their conceptual knowledge on biodiversity, but also their capabilities of using technology in the teaching of biodiversity (evident in Chapter Seven). Some teachers noted that their schools were limited in terms of resources (GO2; DO1; see Chapter Seven). They would therefore not be able to use video clips in their realisation of that achieved functioning. As noted earlier (see Table 4.1), there were different facilitators in the PLCs. They recognised the various facilitators as enablers with regard to the PLC activities because of their different expertise (D11a; D13). One of the facilitators of the Idutywa PLC said:

It does make a difference having more than one facilitator ... what was really good for us, was that ability to have different people presenting at different times, bringing in different components, your videos really made a big difference, the people were really able to enjoy

them but they can't stand alone ... at no stage was there any disagreements in a way that anyone was presenting something and I think a reason for that is because nobody at any stage was taking a personal involvement ... It was just really putting it forward in the educated manner that says, these are the problems, this is the concern, these are the reasons for biodiversity loss, and these are the responses. (NP1R)

Implied in the above extract is the facilitators' professionalism and mutual respect for each other and for the participants (this resonates with comments from D2 and D14). The Fundisa for Change coordinator participated in all three PLC activities. In relation to the facilitation of the PLC activities, she also confirmed that good facilitation acted as an enabler with regard to the teachers' valued functionings. She noted that in the Idutywa and Grahamstown PLCs, personal conversion factors included the participation of the subject advisors in the activities. She noted the absence of the subject advisors in the Cape Town PLC as a real constraint to teachers' capabilities for pedagogical content knowledge. The Fundisa for Change coordinator particularly observed that if there was a subject advisor present in the Cape Town PLC, the assessment aspects of biodiversity in CAPS would have been strengthened. She maintained:

Fundisa for Change is about having the NGO, Department of Basic Education and partners from higher institutions at the training ... these people have different experiences and expertise that might strengthen what ultimately happens. For example I think if we had the Department of Basic Education in Cape Town, I think more of the assessment aspect would have been highlighted in terms of what the expectations and requirements are and that would have had an influence on what was covered and how the content was dealt with ... from the discussions they tried to get the department but did not manage and the training needed to be done. So sometimes we work in spaces that are not ideal, you might want to have these people but because of other engagements are unable to make it. (UP1R)

Emerging from the extract from the Fundisa for Change coordinator is the possibility of not always getting all the facilitators for the PLC activities as wished. The absence of one or more representative (from the Department of Education, institution of higher education or environmental sector) in the PLCs was a potential constraint to teachers' capabilities for pedagogical content knowledge. In the Grahamstown PLC, there was no representation from the environmental sector; however the Fundisa for Change coordinator noted that two of the facilitators in the Grahamstown PLC had many years of experience working in the environmental sector (UP1R). These facilitators were still actively involved in some of the environmental sector activities (UP1R). They therefore had up to date biodiversity knowledge which is the major component that the environmental partners contribute to the PLC activities (D11a; D5). The facilitator from the Idutywa PLC, who supported the Fundisa for Change coordinator, commented on the significant role of the subject advisors in contributing to the PLC activities:

The support from the Eastern Cape Life Science subject advisors ... sitting in on the course really made a significant difference, not only were they feeding into the whole process and

giving appropriate commentary that is possibly locally significant, but also just helping to strengthen the significance of the course. [name withdrawn] have been involved with Fundisa for Change, she gave the support and brought in the CAPS component very nicely and was able to address it ... when we were going through the marine biodiversity unit, they did highlight one or two concerns that were ambiguous in the writing ... They have a greater understanding than the teachers did. (NP1R)

The extract above points to the contribution that the subject advisors made to the PLC activities, not only with their deep understanding of the CAPS curriculum, but also with regard to the situational knowledge required for teachers' practice (South Africa. DHET, 2011). The ability of the subject advisors to bring in pedagogical and practical and fundamental learning that involves learning in context made the learning in the PLCs relevant and meaningful. This points to the importance of having diverse expertise and experiences in the PLC (D14).

Facilitators were observed to be innovative and creative, which ultimately supported teachers to achieve their functionings for improved pedagogical content knowledge. For example, it was observed in the Cape Town PLC that to engage teachers with the concept of biomes, the facilitators' brought plant specimens to the training venue (CO1). The plant specimens were taken from a range of biomes to demonstrate the characteristics of the biomes and the adaptations of different plant species. To engage teachers with the same concept of biomes in the Grahamstown and Idutywa PLCs, video clips were shown (GO2; DO2). The intention was to expose teachers to alternative methods for teaching biodiversity concepts. This was especially important in situations where preferred methods such as conducting fieldwork were difficult. The Fundisa for Change coordinator noted that innovations of the facilitator enabled PLC activities:

... the other thing that I liked in Cape Town was that they also showed that even if you cannot go to a place, you can bring stuff in the classroom because when they did the different biomes, the facilitators pre-picked the plants and brought them to the training venue. So I think the innovation of the facilitators in terms of knowing what they want to cover and in terms of purpose ... good preparation is another thing, the capacity of the facilitator to be innovative and creative is key. (UP1R)

As noted in Chapters One and Five, the Fundisa for Change framework focuses on subject content knowledge, assessment practices and teaching practice (D6; D13). It was observed that in the Cape Town PLC, the focus was mainly on subject content knowledge, not how to teach or assess the subject content. The Fundisa for Change programme tries to support different types of knowledge: subject content knowledge, pedagogical knowledge and assessment practices (D6; D13; Lotz-Sisitka, 2011). The different types of knowledge are required for teachers' capabilities to engage with the integrated types of knowledge in their actual teaching of biodiversity components in the CAPS curriculum (D1; Lotz-Sisitka, 2011). The Fundisa for Change coordinator noted that the

facilitators had completed training of trainers (D5; D13), therefore they were familiar with the Fundisa for Change framework and the programme objectives and should have made better links between the content knowledge, pedagogical and assessment practices. “They should be linked in terms of: you have to choose a topic, than you have to teach it and then you have to assess it” (UP1R). This would expand teachers’ capabilities on how to teach and assess the biodiversity content (D6).

As noted earlier, the absence of the subject advisor might have contributed to the lack of emphasis on assessment in the Cape Town PLC activities. As previously mentioned, good facilitation has been noted as a personal conversion factor that enabled teachers to achieve their valued functionings in the PLCs. However, one of the facilitators in the Grahamstown PLC expressed that there was still a need for facilitators to reflect on how to deal with the complex nature of environmental learning knowledge in the way that does not simplify it. She explained this further:

I think the good facilitation; I am not sure we have achieved this. I think what we need to achieve as facilitators, me being one of them, is how to deal with this complexity in a way that does not simplify but at the same time does not overwhelm. Getting that balance, I think that will be enabling, if we are to get that balance where we do not set the benchmark so high that we lose the teachers, I think finding the balance is more of a challenge than an enabler, but it would be an enabler if we can achieve it. (UP6)

Emerging from the extract by UP6 above is that for facilitators to effectively support teachers with biodiversity concepts, they need to be reflective about their own practices. The above extract confirms why some of the teachers (and this will be discussed in Chapter Seven) still noted a need for on-going support with some of the biodiversity concepts engaged with in the PLC. The South African policy documents on PLCs recommend on-going PLC activities (D2; D4; D14).

6.2.1.3 Participation of the subject specialists

Linked to effective facilitation skills discussed above was the presence of the subject specialists in one PLC. Unlike in the Grahamstown and Idutywa PLCs, subject specialists were invited to the Cape Town PLC activities. The subject specialists were six postgraduate students from the Biological Sciences department of the University of Cape Town (see Table 4.1). The students were enrolled for their masters and doctoral degrees in Zoology and Botany. In Zoology, four presentations were given and these focused on phylogenetic classification of organisms; taxonomic classification of organisms; diversity of species; and genus and species (CO1). In Botany one presentation on plant phylogeny was given, where different types of plants were discussed i.e. moss, liverwort and ferns (CO1). The chlorophytes, charophytes, bryophytes, monocots and dicots were discussed and the differences between angiosperms and gymnosperms (CO1). Even though these concepts are part of the Life Sciences curriculum (D1), these links had not been made in the

Biological Sciences students' presentations. However, despite the scientific skills and amount of content knowledge provided by the postgraduate students, the facilitators in the Cape Town PLC and the Fundisa for Change coordinator observed that teachers could have benefited more from them. The facilitator maintained:

In terms of the university I thought that some of the hands-on stuff that they experienced were useful and I think their knowledge was enriched by being able to interact with the actual scientists, people in the field ... however, the constraint I think was, trying to expose them too much academic content, that in my opinion was limiting. I think we could have done better if we could have done less. It is important to have that input, the specialist input, but you need to somehow think about it. (UP4R)

The Fundisa for Change coordinator seemed to support him as she reflected:

As much as we need expertise in terms of content, because that is one of the things that have been highlighted in South Africa in terms of research ... the reason why teachers are unable to teach or are unable to assess is because they don't have enough content of their subjects, so subject content knowledge is very important. But having said that, even if we are specialists from biological sciences or marine biologists that also should be within the context of the school curriculum ... as much as we would like to cover big scientific concepts, situate them in terms of what needs to be covered in the curriculum, as much as we want teachers to know more than the curriculum ... still should be situated in the curriculum not something up and above the curriculum. (UP1R)

The quotes from UP4R and UP1R confirm what was observed in the Cape Town PLC (CO1). There were no links made between the presentations done by the subject specialists and the curriculum. The facilitator in the Cape Town PLC noted that in future he would define the roles of the subject specialists more clearly:

I have already thought about it, next time I will certainly spend time revising what kind of input they are going to provide rather than just providing the Science input. They were given the curriculum documents and I spoke to the coordinator that these are the topics we want you to focus on, and I want you to do this but I think they got excited. You could see they are very passionate and were just trying to put their story across ... but sometimes you need to highlight this and there I think I could have done a better job, I needed to guide that a little more, in the future that is what will happen. (UP4R)

He went on to say:

That did not work well as intended ... Science is always a good experience to get in the laboratory so that they are doing scientific investigations. Science is not a content subject, it is very practical. If you look at classification of plants, angiosperms and gymnosperms, ferns and moss, one needs a magnifying glass to look at the reproductive structures and all the concepts there ... then you make links, if you have a particular focus. Then you bring in the sustainability issues and other issues which forms the basis of Science or what we are trying to achieve ... you are learning about how things are related and about the actual morphological structures and adaptations, then you have the experience of explaining evolution of plants ... how they adapt to water, then you can explore climate change and its impacts ... it is a

beautiful space to work in, and on the other hand you go and work in the bush get another experience ...

The extract from the Cape Town facilitator is in line with the *Specific Aim 2* of the Life Sciences CAPS curriculum (D1). The Specific Aim notes that Life Sciences involves practical work and investigations (D1). The postgraduate students brought in diversity in the PLC which enriched the teachers learning experiences (CT1I; CT2I). The document on the guidelines for PLCs in South African schools also supports diversity within a PLC to create and stimulate the learning environment (D14). The subject specialists were able to draw on their research and experiences (CO1). Drawing from research is highly encouraged for PLCs to ensure the knowledge shared in the PLC is valid and up to date (D1; D2; D14). Two teachers in the Cape Town PLC noted that the activities done by the postgraduate students expanded their capabilities of teaching biodiversity as they noted “besides Kirstenbosch, we were in the laboratory, the Zoology department, that I really enjoyed very much, that is what we need, activities they showed us, were actually very nice activities” (CT2I). The other teacher noted:

I have always felt uncomfortable teaching about plants. I found them incredibly boring but Fundisa for Change made it really fun for me so I could make it fun for my learners as well. Seeing in the laboratory the different kinds of plants, going back to school is what I did. Of course I did not have all the plant specimens that they had there, I had some pine and some leaves. The learners could look at them. I was really interested to know about the topics after the Fundisa for Change. (CT1I)

6.2.2 Social conversion factors

6.2.2.1 Access to teaching and learning support materials

As mentioned in Chapters One, Two and Five, quality teaching and learning support materials are rare in South Africa (D2; D6; D13; D14). Thus in addition to the expanding teachers’ knowledge mix in the PLCs, teachers’ valued different knowledge resources. This valued functioning is in line with the Fundisa for Change objectives and policy documents to support teachers with teaching and learning support materials (D5; D11a; D11b; D14); thus the teachers were given these materials, which were mainly developed by the Fundisa for Change programme (see Section 5.2.4). The Fundisa for Change materials are designed to articulate with, and to allow teachers to reflect on textbooks and their contents and use in their classrooms (D13). The materials are also designed to provide teachers with access to additional learning support material that can support classroom practice (D7; D9; D10; D13).

In the three PLCs, many teaching and learning support materials were used to help teachers achieve their valued beings and doings related to the teaching of biodiversity and the Fundisa for Change materials were also used (D6; D7; D8; D9; D10; CO1; CO2; DO1; DO2; GO1; GO2). Furthermore,

resource materials from local organisations were used to complement the Fundisa for Change teacher education materials (D7; D9; D10; D13; CO1; CO2; DO1; DO2; GO1; GO2). To expand teachers' situational knowledge, local case studies and materials collected from the local environmental organisations were used (D13; CO1; CO2; DO1; DO2; GO1; GO2). For example, to unpack the concept of biomes in the Cape Town PLC, posters from the City of Cape Town with the local information on biodiversity were used (CO1). Most of the teaching and learning support materials used were determined by the activities. For example, in the Idutywa PLC, field guides were used to identify the marine ecosystems and the marine species (DO1); and in the Grahamstown PLC a wetland study tool kit was used for a wetland study to identify microorganisms (GO1). In the Cape Town PLC South African Biodiversity assessment reports were used to discuss the levels of endemism and endangered species in South Africa (CO1).

The Fundisa for Change teacher education materials in the PLCs were further used to engage teachers with different methods to teach biodiversity (D6; D7; D9; D10), to engage with the content or concepts on biodiversity or marine biodiversity (D6; D9; D10; see Section 5.2.4) and to expose teachers to different assessment practices (D6; D8; D9; D10; see Section 5.2.4). Thus teachers indicated in their interviews and evaluations that the teaching and learning support materials used in the PLCs were enablers to their expanded capabilities of teaching and assessing biodiversity (DT1I-DT6I, DT2E; CT1I, CT3I, CT3E, CT1E, CT4E, GT1E-GT4E). Two teachers, for example, said: “the materials provided were very effective especially during the activity time” (DT2E) and “I got to understand the importance of using local resources to teach biodiversity” (CT3E). On the use of teaching and learning materials in the PLC, the Fundisa for Change coordinator noted:

The Idutywa and Grahamstown facilitators predominantly worked with the Fundisa for Change modules ... But with the Cape Town one, they did not necessarily work with the Fundisa for Change modules, but the activities that they did covered the concepts that are specified in Fundisa for Change module, so also the interpretations, how the facilitators interpret what they do and what they want to do also influence the way the training is run ... (UP1R)

It is evident in the extract above that the facilitators in the PLCs worked with the Fundisa for Change materials but in different ways. Teachers received most of the teaching and learning support materials (see Section 5.4.2) to use in their actual teaching. Teachers acknowledged the resources received (DT3I-DT5I; CT1I; CT1E; GT1I). For example one teacher in Cape Town noted in the evaluation “yes, I got a book on teaching methods, a lot of activities and resources like posters that I can use in class” (CT1E).

The two teachers from Idutywa and Grahamstown PLC expressed in their interviews:

We have been given a lot of materials which I think will go a very long way to assist us as far as our teaching is concerned. However, if only some of these materials we have been led through during this workshop were in the form of videos or audios ... I did a course in which I am trying to integrate technology in the classroom, trying to avoid old methods of teaching, going to the chalkboard and using the textbook all the time ... using new methods which will make the learners more interested in whatever is happening in the classroom. I started using the projector, so if I can have some of these materials in the form of videos and audios I can project them, it makes the lesson so interesting, and it also assist in making the lesson faster and quicker. (DT5I)

There is a T-sheet and a small booklet on assessment used by the facilitators that is very good. We never did that in any of the workshops. Looking at the assessment first and then you know how to prepare the questions for your learners; you know how to prepare your lesson, so I learned that from Fundisa for Change. They taught us about the assessment and I am making use of that assessment booklet that we got. Even the biodiversity book we got at Fundisa for Change, I am using it when I am teaching. They are very useful. (GT1I)

The quote from GT1I starts to demonstrate another outcome from the capability enabled: developed agency to use the teaching and learning support materials used in her actual teaching of biodiversity. All the teachers thus indicated that the use of teaching and learning support materials were social conversion factors that enabled the capabilities for biodiversity teaching. Facilitators confirmed the use of different teaching and learning support materials as enablers in the PLCs. Supporting the teachers with the resource materials received, the subject advisor who helped facilitate the Idutywa PLC activities reflected “one other thing that I liked about the training is that the teachers were provided with materials which they could use in their own classrooms so that they can enhance learning and teaching of learners in their classrooms” (DP2R). Supporting her, one Fundisa for Change partner noted “the materials that we provided to the teachers those that were coming from Fundisa for Change and extra materials they got, they were thankful” (UP2R). However, another facilitator in the Idutywa PLC expressed that teachers received many teaching and learning support materials but most of the materials were not engaged with, in the PLC. She thus noted that teachers might not be able to use some of the received resource materials to realise their achieved functionings. She said:

There was a lot of resource material ... we don't get to work sufficiently with all those resources. I don't know if the teachers have gone through them sufficiently and I particularly go back to the lady who did the assignment, she did not show any indication of having drawn on the resources given to her ... yes we want to make sure that they have a lot of resource material, but it does worry me, how much of those resource materials will be looked over again. But our assignments will hopefully make them look at them a little bit more. An improvement could be to not necessarily have many course materials and maybe to engage a little bit more with the course materials. If we had time where we get groups to work

specifically with course materials ... it is a balancing act, do we spend more time on assisting the teachers engaging with the resource materials? (NP1R)

The facilitator's response suggests a lack of agency from the teachers to work with the teaching and learning support materials in their actual teaching. Signalled in the facilitator's response is also that time was a social conversion factor that constrained in-depth engagement with the teaching and learning support materials in the PLC. The extract from UP1R also suggested that the constrained capabilities could be reconciled with more time available for the PLC activities. As discussed in Chapter Five, teachers are expected to submit an assignment upon completion of the PLC activities (D13). Part of the assignment allows teachers to develop lesson plans, subject dialogues, their own resource materials, and to teach a lesson on biodiversity related concepts (see Appendix 7). These activities require teachers to use more than simply their textbooks; thus the facilitator was hopeful that even though some of the materials were not engaged with in the PLCs in detail, teachers would be able to draw on them to complete certain aspects of their assignments.

6.2.2.2 The doings and beings in the PLC

In all three PLCs many activities were done (D13; CO1; CO2; DO1; DO2; GO1; GO2) which teachers found relevant. As one Cape Town teacher said "the activity on picture building I think was brilliant and will work well in class" (CT1Q). One Grahamstown teacher said "with classification of animals, the way it was done. I still remember that activity, were you had to classify and put animals together, the reptiles and so on. It was one of the first activities we did ... I learned a lot" (GT2I). The approaches used were also acknowledged by the teachers, as one Grahamstown teacher said, "what was happening is we were looking at how to approach this topic" (GT4I).

According to the policy document on guidelines for establishing PLCs in South African schools, among the other roles, the facilitators' role is to facilitate discussions, participate in the discussions, and support teachers to identify gaps in their understanding (D14). In this way, the facilitator provides content to the PLC, guides the process of inquiry and contributes to the community building process and supports discussions (D14). In line with the roles of the facilitators it was evident in the teachers' interviews and evaluations that in all the three PLCs, the facilitators provided opportunities and controlled environments for the teachers to participate in the activities. As observed, teachers had indicated in the interviews that the PLCs allowed them as individuals to raise questions, answer questions, make presentations, share own views, and express their professional needs. For example, one teacher from Grahamstown noted: "my role was to participate, ask questions and answer if I could and if I had knowledge in what was being done" (GT1I). A teacher from Cape Town noted: "I benefited a lot because all the questions I had have been

answered. Participating in the different activities made me understand and helped me gain more knowledge” (CT4I). As a collective, teachers engaged in group activities, debates, discussions, mind mapping, role plays and presentations. Teachers’ participation in the PLCs was confirmed by all the facilitators. The Fundisa for Change coordinator also noted “teachers were asking questions, participating actively in what we are doing and showing interest, doing the practical activities and other activities, sharing and presenting” (UP1R). In line with the Fundisa for Change facilitators guide (D13) in the Cape Town PLC, teachers got opportunities to develop and present lesson plans in groups and as individuals (CO2). The aim was to strengthen their lesson plans for their actual teaching (D13). It was thus evident in the teachers’ interviews that the PLC provided a collaborative environment for them to learn about biodiversity. One of the teachers in the Idutywa PLC noted:

It was good to interact with others in a controlled environment, the training itself and the facilitators’ positive encouraging manner. We got time to discuss issues, especially the challenging topics. You get time to express yourself to your colleagues how you feel about a particular topic or how you should go about that particular topic. So Fundisa for Change has granted us an opportunity to share the information we have with you the facilitators including my colleagues as well. When we go back to our clusters or schools, there is something that we can give feedback on. (DT4I)

The extract from the teacher above is an example of what some teachers in the Idutywa and Grahamstown PLC (DT1I; DT3I; DT6I; GT3I; GT5I; GT11) noted in the interviews. The quote signals another outcome of the expanded capability: the sharing of achieved functionings with other teachers who were not part of the PLC activities. This implies an extension of the PLC. In the extract from DT4I there is evidence that in the PLCs, teachers shared the difficult biodiversity concepts and how to teach them. This was further reflected in the interviews of (DT1I; GT4I; GT5I; GT2I; CT1I). “Especially the activities on biodiversity, I think it is a problem. Even that human impact because it is new to grade 11 ... so some of the teachers do face problems teaching it. Even in this group there is a teacher from a neighbouring school, I go there to help him teach this topic” (DT1I). “And with classification of animals, the way it was done. I still remember that activity, were you had to classify and put animals together, the reptiles and so on. It was one of the first activities we did. And the one where we went to the wetland ... I learned a lot” (GT2I). Teachers (GT1E-GT4E) noted in the evaluations that the methods and approaches used were appropriate, thus enabled them to achieve their desired functionings in the PLC. “What was happening is we were looking at how to approach this topic” (GT4I). “We also had a field trip, we went out and observed water, some plants and animals and also those presentations that were done there by different people they have benefited us a lot” (GT3I). Commenting on the activity that was done to unpack the levels of biodiversity (see Section 5.2.1), one teacher from Cape Town noted in his

questionnaire “the activity on picture building I think was brilliant and will work well in class” (CT1Q).

As noted in Chapter Four, teachers were given opportunities to reflect on their learning and teaching practice related to biodiversity. Reflections were done individually and in groups. Some of the reflections allowed teachers to note biodiversity related concepts about which they needed further clarity. For example, at the end of the second session in the Idutywa PLC, one teacher still lacked the capability to teach the concepts of: marine trophic levels, ethical consideration for marine biodiversity, responses to biodiversity loss (DT4R). One Cape Town teacher needed further support with the concepts of ecological niche, ecosystem services, desertification, overexploitation (CT3R) (see Chapter Seven). The teachers’ reflections (DT1R-DT6R; GT1R-GT3R; CT1I; CT3R) allowed for learning. For example, in the Idutywa PLC, teachers indicated that they lacked knowledge on the different marine ecosystems and hence excursions were conducted to the marine ecosystems (DO1; DO2). In the Grahamstown PLC, following teachers’ reflections, more activities were done on the dichotomous key (GO1; GO2).

In the evaluations, teachers (DT2E; DT4E; DT5E; DT6E; CT1E; CT3E; GT2E; GT1E) described the PLC activities as developmental, fruitful, relevantly defined, well planned and conducted and focused on what was needed to improve their teaching practices. As some teachers wrote “relevantly defined course” (DT5E). “The course was developmental in my profession, well planned and conducted” (DT6E). “The course was well presented and extremely useful. Relevant topics and issues were raised (CT3E). “This was a very fruitful workshop I have ever attended because I am new in teaching and never attended a workshop that equipped me with teaching skills and filled content gaps”(DT2E). “This shows us how we can improve our teaching (how to teach)” (GT2E). “The course was fruitful for me, I gained a lot” (GT1E). It was evident in the teachers’ interviews that their participation in the PLCs were personal conversion factors that enabled them to achieve their functionings. For examples, two teachers from Cape Town and Grahamstown PLC commented:

The activities we completed also gave me a good idea of how to set up and carry out a field study which is something I am planning to do with the future grade 10 classes ... I participated in the form of student; I received a lot of new valuable information I have since used in my teaching. I also felt free during the course to ask questions and make statements. (CT1I)

Fundisa for Change participants are all learners, they are engaged with the lesson. Sometimes you do not engage your learners because you think you want to finish the syllabus. But ... now I know I will be able to go with them step by step ... We were involved with activities ... sharing our ideas and experiences, benefiting and learning from the facilitators as our mentors. (GT2I)

It is evident in the extracts above that the teachers' participation in the PLC activities were conversion factors to achieving their valued beings and doings. The extract from CT11 points to developed agency to conduct fieldwork. Confirming what teachers noted, the facilitators recognised that the PLCs provided a conducive environment for social interactions. As one of the Cape Town PLC facilitators noted:

The strategies used were not too advanced ... I think most of the activities that engaged them were things that they could realise, the expectations were not beyond their abilities, the approaches used in introducing the scientific concepts made it really accessible and that was very useful to them. Working cooperatively, engaging in activities, developing resources as a collaborative rather than as individuals was useful, and another enabler is that they had a lot of materials that they could work with. (UP4R)

What is evident in the extract above is that the choices of pedagogies used in the PLCs were relevant to the teachers' needs. The extract from the Cape Town facilitator reveals that collective agency was an enabler for teachers valued functionings related to the use and development of the teaching and learning support materials in the PLC. He thus confirmed teachers' participation as personal conversion factors that enabled teachers to achieve their valued functionings. Another Fundisa for Change partner also confirmed the teachers' participation in the PLC activities as enablers to their valued functionings. He reflected on the Idutywa and Grahamstown PLCs:

The enabler was the freedom that teachers had in terms of participation. Some of them did not shy out they shared that yes I had a problem with this particular concept and I am thankful at the end of the training that my knowledge on it improved. So that freedom among the teachers, even when they were discussing ... in fact in most instances they worked in groups and you could see they help each other ... they were free to share their ideas, free to express themselves and I think that helped them learn better. (UP2R)

He went on to say:

In the trainings, as much as we are facilitators we still stress that element of us being colleagues, we are in the same situation as teachers and we don't want them to look at us as knowledgeable because there are also things they know that we don't know so we learn from them. You are never fully knowledgeable, there are still gaps and you can learn from the group that you are training that also opens up freedoms of expressions.

The extract from the Fundisa for Change partner confirms that learning in the PLC happened through the social interactions. What is also evident in the extract is the element of respect for each other's opinions and freedom of expressions. This was confirmed by the subject advisor who participated in the Grahamstown PLC activities:

What I really really, really appreciate and you can take this as a compliment; we didn't have an attitude of "we know it all". From day one, we were part of the discussions and whether the presenter was in front or not, everybody was sharing. I really enjoyed that we all as a collective community were working towards a particular topic or concept. Stay enthusiastic, stay committed ... (DP4)

Evident in the extract from the subject advisor is that there was evidence of working together towards a shared practice in the PLCs. The subject advisor also confirmed full participation of teachers in the PLC activities to be a conversion factor for their functionings. He noted the hands-on activities to have been a conversion factor to the teachers learning about biodiversity. He also recognised his participation in the PLC activities as he expressed:

The teachers really enjoyed it ... They were hands on and they were participating, talking and sharing. Everybody was opening up and talking about their experiences ... I also participated in all activities. To learn, to broaden my own views, to share my knowledge and experiences ... I think I achieved to show the teachers that, although I am a departmental official, I am also still a teacher; I am also still a learner. They don't have to look at me in that manner, you are a departmental official, and what are you doing here? I was showing them, whatever position we are, we are still willing to learn. So I don't think even my teachers that were there, look at me with that same amount of fear, I think I have managed to breakdown some of the walls. (DP4)

As indicated by the teachers, in the above extract the subject advisor also confirms teachers' participation and sharing of knowledge and experiences in the PLCs. Emerging from the extract is also that a relationship was developed between the subject advisor and the teachers. The subject advisor had expressed that teachers are not always willing to open up and share their professional needs outside the PLCs. Teachers fear being judged for their poor pedagogical content knowledge. But it emerged in the study that inclusivity in the PLCs allows teachers to express their professional needs freely (see Section 6.1.2.1). To comment on the beings and doings in the PLCs, the Fundisa for Change coordinator observed another enabler in the Idutywa PLC as the links that were made between the content and practical activities. She noted:

The other thing that I liked about the Idutywa one is that what was covered in the content part in terms of classification, was actually played out in the practical task, where they had to do classification and then they did ecosystems studies and then what was covered in terms of the concepts was actually covered when they did the activity. Because sometimes you will find that there is no conceptual progression in what is being taught we cover content in different in isolation without seeing that they are linked, so I liked that, and I hope the teachers also managed to see that ... incorporating the concepts they did in the practical activities. (UP1R)

Life Sciences require both theoretical and practical knowledge (D1). Thus the element of integrating practical knowledge with theoretical knowledge raised by the Fundisa for Change coordinator was a conversion factor for teachers. Teachers in the PLCs (DT2I; GT3I; GT1I; CT1E) have stressed their lack of capability to conduct practical activities (see extract from DT2I in Section 6.2.1.1) of this chapter). The extract from the Fundisa for Change coordinator further revealed the evidence of fundamental learning and situational learning in the PLCs (South Africa. DHET, 2011). However, she commented on the approach used to engage teachers with the concept of classification in the Cape Town PLC. She maintained that the activity could have been done differently to be an enabler to teachers' knowledge and classification skills, by saying:

In Cape Town ... when they covered classification ... what would have been valuable is if the teachers themselves classified the organisms instead of having them classified already as it was done in the botany department. To actually give the teachers the species to create their own keys and classify to practice so that they know how they will do it with their learners. Already when they got to the venue, everything was put in groups and classified ... I would have preferred to be engaged in the classification process, even if it was done by the facilitators but being available to see how it was done ... so definitely the skills were not developed or acquired by the teachers in terms of how to practically classify, especially if there are people who are still not comfortable teaching classification. So that is something I will recommend that rather allow the teachers to work with the classification tools as the Grahamstown did having the species there and doing the classification, or the Idutywa people did collecting all the species and then how do you then classify. (UP1R)

Evident in the extract above is that there are different methods that can be used in teaching biodiversity. However, it is up to the teachers and the facilitators to choose the type of methods that could be more appropriate to engage with certain biodiversity concepts. The Fundisa for Change coordinator noted a need for facilitators to reflect with other facilitators on the PLC activities. This will allow for reconciliation of constrained capabilities in the PLCs, as facilitators will learn and share best practices. She noted:

What will be important is to ask the facilitators to reflect not only on what happened in the training in terms of writing a report but reflect on themselves in terms of their own practice, this is what I have done, and I think I could have done this, what could I do differently. But also to enable them to reflect on their own practice and write about it so that it can be shared when we run the training of trainers ... so that we can learn from each other. From that engagement we can also share best practices and say based on what have come out of all these different experiences, people can develop. (UP1R)

As noted in Chapters One and Five, the Fundisa for Change framework aims at improving teachers' content knowledge and assessment practices (D6; D13). In the Idutywa PLC, the focus of the first session was on the subject content knowledge and pedagogical practices, while the second session focused predominantly on assessment practices (see Appendix 14). In the Grahamstown PLC, there was a balance between content knowledge, pedagogical and assessment practices in all the sessions. In the Cape Town PLC, assessment was an add on, and that was covered on the last day of the PLC activities. One of the facilitators in the Idutywa justified why the chosen model was used in the Idutywa PLC:

I do believe that one needs a certain amount of prior content before going into assessment ... doing the methods beforehand allows to say, if you are having this content, what type of teaching methods can you use for your teaching, you could ask what type of assessment would you use to achieve this. But there is also a bit of a strategic plan that I have added into this. It is because if you have a second component, were you want to encourage the teachers to participate ... is to include the component that they really feel they would like to benefit from. Anyway both could work, you can do both the assessment, the content and the methods and

not in the depth that you want, and you do them again in the second session just strengthening what was done in the first session, so there is an argument for both sides ... the portfolio of evidence is asking the assessment in the last section ... So the planning was also facilitated by the assignment. (NP1R)

Implied in the above quote is that teachers valued beings and doings on assessment and the Fundisa for Change assignment structure determined the model used for training. Here, I argue that with the high enthusiasm and motivation observed from the teachers in that PLC (Idutywa), they would have attended the second session irrespective of the focus. However, it was evident that the subject advisor who helped with the facilitation and the Fundisa for Change coordinator were not in support of the model used in Idutywa PLC. Their views were that all three components (content, pedagogy and assessment) were supposed to be dealt with in all sessions. This would enable teachers see that assessment is integral to learning and teaching (D1; D6; D13). The Fundisa for Change coordinator maintained:

That model does not work for me. Assessment should determine the methods that you use for teaching and the content that you will be covering. So if you do not know what you will be assessing or what the assessment will be covering then how do you chose which methodologies to work with. So I think for me all three aspects, content methods and assessment should be covered on the daily basis throughout the training, they should not be worked with in isolation. For instance if you are looking at one particular concept already how will you teach that concept, how will you assess it. (UP1R)

The above extract demonstrates the need to integrate the three components (subject content, pedagogical practices and assessment practices) in an integrated way; this is in line with the Fundisa for Change documents (D6; D13).

6.2.2.3 Policy context

Fundisa for Change works closely with policies (D5; Lotz-Sisitka, 2011) and institutions of higher education engage in research that informs the Fundisa for Change programme activities (D5; D11d). This is encouraged by the ISPFTEd (2011-2025) (D2). The Fundisa for Change partners (UP6; NP1; NP2; UP3; UP1; DP1) indicated that as a collaborative they have worked together on defining the curriculum requirements. They recognised that the teachers are busy and do not want add on, they value professional development programmes that link to the curriculum that they have to teach. As one partner said “Fundisa for Change professional development ideals are good. They are linking to the CAPS curriculum, teachers don’t want any adds on ...” (UP3). Another partner noted “linking to the curriculum makes teachers confident and competent in their teaching. If you want a competent teacher within the sections of the curriculum you link it with what they are asked to teach” (NP1). However, some of the Fundisa for Change partners observed that the on-going curriculum changes in South Africa are a challenge (see Section 1.4; Section 5.2.1; Section 5.2.6).

Teachers had different interpretations of the curriculum and its demands. One Fundisa for Change partner from the institution of higher education noted:

The curriculum is now more prescriptive and the democratic processes, openness, no longer possible because of different levels of accountability and curriculum shifts. Rather than becoming more democratic and open to teachers to make change and initiate change, paradoxically it became actually more centrally controlled. Even though the rhetoric of the policies was saying site based management, was the order of the day, the exact opposite seemed to be the reality of practice, and still is. (UP3)

The extract from UP3 demonstrates that the structure of the CAPS documents is a social conversion factor for teachers' capabilities in the PLCs. In the ISPFTED it is noted that the PLC activities should include curriculum orientation activities, e.g. activities to develop understanding of, and the ability to use, the curriculum and policy statements (D2; D3). It was observed that in the Grahamstown and Idutywa PLCs, the use of CAPS curriculum documents were enablers to teachers' valued functionings. In the Cape Town PLC, the CAPS documents were not explicitly used, but were referred to in some of the activities. This was confirmed by one of the facilitators in the Cape Town PLC "the content was aligned with their curriculum and obviously they got the approaches and resources that they can use" (UP4R). It was, however, observed that in the Grahamstown and Idutywa PLCs, at the beginning of the PLC activities teachers were not confident in using their CAPS documents. As the activities unfolded in the PLCs, teachers were able to refer to their CAPS documents (DO1; DO2; GO1; GO2). This was confirmed by the facilitator who reflected "they did not understand the CAPS requirements and that to me that was a concern" (NP1R). According to teachers, this is because they did not receive adequate training on using the CAPS documents (see Section 5.2.1). As one teacher in the Grahamstown PLC maintained:

Fundisa for Change ... So what they brought in obviously did help in terms of understanding what this environmental learning in CAPS is all about. They did a better job in making us understand CAPS better. If I were to compare what happened in our CAPS training ... to me they did a much more solid job than the CAPS training and with what have happened before so that developed me professionally. (GT5I)

The above extract demonstrates an outcome of the expanded capability: working with CAPS documents and increased professionalism. This confirms the aim of PLCs (D2; D3; D14). In the Grahamstown and Idutywa PLCs, teachers used the CAPS documents for the activity on progression (GO2; DO1). Teachers noted this activity had enabled their capabilities with regard to working with the CAPS documents and their understanding of conceptual progression. As one Idutywa teacher noted:

There is progression of knowledge which some of the teachers did not notice, even me. But when we came to Fundisa for Change, we got to know that there is progression. So now if I

take a policy document and look, I will see and say okay, here there is progression but it is not clearly shown, but is progression. (DT11)

In the Idutywa PLC, teachers also used the CAPS documents to analyse CAPS in relation to assessment of biodiversity (DO1). This activity further enabled teachers to expand their capabilities of assessment practices required in Life Sciences in terms of Bloom's taxonomy (D1). CAPS further enabled teachers to make links between marine biodiversity related concepts and teaching methods. For example, CAPS was also used to justify the use of fieldwork and investigation methods to investigate local ecosystems (GO1). The Fundisa for Change coordinator noted that the alignment of policy to the PLC activities was a social conversion factor that enabled the PLC activities. Linking the PLC activities to the CAPS curriculum allowed teachers to see the significance of the activities. She noted:

It is important to have the textbooks and curriculum documents there so that they see the relevance of what the problem is doing that we are trying to enhance what you are already doing. If you don't bring that and make it explicit, look at the curriculum, look at the textbook and then compare that to what has been covered in the module, then it will not enable the teachers see the relevance of the training ... they might take the module, go back home, put it on the shelf and not work with it ... (UPIR)

Evident in the extract above is the emphasis on using the curriculum documents and textbooks. The Fundisa for Change coordinator also noted that the Fundisa for Change programme responded to the Work-Integrated Learning policy framework:

In the *Minimum Requirements for Teacher Education*, one of the essential learning that teachers are required to do is what is called Work-Integrated Learning. What that means is that, teachers should learn from their own practice, reflect on what they have done, or learn from observing other teachers teaching. So with Fundisa for Change, through those interactions and dialogues ... we are addressing this issue of work integrated learning. (UPI)

The extract from the Fundisa for Change coordinator is in line with the policy documents that highlight that teacher education programmes should implement innovative mechanisms that support meaningful Work-Integrated Learning (D2; D3; South Africa. DHET, 2011). Through the Fundisa for Change applied assignment that teachers needed to complete as part of the PLC activities, Work Integrated Learning was encouraged. The assignment allowed teachers to be observed by their colleagues, and through the process to reflect on their teaching practice (D13; see Appendix 7). According to the Fundisa for Change facilitators' guide, facilitators in the PLCs should encourage collaborative lesson planning in a form of a lesson study approach (D13). The process of collaborative lesson planning was observed in the Cape Town PLC, but as indicated by the Cape Town facilitator it was a challenge for teachers to implement and reflect on the lessons in a collaborative way. This was because they were teaching different subjects, grades, phases and the topic at different times (see the facilitators extract in Chapter Seven, Section 7.3.1). In line with

policy, the Fundisa for Change programmes are endorsed by South African Council for Educators (SACE) and can lead to the accrual of professional development points on successful completion (D2; D3; D14; SACE, 2008; Lotz-Sisitka, 2011).

6.2.2.4 Timing and duration of PLC activities

Time was most prominent on everyone's list of challenges for PLCs (D2; D3; D4; D14). If teachers find PLCs a valuable activity, they will invest time in it. However, if PLCs are to make headway beyond the very motivated, it is crucial that the education system makes time for teachers to participate in such activities (D2; D3; D4; D14). Adequate time should be formally scheduled in the school timetables for teachers to participate in PLCs (D2; D4; D14).

Consideration should be given to adjusting the schooling week in order to have longer teaching time per day to free up professional development time once a week (e.g. 25 minutes per day could free up an hour and 40 minutes per week for dedicated professional development activities). Alternatively or in addition, use could be made of part of the 80-hour allocation Education Labour Relations Council resolution (such as one hour per 36 of 40 schooling weeks). If and where it may be deemed absolutely necessary to take teachers out of school during term or exam time, then substitute teachers must be made available. (D3:81)

After-school hours and weekends are unsuitable times for offering professional development (D4). Thus dedicated staff development time should be identified in the school calendar (D4). In line with the policy documents on PLCs, it emerged from the teachers' interviews and evaluations (GT11; CT3I; CT3E; CT4I; DT2E; DT4I; DT5I; DT5E) that time was mentioned as the main social conversion factor that constrained teachers' in-depth understanding of some of the concepts, pedagogical and assessment practices. To reconcile this constraint, teachers expressed that more time could have been provided on some of the activities (GT11; CT3I; CT3E; CT4I; DT2E; DT4I; DT5I; DT5E). It was also observed that when some of the activities took a much longer time than allocated, other activities had to be cut short (CO1; CO2; DO1; DO2; GO1; GO2). This was reflected in the comments from the teachers and the facilitators; they all noted time as a constraint to the activities. "There was a lot of content to learn. More time was needed for some of the activities. It gave me limited time to focus on new terms" (CT4E). "There are more areas that needed to be discussed into more detail" (DT5E). "I believe we could have touched more things in details but we were worried about the schedule" (DT2E). One of the Cape Town facilitators also confirmed that time was a social conversion factor to teachers achieving their valued functionings. He commented:

Most of the things we did at SANBI was fine ... it was well thought through and it was coherent but I just felt at UCT we could have gotten more out of it ... you want better than that, and you need to manage it carefully, a better alignment ... time is part of the problem, so I will also have to think about reorganising the time, where we are doing it and how we are doing it. (UP4R)

The Idutywa teachers took days off school to participate in the PLC activities. This was because of the distances between the schools and the PLC venue. The Grahamstown and Cape Town teachers had to attend on weekends starting Fridays after schools (see Table 4.1 for dates of PLC activities). Some of these teachers (GT1I; CT4I; CT3I) noted that the timing was not convenient; they were tired and unable to fully grasp some of the concepts. They maintained that insufficient time had constrained their full achievement of their valued functionings. One teacher in the Grahamstown PLC did not value attending the PLC activities on Sundays: “but I did not like the Sunday attendance because I am a church member” (GT1I). She also noted in her evaluation “we attend after school tired and is only two days with many concepts to learn” (DT1E).

As mentioned in Chapter Four, some teachers were unable to attend some of the PLC sessions. This was mainly because of other personal valued functionings. This was supported by the subject advisor who participated in the Grahamstown PLC activities. He noted that as adults, teachers had other personal functionings that sometimes prevented them from attending to their professional or occupational functionings. He noted:

You are working with adults, and you are working with people that are already in the profession that have its own constraints. It is very difficult to find a day that suits everyone. It is very difficult to get teachers to come every time, because irrespective of them being teachers, they also have commitments in their own schools and in their own families. They are not full time students, so that is going to be your biggest problem. I would say don't change anything that you are doing ... If you are excited, they will be excited to come irrespective of the problems at home. We had two funerals on that first day, so, there will always be these other external factors. (DP4)

Evident in the extract above is also that responsibilities at schools are possible constraints to teachers' participation in the PLC activities. However the document on guidelines for PLCs in South Africa (D14) advocates for PLCs at school level; this could contribute to teachers' valued beings and doings, especially if the document stipulated that the PLC activities at school level would be scheduled in the timetable (D14). This could be an enabler for teachers' participation in the PLCs. However, the extract from DP4 also reveals that the personal conversion factors within the PLC (i.e. enthusiastic facilitators) can be an enabler that will motivate teachers to sacrifice their other personal and occupational functionings to participate in the PLC activities. It is likely that external factors will always hinder the participation of teachers in the PLC activities.

6.2.3 Environmental conversion factors

6.2.3.1 Collaborative learning space

The PLCs “provide spaces where teachers share innovative ideas with experienced teachers and where experienced teachers mentor young teachers. This stimulates teachers to interrogate and re-

invigorate their practice rather than to recycle old ideas” (D14:7). In view of the above quote on what PLCs are or what type of learning should be happening in the PLCs, it was evident from the teachers and facilitators that the PLCs were collaborative spaces that enabled teachers to achieve their functionings (see Section 6.2.1.1). The Fundisa for Change coordinator noted that the PLC activities brought teachers together from different schools according to phases and subjects. She further maintained that bringing teachers together in the PLCs enabled teachers to share their knowledge and experiences, as she said:

We train teachers according to phases and subjects ... So when we bring them together, we are building relationships ... you might be coming from different schools, but you are teaching the same content, same grade. So this is an opportunity to share ... teachers had discussions; how have you been teaching biodiversity? What challenges have you been facing ... Where were you getting the support? We created a platform for teachers to share their experiences and what they have been doing before we could engage them; we see where the need is to support them. (UP1)

As noted in Chapter Four (Section 4.4), in contrast with the Fundisa for Change PLC model, in the Cape Town PLC, teachers who participated in the activities were teaching different subjects and phases. One of the facilitators (UP4R) in the Cape Town PLC noted that even though some teachers were not teaching Life Sciences, biodiversity concepts were integral to the Advanced Certificate Course they were enrolled for (see Section 6.2.1.1). The teachers’ participation in the PLC activities would therefore expand their science skills and their biodiversity knowledge (UP4R). The teachers (CT2I - CT4I) in Cape Town thus recognised the PLC activities as part of their Advanced Certificate Course. The Fundisa for Change coordinator maintained that involving teachers in the PLCs who were not teaching Life Sciences was a constraint to the achievement of the Fundisa for Change programme objectives. She commented:

When we run training they are subject specific to the extent that when we invite teachers we tell them to come with the curriculums and textbooks that they work with for relevance so that when they go back they can apply what was covered in the training. So now if you get teachers that are not teaching the subject ... it will not translate well ... Even when teachers work in groups and expect them to discuss how they might work with this or plan the lesson, the other teachers just sit there and listen, but it is not relevant so they cannot take it to the classroom. They might take the methodologies and use them to teach whatever subject or grade they are teaching but not specifically enhance what we are trying to do. (UP1R)

The extract above stressed that if teachers participate in the PLC activities that are not aligned to the grade or subject that they teach, their achieved functionings might not be fully realised in their actual teaching. However, the teachers and facilitators noted that the PLC space enabled collaborative learning (see Section 6.2.1.1); therefore environmental conversion factors enabled teachers to achieve their valued functionings. Thus as indicated above, teachers noted that they learned a lot in the PLCs through discussions and engaging with each other and with the facilitators.

It was observed that in all three PLCs, teachers were open to sharing their knowledge gaps (see Section 6.2.1.1). This was also evident in the interview with the subject advisor who participated in the Grahamstown PLC activities:

... everybody was opening up and sharing and talking about their experiences also met my expectations. I was pleasantly surprised that some of them admitted that they lack knowledge and expertise in certain areas. Remember the problem that we had with the dichotomous key that they were willing to admit that they need to know more. They were willing to admit that they are textbook bound, that they don't look for something to help them elsewhere. So our teachers actually have come out of the cupboard and I think that to me was very very enlightening. (DP4)

Thus, as evident in the extract above, the teachers (see Section 6.2.1.1) recognised that engaging in professional conversation and dialogues in the PLCs enabled them to improve their teaching practice and professionalism as teachers (see Chapter Seven).

6.2.3.2 Site where the PLC activities happen

According to the CAPS document, for Life Sciences to be called a Science, it should be able to use certain methods that allow for discovering new things and broadening existing science knowledge (D1). The suggested methods include conducting investigations and experiments as part of scientific inquiry (D1). The PLC activities happened at different sites. The Idutywa PLC activities took place at Donaldwoods near the Dwesa/Cwebe Nature and Marine Reserve. The venue is in a rural area of the Eastern Cape province and was a bit difficult to get to because of the bad roads (NP1R). The Grahamstown PLC activities took place at Rhodes University. The Cape Town PLC activities took place at the South African Biodiversity Institute Centre, Kirstenbosch Botanical Garden and the University of Cape Town. In all three PLCs, the venues chosen were environmental conversation factors that enabled teachers to achieve their valued beings and doings. For example, for the Grahamstown PLC, there was a wetland nearby that enabled a wetland study (GO1). Two teachers in the Grahamstown PLC noted in the questionnaire “the wetland fieldtrip increased my confidence on how to take learners out on the fieldtrips” (GT1Q). “The fieldtrip was good because it helped us to identify the microorganisms” (GT4Q). This was supported by the subject advisor who participated in the Grahamstown PLC activities as he noted:

I think some of the activities were really very much fun, for example the ones with the pictures on dichotomous key, and the wetland hands-on. The teachers really enjoyed it. It wasn't just sitting and listening, listening and listening. They were actually hands on, and they were participating, and they were talking and sharing. So get them to do things. (DP4)

In the Cape Town PLC, some of the activities took place at the University of Cape Town in the Biological Sciences department. The Biological Sciences laboratories allowed teachers to conduct practical investigations (CO1; CT1I; CT2I; UP4R). Some teachers (CT1I; CT2I) confirmed in their

interviews that the activities done in the laboratories at the University of Cape Town were enablers to their achieved functionings. For example, one teacher in the Cape Town PLC noted “besides Kirstenbosch, we were in the laboratory, the Zoology department, that I really enjoyed very much, that is what we need, activities they showed us, were actually very nice activities” (CT2I). Another teacher said:

I have always felt uncomfortable teaching about plants. I found them incredibly boring but Fundisa for Change made it really fun for me so I could make it fun for my learners as well. Seeing in the laboratory the different kinds of plants, going back to school is what I did. Of course I did not have all the plant specimens that they had there, I had some pine and some leaves. The learners could look at them. I was really interested to know about the topics after the Fundisa for Change. (CT1I)

In the extract above it is evident that this teacher exercised his agency to realise his achieved functionings in his actual teaching. In the Idutywa PLC, excursions were conducted to the marine ecosystems. All the teachers in the Idutywa PLC found going for excursions to the marine ecosystems as great enablers with regard to their valued beings and doings on biodiversity content knowledge. Their valued doings on conducting fieldwork (Tables 5.1 and 5.2) were thus achieved. Echoing what the other teachers in the Idutywa PLC noted, two teachers maintained:

I am used to workshops that you sit down, you talk and then you leave. So, going for excursions was quite big for me and eye opening ... It helped me see things that I never saw. For instance in our first excursion, I took pictures. But then when I demonstrated them, [facilitator] taught me something I never realised, three ecosystems in one area. I knew there were ecosystems of that nature but seeing them at that moment in time in one picture was wow ... many of the things, I only saw them in the book, I never got to experience, touch or feel them, but now because of Fundisa for Change, I got to visit sites and see these things. (DT3I)

.. the field trips of looking at different ecosystems, those activities worked for me, because I got a chance to understand them better. I can now differentiate between the different marine ecosystems. I can now differentiate an estuary from mangroves; I can differentiate a sandy shore from a rocky shore and sand dunes. It really worked for me because now I can say this is where sandy shores starts, this is where it end, this is where sand dunes starts and this is where they end, so to me it has made sense and it gave me more clarity on the marine ecosystems, so it worked for me really. (DT4I)

The Fundisa for Change coordinator also supported what teachers said by noting that the site and/or venues in which the PLC activities were conducted were environmental conversion factors that enabled teachers to achieve their valued functionings. Drawing from her observation on the three PLCs she noted:

In fact, what I can highlight in three trainings, there was a fieldtrip, there were hands on activities, which was enriching teachers’ knowledge but at the same time modelling how teachers can engage with those concepts, this is how you do this ... Sometimes we don’t see translations in the classrooms, because we only tell teachers, this are the methods that you can

use and then when we go and observe the teachers and they don't do them, we wonder why ... Once they see how someone has worked with it ... it becomes easier for them to translate them in their classroom, so I think strengthening how teachers can work with the concepts through modelling... that is actually best than saying these are the methods books and these are the methodologies ... Modelling of methods helps to develop particular skills ... they can either adapt it or adopt it depending on how it work best in their own context ... And the other thing that I liked ... the fieldtrip is that, they had worksheets that they worked with, there was a structure, this is what we are doing, and this is what we are looking for. Sometimes as teachers we miss that, we just take learners for the fieldtrip and it is just an outing. (UP1R)

One of the facilitators from the Cape Town PLC reflected in the interview:

And of course the hands-on, you know yourself that doing fieldwork is a real plus. I am sure they underwent a tremendous personal development not only growth from the practical point of view but that also has an emotional spiritual side. But when they go to the schools, the problem is that they often have a stuck environment and it is not easy for them to provide the same kind of experience for the learners. To take 100 learners to Kirstenbosch is a mission, not that they can't do that ... they might have a tree or two at school but they need to be complementing that with this wholeschool approach, transforming the schools as well ... they have some limitations. (UP4R)

The extracts above stressed the environmental conversion factors that enabled the activities of the PLCs. Emerging from UP4R extract is that the school contexts are potential environmental conversion factors that could constrain teachers' realisation of their achieved functionings. Fundisa for Change documents take cognisance of the core of teaching practice, but do not "ignore the wider framework of whole school and community engaged education processes, and the social-ecological contexts in which environmental learning takes place" (D13:3). This quote confirms what UP4R noted on the role of school contexts for biodiversity teaching.

As indicated earlier, the Idutywa PLC activities took place at Donaldwoods in a deep rural area of the Eastern Cape. This was both an enabler and constraint to PLC activities: an enabler because it was close to the marine ecosystems and excursions could be conducted, but a constraint because it was far and only a few teachers could attend. They had to be accommodated. This was revealed in one of the facilitators' reflective interviews:

In rural areas teachers because of the distances between the schools do have to stay over, it does help the facilitator that the teachers are there for a period of time ... they don't have other commitments, they are there fulltime only to do this work and you can nicely do long stretches of hours but the disadvantage is that the accommodation limits the number of participants ... in a remote area, where it becomes difficult for teachers to get to the venue, but again it was also a bit of an enabler because that allowed us to get to the coastal area where the teachers were then able to be onsite. (NP1R)

Emerging from the quote above is that social and environmental conversion factors were enablers to teachers' participation in the PLC activities as well as to the teachers' achievement of their valued

functionings in the PLCs. It is thus evident that the site where the PLC activities take place has a critical role to play in expanding teachers capabilities for biodiversity teaching.

6.3 Discussion

The capability approach looks at the relationship between what people have and what they can do with resources they have. Individuals differ in their ability to convert resources into beings and doings (Sen, 1999; 2009). It emerged that even though the teachers had similar functionings to expand their capabilities related to the teaching of biodiversity, they had different abilities to achieve their valued beings and doings. They therefore needed different resources to convert the available resources into the achieved functionings. As described by Robeyns (2005a), it emerged that in the PLCs there were different personal, social and environmental conversion factors. These conversion factors were enablers and/or constraints to teachers' valued functionings related to biodiversity teaching. The conversion factors identified resonated with the supportive structures and collegial relationships found in the PLCs (Hord, 1997). The structural conditions included collaborative space, policy documents, teaching and learning support material. The collegial relationships included teachers' positive attitudes, shared vision, norms of continuous critical inquiry, mutual trust and respect, caring and open relationships, individual orientations to change and group dynamics and the knowledgeable facilitators.

Teachers in the PLCs had varied experiences and qualifications. This diversity is advised for effective PLCs (see Section 2.6.3; Levine, 2011; South Africa. DBE, 2015). The goal of the PLC is for teachers at all stages of their careers to learn from each other (Levine, 2011). It thus emerged that the different experiences and qualifications enabled individual teachers to achieve their valued functionings. The novice teachers learned from the experienced teachers; for example, on the effectiveness of used textbooks. The experienced teachers learned from novice teachers' new ideas and pedagogies that the experienced teachers may not have been exposed to in their training. It was observed that as individuals, teachers brought enthusiasm and understandings of the use of technologies to the PLCs (Levine, 2011). Therefore, the individual teachers' capabilities were personal conversion factors that enabled teachers to achieve their valued functionings in the PLCs. In addition to their different experiences and different qualifications, teachers in the PLCs also differed in terms of their age groups, positions and cultural backgrounds. But irrespective of their experiences, position, age, background and gender, the PLCs were structured so that all the teachers' opinions were valued and respected. This was defined by the characteristic of inclusive membership, where all teachers were enabled to express their challenges and difficulties (see Section 2.6.3.6; Levine, 2011; South Africa. DBE, 2015).

The inclusivity in the PLCs was modelled by effective facilitation which emerged as another personal conversion factor. International researchers noted effective facilitation as critical in PLCs (see Section 6.2.1.2; Morrow, 2010). This requires someone who has experience and who is trained to facilitate the PLC activities (Fulton et al., 2010). The facilitators of the PLCs had participated in Fundisa for Change training of trainers, thus were enabled to facilitate the PLC activities. Resonating with Feger and Arruda (2008), the facilitators were innovative and creative in supporting teachers to understand the different concepts and pedagogical practices for biodiversity. As noted in Chapter Six, biodiversity is conceptually complex, requiring pedagogical approaches and assessment practices that will allow for problem solving and critical thinking.

External support is encouraged for effective PLCs (Louis et al., 1995; Harris, 2011). Stevenson (2007) also observed that in the case of environmental knowledge (such as biodiversity knowledge), many teachers have to go beyond their colleagues to deepen their knowledge of environmental issues. It emerged that in the PLCs, external expertise was recognised as crucial for the achievement of teachers' valued functionings in the PLCs. Therefore, external expertise was brought in through knowledge resources and through subject specialists (subject advisors and scientists). The external expertise supported teachers to build on the biodiversity knowledge and pedagogical approaches that were introduced in the PLCs. It was evident that the participation of people with external expertise (i.e. subject advisors, subject specialists) were personal conversion factors that enabled teachers to achieve their valued functionings related to enhanced biodiversity knowledge, scientific skills and the use of CAPS documents.

The Fundisa for Change model used to bring teachers together who were teaching the same subjects and same phase is supported by international researchers of PLCs. It was argued in the literature in Chapter Two that there are different models of PLCs; PLCs consisting of teachers teaching multiple subjects and phases are noted to limit the depth or effectiveness of work on content knowledge or pedagogical content knowledge (Stoll et al., 2006; Fulton et al., 2010). It thus emerged that in the Grahamstown and Idutywa PLCs, the model of having teachers teaching the same subject and grade was an enabler for teachers' subject content knowledge and pedagogical content knowledge. Despite having teachers teaching different grades, phases and subjects in the Cape Town PLC, teachers still indicated their enhanced subject content knowledge and pedagogical practices (see Chapter Seven). However the argument here is, if teachers participate in the PLC activities that are not aligned to the grade or subject that they teach, their achieved functionings might not be fully realised in their actual teaching. This might constrain the achievement of the overall objective of the Fundisa for Change programme "transformative environmental learning through teacher education".

Sen (1992) noted that for individual functionings to be achieved, the social arrangements need to be sensitive to the individual capabilities. This is to allow the individual to convert their particular capabilities into the functionings (ibid.). PLCs are based on the vision that learning is more effective when it takes place within a community of professionals. The community aspect of a PLC enables collegial support for individuals (see Section 6.2.3.1). Senge (1990) noted:

Learning communities are groups of individuals who have come together with a shared purpose and agree to construct new understandings...a place where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together. (p.14)

In line with the above arguments and emerging from the study is that the PLC activities allowed teachers to share ideas, teaching experiences and engage in discussions. The teachers had acquired new biodiversity knowledge and various skills through social interactions. Learning in the PLC happened through social interactions (Lave & Wenger, 1991) and this contrasts with the traditional view of learning as acquisition of knowledge, a view that has been criticised by many authors (Freire, 1972; Wood, 2007). Teachers recognised that engaging in professional conversation and dialogues in the PLCs was an enabler to both their teaching practice and professionalism as teachers. In line with this, Vygotsky (1978) noted that learning is a social activity and people learn from their capable peers. Therefore, the collaborative space emerged as an environmental conversion factor that enabled teachers to achieve their valued functionings.

The structures provided by the Fundisa for Change programme not only expand teachers' functionings related to their teaching of biodiversity. They also expand teachers' agency to be not only active participants in the PLCs but also to act on their achieved functionings as will be discussed in detail in Chapter Seven. Human agency emerges through social interactions. Teachers in the PLCs have, individually and collectively, developed the ability to define their own goals and act on them. Kabeer, as cited by Lotz-Sisitka (2009:87) suggested that:

Agency is about more than just the observable action; it encompasses the meanings, motivation and purpose which individuals bring to their activity, their sense of agency, or 'the power within'. While agency tends to be operationalised as 'decision-making' in the social sciences literature, it can take a number of other forms. It can take [the] form of bargaining and negotiating, deception and manipulation, subversion and resistance, as well as more intangible, cognitive processes of reflection and analysis. It can be exercised by individuals as well as by the collectives.

The participation of teachers, facilitators, subject advisors and subject specialists allowed for different expertise and alternative viewpoints to be shared in the PLCs (South Africa. DBE, 2015).

It was noted that teachers in the PLCs shared difficult concepts on biodiversity and how to teach them. This resonates with the National Council of Teachers of English (2010) in the United States who noted that teachers in PLCs shared successful teaching strategies, developed new approaches to shared problems and shared the specific subject content knowledge. PLCs privilege theory as well as practice, thus it was evident in the PLCs that teachers were encouraged and supported to examine their practice, to try out new ideas, and to reflect together on what works and why. This provided opportunities for the collective construction and sharing of new knowledge (Hord, 1997; Westheimer, 1999). Research shows that in South Africa, many teachers do not have the ability to reflect critically on their own practice (South Africa. DoE, 2006). Emerging in this study were the teachers enabled capabilities to reflect as individuals and as a collective on their learning in the PLCs and on their teaching practice related to biodiversity. This corresponds with Levine and Marcus (2009) who observed that effective PLCs offer teachers time to reflect on their professional development and their classroom practices. Teachers' capabilities to reflect on their teaching practices were therefore noted as enabling personal conversion factors. Teachers further reflected on their school structures, teaching contexts and what influence they had on their teaching about biodiversity. This is in line with Katz and Earl (2010) who discussed how PLCs do not exist separately from their school contexts: they are influenced by the context in which they exist.

As Lewis and Hurd (2011) have argued, the process of collaborative lesson planning was observed in the Cape Town PLC. In this PLC teachers' presentation of lesson plans enabled them to share their assumptions of teaching and learning, allowing for critiques from colleagues. Critical feedback strengthened their lesson plans for improved practice. This is reflective of Little's (2003) work who noted that in a learning community, individual members are learners who are willing to suspend assumptions, respect the ideas of others, and engage in dialogue to continually construct and refine their purpose and shared understandings.

In the PLCs, external expertise was also brought into the PLCs through the use of knowledge resources. The uses of the Fundisa for Change teacher education materials in the PLCs were social conversion factors that enabled teachers to achieve their functionings. The use of local materials to complement the Fundisa for Change teacher education materials not only expanded teachers' subject content knowledge and pedagogical content knowledge, they also developed teachers' agency for designing their own knowledge resources to teach biodiversity. For meaningful learning the local knowledge resources were used in the PLCs (see Section 6.2.2.1; Katz & Earl, 2010). According to Talbert (2009), PLCs do not operate separately from their surrounding entities. To support this argument, it emerged that the presence of the ocean, the botanical garden and the wetland were environmental conversion factors that enabled teachers to expand their capabilities for

conducting fieldwork and to acquire scientific skills required by the Life Sciences CAPS curriculum. In line with Reddy (2011), teachers had different interpretations of the curriculum and its demands. Using the curriculum policy documents directly or indirectly to inform the PLC activities such as Work-Integrated Learning and CAPS policy documents, were social conversion factors that enabled teachers' achievement of their valued functionings.

Emerging from the study is that if the personal, social and environmental conversion factors that constrained teachers' capabilities can be reconciled, then teachers' functionings will be achieved. Time was noted as the main structural condition that constrained teachers in the PLCs to achieve some of their valued functionings. Time needs to be reconciled to become an enabler to teachers' valued functionings in the PLCs. This could be achieved through providing more time for the beings and doings in the PLCs and engaging teachers in PLC activities during school hours rather than during weekends and holidays. This would not only allow time to expand teachers' pedagogical content knowledge (among their other functionings in the PLCs) but would also allow them to achieve their other personal valued beings and doings, which hinders their full participation in the PLCs. This reconciliation is highlighted in the policy documents on PLCs in South Africa (South Africa. DHET & DBE, 2011a; 2011b; South Africa. DBE. 2014; 2015).

It emerged that facilitators were reflexive of their practice in the PLCs. For example, the facilitator in the Cape Town PLC noted that, in future to ensure that the participation of external expertise was an enabler to teachers' pedagogical content knowledge (especially as they relate to scientific skills), he would define their roles more explicitly. In line with Stoll et al. (2006), the subject specialists brought in diversity in the PLC which enriched the teachers' learning experiences. It also emerged that teachers and facilitators need to continuously reflect on their learning and teaching practices, as well as PLC activities. This would allow teachers to explore different methods for engaging with biodiversity concepts in the PLCs which could be an enabler to teachers' valued functionings. Facilitators could use other available structures such as the Fundisa for Change training and trainers to reflect on their facilitation practices and through the sharing and discussions, they can expand their facilitation skills. This is supported by DuFour and Eaker (1998) who claimed that facilitators need to be reflective about their practices in the PLCs. They recognised that to build a sense of community and to grow the framework and structures of the PLCs, both teachers and facilitators need to be reflexive of the activities. It emerged in this chapter that many decisions made in the PLCs i.e. venues for activities, participants, types of activities, teaching and materials used, the models for facilitations, were dependent on the facilitators. Thus, if facilitators can share their practices, they will also reconcile the social, environmental and other personal factors that could be translated into enablers. This confirms why some of the teachers (as will be discussed in Chapter

Seven) still noted a need for further support with some of the biodiversity concepts engaged with in the PLC. The teachers noted the challenge of teaching biodiversity concepts thus expressed the need for on-going support on those concepts. On-going PLC activities would allow for action research, which is one of the activities recommended for successful PLCs (DuFour & Eaker, 1998; South Africa. DBE, 2015). Drawing from research that aims at improving teaching and learning is highly encouraged for PLCs to ensure the knowledge shared in the PLC is valid and up to date (Hiebert et al., 2002).

In summary, it emerged that teachers were able to share their experiences and expertise amongst one another; they learned different ways of teaching biodiversity concepts, in the process developing new capabilities, leveraging best practices and expanding their knowledge through social learning. Glasser (2007) noted that social learning involved gaining new knowledge and understanding through experience/ interactions. As indicated by Borko (2004), it thus emerged in the PLCs that professional development was situative and that outcomes were influenced by personal and group processes.

6.4 Conclusion

This chapter aimed at answering the research questions: what conversion factors are associated with functionings in PLCs for teachers' professional development related to the teaching of biodiversity? And partially, the research question: how do the conversion factors in the PLCs for Science contribute to teachers' professional development in biodiversity education? It emerged from this chapter that there were various personal, environmental and personal environmental factors that enabled teachers to achieve their valued functionings as they relate to the teaching of biodiversity. As agents, teachers, the Fundisa for Change facilitators, subject advisors and the subject specialists engaged in collegial dialogues and discussions in an enabling environment. This collaborative space allowed teachers to exercise their agency individually and in cooperation with other teachers, facilitators, subject advisors and subject specialists that enabled expansion of pedagogical content knowledge. It emerged from this chapter that Fundisa for Change is a conversion factor that provides personal and social conversion factors that enable teachers to achieve their valued functionings. It further emerged that if structural and agential conditions that constrained capabilities can be reconciled, the PLCs will be fully achieved; this is further discussed in Chapters Seven and Eight.

Chapter 7: Teachers' achieved, realised and new functionings

7.1 Introduction

The previous chapter discussed the conversion factors that were associated with teachers' valued beings and doings in the PLCs as they relate to the teaching of biodiversity. Most of the conversion factors discussed were enablers to the teachers' valued beings and doings. This chapter therefore answers the question: how do the conversion factors contribute to the teachers' professional development. The chapter discusses the teachers' achieved functionings in the PLCs as they relate to the teaching of biodiversity. It further discusses the teachers' realisation of the achieved functionings in their actual practice. Finally the chapter discusses the teachers' new valued beings and doings related to the teaching of biodiversity. The new valued functionings emerged mainly from constrained capabilities in the PLCs or constrained realisation of achieved functionings in their actual practice.

7.2 Teachers' achieved functionings

To answer the research question on whether Fundisa for Change was a conversion factor that enabled and/or constrained teachers' valued beings and doings, I had to find out about teachers' achieved functionings in the PLCs. It was evident in the teachers' interviews, reflection tools and evaluations that some of their valued functionings (see Tables 5.1 and 5.2) were achieved. Sen (1999) noted that individuals differ in converting resources into functionings. Thus despite the conversion factors discussed in Chapter Six, it was evident that the extent to which valued functionings were achieved was different. Even for teachers who were in the same PLC with the same resources, the extent to which they achieved their valued functionings was different. Therefore, even though this chapter presents a single story of teachers' achieved functionings, it is more complex than this. The achieved functionings include: improved subject content knowledge, pedagogical and assessment practices; expanded capabilities for making links between the biodiversity concepts and the Life Sciences curriculum; increased confidence; and renewed love for teaching. Unintended outcomes of the PLCs included the pastoral role of the teachers and teachers as researchers. The chapter discusses these achieved functionings in detail.

7.2.1 Subject content knowledge

In the interviews and reflections, teachers noted their improved subject knowledge. They explained that their capabilities were expanded to teach some of the biodiversity concepts and content (DT1I-DT6I; DT1R-DT6R; CT1I-CT4I; CT1R; CT3R; CT4R; GT1I-GT5I; GT1R-GT4R). Some of the concepts that teachers were feeling comfortable teaching after the PLC activities were noted down in the reflection tools. Teachers from Idutywa noted the following concepts:

DT1R: Ecological niche, marine biodiversity, marine ecosystems, ecosystem services (especially economic benefits of marine biodiversity), responses to biodiversity loss.

DT2R: Ecosystems, biodiversity, taxonomic classification, ecosystem services (provisioning, supporting, regulating), human impacts (overharvesting), invasive alien species.

DT3R: Biomes, taxonomic classification, ecosystem services, ethical consideration, mangrove species.

DT4R: Marine ecosystems, taxonomic classification, biomes, ecosystem services (economic benefits of marine biodiversity), human impacts to biodiversity loss.

DT5R: Biomes, taxonomic classification, ecosystem services, ethical consideration, human impact on biodiversity, responses to biodiversity loss.

DT6R: Biodiversity, biomes, taxonomic classification, ecosystem services / economic benefits of marine biodiversity, negative human impacts, responses on human impacts.

Teachers from Cape Town wrote:

CT1R: Biomes, ecosystems, species, genus, nutrient cycling, water and food provisioning, overexploitation, extinction.

CT3R: Species, population, genus, community, habitat, biomes, ecosystems, provisioning services, invasive alien species, extinction, desertification, overexploitation.

CT4R: Biodiversity, the positive impacts of plants on humans, and the use of plants and animals for economic use (attracting tourists).

Teachers from Grahamstown wrote:

GT1R: Biodiversity, genetic biodiversity, biomes of South Africa, roles of biodiversity.

GT2R: Biodiversity, wetland, biome.

GT3R: Biomes, biodiversity.

GT4R: Variety of living things, classification, biomes, habitat, healthy environment.

It was thus evident in the reflection tools that across the three PLCs, teachers have expanded their capabilities to teach the key concepts of biodiversity, roles of biodiversity, human impact on biodiversity loss, and responses to biodiversity loss. These concepts are key to biodiversity (D1; D9; D10). Even though all the teachers indicated in their interviews and reflections that they had learned new knowledge in the PLCs, 11 teachers (DT1I-DT6I; CT1I-CT3I; GT1I, GT2I) explained in detail in the interviews, the content knowledge learned in the PLCs. Two Idutywa teachers said:

To be honest, my knowledge was too little; I did not come across this topic of marine biodiversity until I came to Fundisa for Change, I was not familiar with it. We are not far from

the ocean. We once went there with learners for an excursion, we stayed for two days. We tried to identify the different species but it was very difficult. I had a colleague of mine; we saw those different types of marine species, which I can now call marine biodiversity. I did not know much about it, until now. (DT2I)

Before the workshop, my knowledge was too little, but now I know and I understand what is meant by marine biodiversity ... and that there are different species, different plants, and different animals found in different ecosystems ... Now I know that there are different ecosystems found in rivers, in seas like sand dunes, rocky shores, forest ecosystems and mangroves, I know that now. (DT6I)

According to three teachers in Cape Town:

I learned the importance of biodiversity; that exploitation of plant species can lead to extinction; and how pollution, urbanisation and overgrazing impact biodiversity. (CT3R)

I had very little knowledge on biodiversity; it helped me to see a bigger picture on biodiversity. It really opened my mind ... It increased my interest in teaching Life Sciences and Natural Sciences. It also helped me to understand some of the concepts. (CT4R)

Before Fundisa for Change, I knew a bit about biodiversity. I studied it in my first year at university and then for three years I did no biodiversity. So I did not feel properly prepared to teach it. There were gaps in the information I knew. After Fundisa for Change, working around Kirstenbosch and so on, I felt more comfortable teaching it. Not only did I enjoy the work they gave us, but I did some research afterwards about some of the information. So I think I know more about biodiversity than I ever learned and definitely more excited and enthusiastic about teaching it. (CT1I)

In Grahamstown, one teacher wrote in her evaluation “genetics used to be a challenge for me but now I can teach it” (GT1E). Another teacher expressed in an interview:

For example with the biomes, I usually just say look at the climate, but now I have more knowledge how I will approach it. I will mention all the eight biomes and then will ask them to research the climate, animals and plants that are found in those biomes. Now I can also say in our area, this is the biome we have, then we do research on that biome. (GT2I)

As discussed in Chapter Five, it is evident from the teachers’ interview data and reflection tools above that their subject knowledge was limited. Through the PLC activities, their content knowledge was enhanced. What is evident in the extract from the Idutywa teacher (DT1I) is the valuing of situated learning (South Africa. DHET, 2011). Despite her lack of knowledge on marine biodiversity, she had attempted to take learners to a marine ecosystem to study marine biodiversity. As noted in Chapter Five, the extract from the Cape Town teacher’s interview above (CT1I) showed that even though some of the pre-service training does prepare teachers to teach biodiversity, it is inadequate (see Section 5.2.1). The extract further demonstrated another outcome of the PLC: curiosity and motivation to conduct research on some of the biodiversity concepts engaged with in

the PLCs. One teacher in Idutywa noted in her portfolio of evidence that PLC activities had stimulated an interest in her to teach biodiversity content and concepts: “the knowledge I have obtained about the environment, I am keener and interested to cultivate it into the mind of the learners to change the way they live. Learners will be prepared to deal with current and oncoming situations” (DT2P). Even though this teacher did not expand on what she meant by ‘learners to change the way they live’ she did recognise that biodiversity issues are changing, thus learners need to be prepared to deal with not only current issues but also future (anticipated) biodiversity issues and associated risks (D6; Cundill et al., 2014).

The ultimate purpose of the PLC activities was to improve teachers’ practice on biodiversity in the Life Sciences CAPS curriculum (D1; D6; D14). It was thus important to ask if teachers were capacitated to make links between the new content knowledge and the Life Sciences curriculum. This was in line with their valued functionings (see Table 5.1). Teachers said they were comfortable to make links between the biodiversity content knowledge learned and the Life Sciences curriculum. These links were made in the reflection tools, evaluations and interviews (GT1R-GT4R; CT1R; DT1R-DT6R; DT1I-DT6I; CT1I-CT3I; GT1E-GT3E). To support this, some teachers said “there is now a clear link between Life Sciences curriculum and marine biodiversity only that teachers needed more exposure. A lot of it was the unknown unknowns” (DT6I). “Grade 10, 11 and 12 talk about biodiversity, hence this was more related to what I teach my learners. I got a better understanding” (DT4R). “Biodiversity links with environmental studies in grade 10-12” (GT3R). “There is a clear link between biomes and grade 11 and 12 curriculum” (GT2R). “Grade 10 and 11 has a big section on biodiversity” (CT2I).

We are studying sustainability and biodiversity in grade 10. I always make learners aware that if we lose one part of the ecosystem is going to affect all of us eventually. So they are beginning to understand that and are actually excited about keeping and wanting the birds to come back in the area so that we can have a diverse ecosystem. (CT3I)

The concepts of biodiversity, taxonomy, role of biodiversity, ethical issues learned are all relevant to CAPS. I teach the concept of biodiversity in grade 10, 11 and in GET phase. It builds on general knowledge and on things done during teacher training. We also do human impacts on the environment in grade 10 and 11; this includes what causes biodiversity loss and how humans respond. (CT1R)

The above links made by the teachers are evident in the CAPS curriculum (see Appendix 1).

7.2.2 Pedagogical practices

Chapters Two and Five discussed in detail the types of pedagogical approaches that are encouraged for biodiversity education (D6; D7; D9; D10; see Section 2.3.1; Section 5.2.2). The teachers expressed in the interviews and in their reflection tools that they had learned new pedagogical

approaches (GT1I-GT3I, GT3R; GT4R; GT1R; CT1I; CT2I; CT3R; CT3I; DT1R-DT6R; DT1I; DT2I). These teachers maintained that the PLC activities were ‘fun’ and hands-on. They were thus feeling capacitated to make teaching biodiversity ‘fun’ for their learners (see Section 6.2.5). This is in line with their valued functionings on wanting to expand learners’ capabilities and interest in biodiversity (see Table 5.1). When asked what they meant by ‘fun’, teachers referred to participatory, hands-on and fieldwork activities. These pedagogical approaches are recommended for biodiversity education (D6; D7; D9; D10; see Section 2.3.1; Section 5.2.2). Three teachers from the three PLCs expressed this as follows in the interviews:

I have been teaching biodiversity for many years, but it’s only after Fundisa for Change, especially that one day at Kirstenbosch, I found teaching biodiversity very exciting. It made me realise that there are different ways of introducing biodiversity to learners. That is something I especially learned. I have changed my approach since then. (CT3I)

In grade 10, there is a topic on classification. I was not really sure how to implement it to my learners so that they can understand it ... more practicals were done during the workshop. So I was very interested after the workshop to go back to my learners to deliver the knowledge and use strategies that I gained from the workshop. (DT1I)

Fundisa for Change made me realise the need for hands-on and creative activities in the teaching of biodiversity, it really improved my teaching. With biodiversity I was just using the textbook, but now I saw that you can take the learners out for an outing; even using the environment at school, all those wetlands and so on. (GT2I)

What was evident in the teachers (CT1I; CT3I; GT2I; DT1I-DT5I) responses is that they were reflective about their classroom practice. This is in line with the policy document that notes that teachers in PLCs need to be reflective and reflexive of their own practice to transform their classroom practices (D14). The extract from GT2I revealed another outcome in the PLC: not only relying on the textbook to teach biodiversity. Textbook knowledge is incomplete (D6; see Section 5.2.4). The facilitators (UP1R; UP2R; UP4R; DP2R; NP1R) confirmed that teachers’ pedagogical practices had improved. The subject advisor who was a facilitator in the Idutywa PLC reflected:

The teachers were exposed to the various teaching methods which they are not used to ... In most cases what we usually do is this lecture method, even if they are teaching ecosystems they don’t take the learners outside just to observe what is in the ecosystems in the schools ... the way the training was structured. It made them to go outside, go to the sea, so that they are able to observe the different ecosystems that are there. And by observing those different ecosystems they are able to identify the organisms which were there ... and they were able to come up with the different food chains. (DP2R)

One of the Cape Town PLC facilitators reflected:

... there is no doubt that we influenced the way teachers taught the topic – it was reflected in the materials or portfolios that were developed by some of the teachers. But this was at an individual level. We were able to follow up with teachers who are doing ACE, we were able to

go and observe them in their classrooms and some were actually teaching the topic that was aligned to the things we did with them on biodiversity. (UP4R)

The subject advisor points to the teachers' lack of abilities to use local ecosystems and experiential methods to teach biodiversity content (see Section 5.2.2). The Life Sciences curriculum stipulates that teachers should expose learners to local ecosystems and biomes (D1). The use of local ecosystems points to situational learning and knowledge required for good teaching (South Africa. DHET, 2011). The Cape Town facilitator highlighted teachers' developed agency. Teachers' expanded capabilities and agency enabled them to realise their valued functionings to develop knowledge resources for teaching biodiversity. This is in line with the aims of Fundisa for Change (see Appendix 7).

7.2.3 Improved assessment practices

In line with their valued functionings, teachers' revealed in their reflection tools and evaluations (GT1E - GT3E; DT4E; DT5E; CT3E; DT1E; DT1R-DT6R; CT1E; CT3E) that their capabilities on assessing some of the biodiversity concepts had expanded. There was not significant detail in the extent to which teachers reflected and explained their expanded capabilities for assessing biodiversity as had been the case with the new knowledge and pedagogical approaches. However, one teacher in Cape Town commented:

The concept of loss of biodiversity can be useful when teaching human impacts on the environment. It teaches learner to care for the environment and to appreciate it. It makes a good term assessment project – loss of biodiversity in your area ... Basically what it taught me is how to set up assessment and how to be more comfortable teaching in front of large classrooms. (CT1I)

To explain how their assessment practices had been expanded, some teachers (CT1R; CT3R; DT5R; DT6R; GT3R) mainly referred to the assessment methods and tools that they had learned in the PLCs. These included designing practical and research activities and finding out (exploring) certain aspects of biodiversity in local contexts. These were in line with the Life Sciences CAPS curriculum (D1; D9; D10). One Cape Town teacher noted in her reflection tool "I know now how to design and plan investigations, working with graphs, conducting surveys, research, and how to engage learners with case studies on the real issues on biodiversity loss" (CT3R). And two Idutywa teachers noted in their evaluation "based on the deeper understanding of the content I will be able to confidently explain to my learners and also be able to use the techniques acquired to develop assessments" (DT5E). "The best aspect was getting to know the assessment criteria stipulated in the CAPS document. This will develop my expertise of assessing learners, allocating marks and weight of these marks" (DT2E).

The Life Sciences CAPS document explicitly discusses assessment *of* and *for* learning, how and why they should be done (D1; see Section 5.2.3). Two teachers (DT1R; GT5I) made general comments in the interviews and reflection tools that they had learnt assessment *of* and *for* learning. For example, three Idutywa teachers wrote in their reflection tools “I learned to assess learners by giving them a topic to debate on e.g. is it worth it to conserve species?” (DT4R). “I learnt to give my learners projects where they will have to go out to search for the different biodiversity” (DT3R). One teacher indicated that he now understood “rubrics, case studies, field reports, practical activities, assignments” (DT6R). Like in Idutywa, in Grahamstown, there were activities focusing on improving teachers’ assessment practices (DO2; GO2). The Grahamstown teachers did not complete the section of improved assessment in the reflection tools but two teachers (GT1I; GT5I) did show evidence of expanded capabilities on assessment practices in their interviews. Interestingly, it was observed in Idutywa and Grahamstown that teachers did not know that assessment could be used to assess their own teaching (DO2; GO2). This was also observed by one of the facilitators who noted “in the discussions you will hear teachers say, I did not know much about biomes for instance, I didn’t know much about assessment, I only thought of assessment as testing or giving exams but I did not know that I can use it to see that I am on track ...” (UP2R).

To support what teachers said about their expanded capabilities for biodiversity teaching, one of the Fundisa for Change partners (UP2R) revealed that the PLC objectives were achieved in relation to the intended outcomes (improved subject content, teaching methods and assessment practices). He said “I think the trainings objectives were achieved in relation to what the teachers were meant to achieve in terms of the subject content, teaching methods and assessment practices those elements were covered throughout the trainings. For me the trainings went as planned” (UP2R). Partially in agreement, two facilitators in the Idutywa PLC observed that more activities could have improved teachers’ content knowledge, pedagogical and assessment practice. One reflected:

I am concerned that the teachers arrived fairly at a very low level of assessment understanding and links with CAPS. We went through a lot of things on assessment ... we have allowed them to move forward, in the scaffolding process but not sufficiently enough that they are confident in the teaching of that section. And when I say teaching of that section, not only fully understanding the content and concepts or at least understanding the content better than previously but I don’t feel that they are confident in the assessment component and how to assess that or assist the learners with the different levels of assessment. (NP1R)

The above extract proves a need for further support of teachers for biodiversity teaching.

7.2.4 Other achieved functionings

Evident in Tables 5.1 and 5.2 and Section 5.2.4 is that teachers valued teaching and learning resource materials for biodiversity teaching. Chapter Six discussed that Fundisa for Change resource materials and locally relevant resource materials were used in the PLC activities (see

Section 6.2.2.1). It emerged from five teachers' interviews (CT1I; GT1I; DT3I-DT5I) that the PLC activities expanded their capabilities for using different resources to teach biodiversity content and concepts (including the use of technology such as video clips) (see Section 6.2.2.1). This is evidence of fundamental learning (South Africa. DHET, 2011). Moreover, seven teachers' (GT2I; GT1I; CT1I; CT3I; DT1I-DT3I) learnt that learners need to be engaged in the teaching and learning of biodiversity. As one Idutywa teacher noted "learners should be given an opportunity to do research or go on excursions to identify and explore different types of biodiversity. Alternatively, they should watch video clips" (DT4R). They recognised, however, that learners are changing every year. They thus noted the need to keep abreast with the changing learners in terms of their teaching of biodiversity. One Grahamstown teacher said:

Fundisa for Change helped us. Most of the time we just work through the book and then we don't do other things, but when we attended these meetings, we got to know. The learners are changing every year. Most of them are now challenging ... if my lesson plan was like this this year, next year the learners are brighter ... They are busy with social networks. So they come to class knowing more. Meaning me as a teacher, I have to try to be one step ahead ... when I am doing my preparation, let's say, I am going to teach that topic next week, I will start preparing this week. So that I can also go to the internet, not only to the textbook like I did years back. I am including internet and some of the books to gain more. (GT1I)

In Idutywa and Grahamstown, there were activities based on conceptual progression (see Section 5.2.1). Three teachers (DT1I; DT2P; DT2R; GT4R) found progression activities challenging. This is not surprising as research had shown that teachers do not make conceptual links in their teaching of the subject content (D6). Therefore, in line with their valued functionings (Tables 5.1 and 5.2) three of the teachers (DT1I; DT2P; DT2R; GT4R) noted that the PLC activities have expanded their capabilities for making conceptual links in the curriculum. One Grahamstown teacher said "I learned that biodiversity is a system and the importance of progression, integration and building up of concepts in Life Sciences" (GT4R). One teacher in Idutywa said:

There is progression of knowledge which some of the teachers did not notice, even me. But when we came to Fundisa for Change, we got to know that there is progression. So now if I take a policy document and look, I will see and say okay, here there is progression but it is not clearly shown, but is progression. (DT1I)

Another teacher from Idutywa noted in her reflection "progression helped in understanding the interconnectedness and progression between concepts, i.e. cell division biodiversity and classification" (DT2R). She demonstrated examples of progression of biodiversity concepts in grade 10-12 in her portfolio of evidence, as shown in the extract below:

In grade 10, learners studied indigenous knowledge systems which link with loss of biodiversity in grade 11 and 12, where the use of these indigenous systems contributes to loss of biodiversity through over harvesting of the indigenous plants to make medicines ... Biosphere and ecosystem in grade 10 links with population ecology, biodiversity and

classification in grade 11. And also links with human impact on the environment in grade 11 and 12. In grade 10 learners learn about food webs, in grade 11 they learn about how that energy is formed (photosynthesis). (DT2P)

But one of the facilitators in the Idutywa PLC reflected “progression, that one I think there was confusion, in the first session, we were looking at links between the topics, I don’t think they have grasped it” (DP2R).

With the above evidence, teachers (CT1I; CT4I; DT1I, DT5I) also indicated in the interviews that the PLC activities had increased their confidence for teaching and assessing the biodiversity concept and content. This was in line with valued functioning of being confident to teach biodiversity concepts (see Tables 5.1 and 5.2). For example, one teacher in Cape Town noted “what was important to me was that the chapter of dealing with plants, it was so difficult. But now at least I do have self-confidence to stand in front of the class to deliver the lesson” (CT4I). Emerging from one teacher’s interview (DT5I) was improved professionalism. This is in line with the South African policy documents that note that teacher education needs to enhance teachers’ professionalism (D2; D3; D4; D14). Moreover, three teachers (CT2I; DT1E; DT5I) expressed their renewed love of Life Sciences and teaching, as noted by one Idutywa teacher: “the renewal of my love for Life Sciences and my job” (DT1E).

It was observed that some teachers did not prioritise the use of the CAPS documents in their teaching (DO1; DO2; CO1; CO2; GO1-GO3; see Section 6.2.2.3). Through the PLC activities, two teachers in Grahamstown (GT2E; GT5I) explicitly noted that they got to understand the significance of using the CAPS documents in the teaching and assessing of biodiversity concepts (see Section 6.2.2.3). This was mainly in Grahamstown and Idutywa where the curriculum documents were directly used to inform the PLC activities. As mentioned in Chapter Six, in Cape Town, CAPS documents were not used but were referred to (see Section 6.2.2.3). This is in contrast with the Fundisa for Change facilitators’ guide (D13). The Fundisa for Change facilitators’ guide explicitly indicates that facilitators should encourage teachers to bring their curriculum documents to the PLC and work with them in the PLCs (see Section 6.2.2.3). What might have been a constraining capability in Cape Town as mentioned in Chapter Six was the absence of the subject advisor. As noted in Chapter Four, Cape Town teachers were teaching different subjects and phases, unlike Grahamstown and Idutywa who were all teaching Life Sciences. This might also have been a constraining factor on the use of CAPS documents in Cape Town. Reconciling the constraining factor could expand Cape Town teachers’ capabilities to work with the CAPS documents in their teaching.

An unintended outcome was that one teacher (DT4I) indicated that the PLC activities had improved their behaviour in workshops. “It has worked for us, really in that way I mean it have improved our behaviour in the workshops” (DT4I). This teacher did not explain in detail what he meant by improved behaviour, however he said “what I am saying is that you came from your universities and institutions to come help us, so you mean business and we take you more serious” (DT4I). The three teachers from Idutywa particularly noted expanded capabilities “to reflect on whether I am doing enough to conserve biodiversity” (DT3E). Therefore “the next time we visit the ocean we will appreciate it more” (DT3I). Emerging from all the teachers’ evaluations was that the PLC activities were very developmental. To describe the PLC activities in a few words, two teachers wrote “developmental workshop in my profession” (DT6E). “This was a developmental course” (GT2E). Some teachers even expressed that the PLC activities went beyond their intended outcomes (CT3I; DT3I; DT4I; DT5I). For example in the Idutywa PLC one teacher noted “I never had any expectations as to the level to which it has set me; I was thinking it was one of those ordinary workshops we use to attend, were you go to the workshop, you sit, the same thing you knew will be repeated” (DT5I). One teacher in Cape Town maintained:

I had no expectation but I was gloriously surprised, I thought it was going to be one of those courses where you go sit, take notes and get your diploma without learning anything. But I must say it was very interesting, we were busy and hands on. I left there full of energy to go and do the same things. So it was a worthwhile two weekends. (CT3I)

It is evident in the extract from the Cape Town teacher that PLC activities were effective for their professional development. As highlighted in Chapter Six, this was because of the different social, personal and environmental conversion factors. One of the Fundisa for Change partners confirmed unexpected outcomes in the PLCs. She noted that as much as Fundisa for Change valued expanding teachers’ content knowledge, pedagogical and assessment practices, teachers valued more than that (see Table 5.1 and 5.2). She claimed:

Those subtle things were some of the unexpected outcomes of the PLC activities. For example, being kind, it did not have to do with content knowledge, teaching pedagogy or assessment. It is about the pastoral part of being a teacher, the part about being patient, caring and just continuing to try and get out of your learners what you can get out of them. That perseverance was actually modelled according to good facilitation. In other words, teachers watched how the facilitator was scaffolding the learning and working with them in a very motivating and positive way. Yes, you have your objectives ... but is actually also about what teachers need or want in their particular experience. So they take what is meaningful to them. (NP2)

The extract above draws attention to another outcome of the PLC: the pastoral role of the teacher. This extract also confirms that teachers’ agency and achieved functionings depends on individual teachers’ valued beings and doings. This, as discussed in Chapter Five, points to the need for PLC

activities to be responsive to individual teacher's needs (D2; D3; D4). One of the facilitators of the Idutywa PLC maintained that despite teachers' achieved functionings, more could have been achieved in terms of knowledge, assessment and pedagogies and teachers' confidence for teaching biodiversity. She said:

I would have liked to see a greater confidence than I saw. One or two teachers I get that, yes they were knocking at that door, if not already opened that door of confidence, and others are sitting there thinking I know more but I still can't manage to get this across entirely ... their marine knowledge was relatively low initially, and they really did appreciate ... And the methods of teaching seem to have an effect ... What I think they definitely gained there was the sense of community of practice. I got a feeling that there is quite a good community of practice within that group but it might have been strengthened to an extent, allowed for more interactions and for more involvement and understanding of the curriculum. (NP1R)

Evident in the extract above is the strengthened community of practice. This is in line with Lotz-Sisitka (2011) who noted that it was envisaged that Fundisa for Change activities could constitute a foundation of PLCs in early research into the Fundisa for Change programme needs and structure. PLCs should be on-going for the purpose of increasing teachers' own learning for the purpose of improving learners (D2; D4; D14). Thus, in line with the extract by NP1R above, if teachers can continue to engage in PLCs, their confidence for teaching biodiversity will be potentially increased, and their capability for teaching biodiversity will continue to be expanded.

7.3 Teachers' realisation of achieved functionings

The interviews and portfolios of evidence showed that some teachers had realised some of their achieved functionings in their actual teaching as discussed below.

7.3.1 Realised achieved functionings

In the evaluations, nine teachers (GT1E - GT4E; DT3E- DT5E; CT1E; CT3E) indicated that the PLC activities were relevant to Life Sciences and to their needs as teachers, thus they were very likely to realise what they had learned in their own teaching. As two Idutywa teachers wrote: "based on deeper understanding of the content, I will be able to confidently explain to my learners and also be able to use the techniques acquired to develop assessment" (DT5E). "Presentations that we had and different teaching methods that were shown helped me a lot" (DT4E). One teacher in Cape Town said, "it was very useful information" (CT3E). It was evident that eight teachers (DT1I; DT2I; DT5I; CT1I; CT3I; GT1I; GT3I; GT4I) had realised some of the achieved functionings. The realised functionings were mainly the new knowledge, new pedagogical practices and the use of different teaching and learning support materials as was modelled in the PLCs. Before reporting on the teachers' realised functionings in their actual teaching, I will summarise the teachers achieved functionings in Table 7.1 below (as discussed in Section 7.2.1 to Section 7.2.4 above):

Table 7.1: Teachers’ achieved functionings in the PLCs

Teacher	Achieved functionings					
	New knowledge	New teaching practice	New assessment practices	Teaching and learning support materials	Improved confidence and professionalism	Other
PLC 1						
DT1	√ ²⁴	√	√		√	√
DT2	√	√	√			√
DT3	√	√	√	√		√
DT4	√	√	√	√		√
DT5	√	√	√	√	√	√
DT6	√	√	√	√		
PLC 2						
GT1	√	√	√	√	√	√
GT2	√	√	√	√		√
GT3	√	√	√			√
GT4	√	√				√
GT5	√	√		√		√
PLC 3						
CT1	√	√	√	√	√	√
CT2	√					√
CT3	√	√	√	√		
CT4	√				√	

The teachers’ realisation of the achieved functionings in their actual teaching was determined by the time of the year that the PLC activities happened, the time the interviews were conducted and the grade the teachers were teaching. Eight teachers (DT1I; DT2I; DT5I; CT1I; CT3I; GT1I; GT3I; GT4I) revealed that the PLC activities had improved their teaching practice through teaching biodiversity concepts and content they had not taught before. For example three teachers, one from each of the three PLCs, said:

I tried to implement my lesson to grade 10, but the topic was too short for them, because the topic on biodiversity is in the fourth term. Due to circumstances we only had one week. So, I gave them the biological terms related to biodiversity like ecosystems, ecological niche and habitat. Now, they know the interactions between species; they now know how to do food chains and food webs properly. (DT1I)

The thing I won’t forget is the dichotomous key; I never used to teach that concept because I did not understand it. But after Fundisa for Change, that week I went to my learners and I said let’s go guys. We went outside and I explained to them the dichotomous key. I was comfortable with it and I will do it again next year. I never taught it all those years I have been teaching. I used to ask my colleague to teach that part for me, but now Fundisa for Change did that for me, so I am now confident to teach it myself. (GT1I)

²⁴ √ shows that the teacher had achieved that functioning

At the Fundisa for Change training we went through some content that we have to teach, I prepared a lesson that I taught on animal diversity ... I felt more comfortable, I had more information to share with my learners, I had better teaching techniques and I was sure what was important, so I knew what to ask, and how to ask it, so it definitely helped ... After a lesson the learners came back the following day and said, Sir for the first time we really understand these things. (CT11)

He further noted:

The learners in groups had to make posters and present them in class. They asked questions and had to defend their stand points. I have been doing that since. Learners are now doing most of the work, I am only facilitating. It took a lot of preparations to get them to work. The longer I have been doing it, focusing more on them and having them interact, they are becoming more and more open to it. At the beginning they did not like it, they didn't want to do anything themselves, they liked to be spoon fed, just writing things down and now they are more open to thinking for themselves.

The extracts above provide some interesting evidence into teachers' realised functionings. Evident in the extract from Grahamstown teacher (GT11) is the culture of asking colleagues to teach the challenging concepts on their behalf. This was not only evident in this teacher's interview; three other teachers had also recognised that some of their colleagues were knowledgeable and had also indicated that they sought assistance from them (GT4I; DTII; DT3I). In some cases teachers would observe what and how their colleagues were teaching to improve their own practice (GT4I; DT1I). This resonates with the South African policy on Work Integrated Learning (D2; D3). Evident from the Cape Town teacher (CT11) is that not only did the teacher feel comfortable to realise his functionings, but they also had changed their roles to being facilitators in teaching; and the learners' roles has changed from being passive recipients to active participants in learning. This is evidence that teachers' professional agency was developed in the PLCs (D4).

Some of the teachers (DT2I; DT2P; GT21; DT11; CT1I; CT3I) also indicated in the interviews and portfolio of evidence that they had realised some of the pedagogical approaches learned in the PLCs. One teacher (DT2I) in Idutywa expressed that she even used some of the teaching methods learned to implement other curriculum topics that were not related to biodiversity. She said:

Some of the teaching methods that we did in the training were made very simple, very straightforward and fun. So I did some of the lessons using some of the examples of the teaching methods we did ... we used examples of teaching methods using marine biodiversity. Now after the training even when I was doing other topics, I could use those methods that I learned ... it becomes easier to do something that you have just recently studied about. Unlike those theories that we normalise at schools ... with these teaching methods we practiced them so it was easy for me to copy what we did, and implement it on any topic that I was teaching, it became more fun. (DT2I)

As shown in Table 5.1 and 5.2, teachers' valued teaching methods that are easy and better to use, and to make teaching biodiversity fun for their learners. The above extract confirms an achieved functioning. Some teachers (GT21; CT1I; CT3I; DT11) explained in more detail how they had modelled the teaching methods to teach specific biodiversity concepts. This point to teachers' expanded capabilities to make links between biodiversity knowledge and pedagogical knowledge. For example, the teachers from Grahamstown and Idutywa expressed:

I was unable to approach biodiversity more especially in grade 11 and 12. But after Fundisa for Change, I just did what we did there. I took the learners to the river and around the school and they enjoyed it. At the river we tried to catch microorganisms. The problem with the learners is that ... they take it as free time and not do what you want them to do. (GT2I)

By coming to Fundisa for Change I learned a lot. There is an ecosystem near our school, I did not realise that it was an ecosystem until I came to Fundisa for Change. It is a small wetland. After the training we went there with the learners and identified the species. We used them to do the food chains, food web and the food pyramid. (DT1I)

The extracts above demonstrate that teachers exercised agency in realising their achieved functionings. Evidence (GT2I; GT4I; DT1I) confirms expanded capabilities for conducting ecosystems studies. As discussed in Chapter Five, despite the explicit curriculum expectation, prior to the PLC activities many of the participating teachers lacked the capability for conducting field studies and investigations in the local ecosystems to teach biodiversity (see Section 5.2.3). The PLC activities expanded their capabilities, hence the realised functioning of conducting investigations using local ecosystems. One teacher in Cape Town revealed that the PLC activities enabled her to change her teaching practice. This was modelled based on the observed activities at Kirstenbosch Botanical Garden. In those activities, facilitators used pictures from magazines and newspapers to help scaffold certain concepts of biodiversity. The teacher said:

Before Fundisa for Change I use to use whatever I had or from the internet to do PowerPoint presentations. It didn't really use to work for the kids; but it worked for me because it covered whatever I needed to. But these things of bringing things from home, from magazines, building up their own ecosystems, learners love it. And then when it comes to where they live, some of our kids live in shacks and some of the kids live in those houses that you build with sand bags and stuff like that. So they all have different ideas of what is needed in that environment. (CT3I)

The above extract reveals that through the PLC activities, the teacher changed her practices to using local resource materials to make learning relevant and meaningful (D13). The extract revealed that the teacher's old teaching methods enabled her to cover the curriculum expectations at the expense of the learners' learning. This triggers a question regarding the purpose of education.

Unlike in Grahamstown and Idutywa, one of the facilitators in Cape Town (UP4R) observed that teachers realise their achieved functioning in their actual teaching. He noted that not all the

teachers were teaching biodiversity at the time he was observing them. This was because of the different grades, subjects and phases that they were teaching. He confirmed, however, that some teachers had not realised their achieved functionings due to the time of the year. As noted in Chapter Five, the CAPS curriculum is very specific in terms of what content should be taught when (D1; see Section 5.2.1). His intention was to support teachers as a community of practice through the lesson study approach (D13). This would include teachers planning lessons collaboratively (this was done in the PLC), implementing the lessons and then reflecting on the lessons as a collective to improve their teaching practice. However, because teachers were teaching different grades and subjects, it was difficult to engage in a lesson study activity. He noted:

The FET teachers, none of them were teaching biodiversity in the first term. There was one exception ... who actually taught the topic in the first term. I was therefore able to go to his class and see him teach. In his school they have changed the order in which they were teaching. I was able to see him teaching animal diversity, and there I could see that he really engaged with the things that we have done. For example he developed lessons based on the T-Sheet²⁵. So it was very much of how the individuals responded, in terms of supporting them in a community of practice was a little bit tricky because they were not teaching that topic. So that was a bit of a challenge ... the idea is to still follow up with them and see what they are doing, how are they implementing it. (UP4R)

As evident in the extract above, the facilitator valued supporting teachers to realise their achieved functionings at classroom level. As is evident in his extract, the CAPS curriculum does make provision for changing the sequence of the content, as was the case with the one teacher (CT1I) referred to in the extract by UP4R above. One teacher however revealed that it was up to the subject advisor to change the sequence of the topics “you can control it provided your subject advisor is a reasonable person” (CT2I).

Four of the teachers indicated in the evaluations (DT2E; DT6E; GT2E; GT3E) that they would be able to explain to their colleagues what they learned in the PLCs. As two Idutywa teachers said, “I can share with some of the information learned with my colleagues, even with the Geography teachers” (DT2E). “I am going to apply in my own teaching as well as share with all the Life Sciences educators” (DT6E). A Grahamstown teacher said, “to improve our teaching and showing my colleagues that we can use different teaching methods and our CAPS documents to teach” (GT2I). Some teachers (GT2I; GT5I; DT1I; CT1I; CT2I) therefore expressed in the interviews that they realised their achieved functionings by sharing with their principals and colleagues at school and in their clusters. As revealed by three teachers:

²⁵ Knowledge and assessment planning tool / tool used to plan a lesson that incorporates the knowledge, pedagogical approaches and assessment practices (template in O’Donoghue, 2013: 26-27).

First of all, after the first session of Fundisa for Change I went back to the school and told the teachers and the principal (and the School Management Team), that we went on the workshop and it happened like this. So everybody feels this workshop is useful ... So I tried to educate them... (DT1I)

Yes, I have shared some of the activities and resources with my colleagues. I have also shared the T-sheet lesson planning with a friend who is currently doing her practical teaching and she has so far given good feedback when using that type of lesson planning form. (CT1I)

I shared with my cluster; some of them attended, so we have been sharing. But to share with the cluster is one thing, whether it is going to be implemented is something that needs follow up work. And this is where we need professional people like you within the PLC to monitor that progress. Because you can have all those workshops but if there is no one to go and monitor it does not help. Otherwise I will say yes, this is what I learned but will I do it? Yes we all should be professionals but we all know what happens when we are in the classrooms, it's different ... I mean you have these workshops, you give people resources but they will get to their schools and they are just not bothered ... time factors and class capacity, which is also something that you need to look at if you are going to be developing any of these resources or activities ... (GT5I)

The extract from GT51 above demonstrates a need for follow-up with the teachers to observe and support them as they realise their achieved functionings. In line with observing teachers' actual practice, the subject advisor who participated in the Grahamstown PLC activities noted that "winning teachers' trust to invite you into their classrooms is the biggest problem" (DP4). The extract reveals constraints for realising expanded capabilities. These constraints were confirmed by the subject advisor who participated in the Grahamstown PLC activities, as he noted:

Size of classes, time frames, we had a whole day, but it is very difficult when you only have 40 minutes or 35 minutes for a lesson and you have 60 learners, or 70 learners or 50 learners. So the time schedule in the school environment is a barrier as well as the number of learners. Not so much in Grahamstown, but I know in other districts the learners sit on beer crates, which is their chairs and tables. So space, although, it does not mean you cannot do this type of lesson outside under the tree in the open, which I actually think is marvellous to let the learners play, "role play". The teachers need to plan, how can I do it in a different manner but still get the same idea across. (DP4)

The next section reports on these constraints as they had been discussed by teachers in detail.

7.3.2 Unrealised functionings at classroom level

At the time of the research, some teachers (DT3I; DT4I; DT6I; CT21; GT3I) had not realised their achieved functionings in the PLCs in their actual teaching. This was because of the time the PLC activities happened, lack of teaching and learning resource materials, busy schedules at schools, learners' abilities, the CAPS content, lack of funding, large class sizes and lack of support from other colleagues at schools. Some teachers (DT3I; DT4I; DT6I; CT21; GT3I) were looking forward

to realising their intended achieved functionings at classroom level but mentioned the above factors as potential constraints to their actual teaching.

7.3.2.1 CAPS content

In terms of time allocation, Life Sciences is allocated four hours a week from grade 10 to 12 (D1). Grade 10 and 11 has been designed to be completed in 32 weeks out of the 40 school year weeks (D1). This leaves eight weeks in the year for examinations, tests and disruptions due to other school activities (D1). Grade 12 is to be completed in 27.5 weeks of the 40 weeks in the school year, leaving 12.5 weeks in the year for examinations, tests and disruptions due to school activities (D1). Time allocated in grade 10-12 includes the practical tasks and investigations (D1). These are an integral part of the teaching and learning process (D1; D13) (see Appendix 1 for time allocated for biodiversity content in the Life Sciences curriculum). Four teachers (CT21, DT2I; DT3I; GT5I) noted the amount of time allocated for Life Sciences was insufficient for quality teaching. The concepts and content that were stipulated to be covered in the allocated time frame were considerable. Echoing other teachers, the two teachers from Cape Town and Idutywa maintained:

The content matter of CAPS is absolutely perfect, no doubt about that. Those are the kinds of things that we learned about when we were in school in the 70s; higher grade Biology at that time. That is what we do in CAPS, but it is too much, that is the problem. As a result, you cannot do a thorough job on it, because you don't have the time, you have the syllabus to complete. (CT2I)

Time is very limited, and there is a lot of work to do ... especially that part that talk about assessment and effective feedback. You go to your class, you deliver a lesson and then after that you are supposed to give learners an assessment activity. It is impossible to give the learners an assessment activity everyday so that you can reflect on it, the bell will ring before they finish the activity, and you will say okay, let's do it as homework, and tomorrow it will be an obvious thing that they will just copy from the textbook. So it's like practically difficult. (DT2I)

It is evident in the extracts above that teachers found the amount of CAPS content to be covered constraining. The extract from the Idutywa PLC teacher (DT2I) provides evidence that teachers did recognise formative assessment and effective feedback as integral to teaching (D1; D6; D13). However the CAPS content that needed to be covered constrained implementation of formative assessment and effective feedback, compromising the quality of teaching and learning.

7.3.2.2 Fieldwork

As noted in Chapter Five, conducting fieldwork was one of the expanded capabilities that teachers would have liked to realise (see Table 5.1 and 5.2). Despite the value that fieldwork has in teaching biodiversity (D1), teachers mentioned lack of financial resources, large class sizes and safety as

some of the constraints to conducting fieldwork activities (DT3I; DT4I; CT2I; GT1I; GT5I; GT3I).

Illustrating this, one teacher in Cape Town expressed:

I mean if you have 300 grade 9s how are you going to take them to Kirstenbosch ... We tried with a group of grade 11 learners. We went on the train to the sea. We are in kloft; the station is ten minutes' walk from school. It was a beautiful experience, learners saw a lot and learned a lot, but there were two teachers with 97 learners. I spend two hours on the phone trying to find two girls who got off in Muizenberg without permission. How am I supposed to see the two learners slipping off the train? I realised we can't do this again; we are exposing ourselves to issues. These are the challenges. (CT2I)

He added:

Unlike the model C or private schools, our classes are getting bigger all the time. So the problems are becoming bigger. That is one of the complaints I had from my colleague when I asked if they did the practicals with the learners. They said they did but the class was too big to let the learners do it themselves. The teacher did it while learners observed. Some learners were listening and got it right, but those at the back did not pay attention they were having fun and did not take notes.

In line with the above extract, the Life Sciences *Specific Aim 2* notes that learners should be able to follow instructions, handle equipment or apparatus (D1). Thus constraints to practical activities, constrain achieving this Specific Aim of the curriculum. However the extract from the Cape Town teacher is in line with the curriculum document that stipulates that in cases of constraints, teachers should demonstrate the practical activities to learners because it is better than not conducting the practicals at all (D1).

7.3.2.3 Lack of teacher interest

Two teachers (CT2I; CT3I) in Cape Town noted the lack of interest among other teachers as constraints to actual teaching of biodiversity. One teacher maintained that at the school where he was teaching, there was a national botanical school garden but because of lack of time and teacher interest, the garden had been ruined. He said:

When Nelson Mandela was released from prison; the first school he visited in Cape Town is the school where I am teaching. He opened up our biodiversity garden. This is because the school has a history from the apartheid times. He opened up this rich garden, but I subsequently left after that. Now I am back but the garden is ruined. The interest is not there ... there are few things but it is not maintained as a biodiversity garden. The National garden which was opened up by Nelson Mandela (was neglected), that shouldn't have been allowed to happen, but time, interest, when you have in my case three periods a week for admin and you need more, there is just no time for anything. (CT2I)

The extract above reveals a political interest in biodiversity conservation. The extract further demonstrated how lack of time and lack of teachers' interest constrained biodiversity conservation. This teacher did not explain or make any explicit links between the botanical garden and the

teaching of biodiversity. In line with whole school development (D6; D13) and CAPS, he could use the botanical garden to teach biodiversity content (this teacher had experienced the activities done at Kirstenbosch Botanical Garden; he could model that to teach biodiversity in the botanical garden at his school). Ironically he was one of the teachers who noted class size as a constraint to fieldwork activities (see extract in Section 7.3.2.2).

7.3.2.4 Learners' abilities

Five teachers (CT31; GT1I; DT2I; DT3I; DT2I) recognised learners' abilities as constraints to their expanded capabilities. As mentioned in Chapter Four (see Section 4.3), teachers in this study were mainly teaching in the rural areas or township schools. In line with their school contexts, they noted the learners' inabilities to read and write as constraining factors to their actual teaching (CT31; GT1I; DT2I; DT3I; DT2I). Learners' lack of abilities influenced the concepts and the teaching methods employed in teaching biodiversity (DT2I; CT3I). Teachers recognised the contextual factors as contributing factors to learners' inabilities to read and write and their lack of participation in teaching and learning (DT2I; DT3I; CT3I; GT1I). The teachers from Idutywa and Grahamstown explained:

I think the area where you are teaching is also contributing because one thing that is holding the learners back is inability to participate in the classroom ... In my case, you will be asking a question and they will take about five minutes to give you a response. So in many cases you just present and present without asking questions and there won't be participatory learning as it is supposed to be. But for learners, who are, I don't know whether to say in towns or urban areas, the teaching and the lesson is just flowing nicely because the class is active, you pose the question and they answer the question, so if you set a particular time you always meet your target. (DT2I)

She went on to say:

I don't know, I will say it is because of the environment. It is because they are in rural areas; their understanding ... it is like you need to spoon feed them. They just sit, they are shy, and they don't want to talk and to voice their opinions ... they find it very difficult to communicate, unlike those learners that you find in private schools, so in a way that is restricting you in a classroom, you will be spending time doing one thing without progressing to what you wanted or without finishing your core business in the class. So those are the things that we find difficult, or I find difficult in my class.

One of the Cape Town teachers noted:

Our learners' level of understanding, their reading ability, their writing skills, is very difficult. So what I do is take what we do in the courses and do a little bit of what they will understand. What they can grasp, because I cannot do all of it. Especially with the ACE that we are doing now, with the reading, the scientific reading and understanding that does not work for our learners, so that is a bit of a problem. (CT3I)

The Idutywa teacher's extract shared above recognises the importance of participatory methods in teaching biodiversity (see Section 2.3.1; Section 5.2.3). However, like the two other teachers (CT3I; GT1I) she indicated that learners' inability to read, write and lack of agency determines the choice of methods used to teach biodiversity. As noted in Chapter One, it was evident in the teachers' interviews that the Idutywa district is a rural area and learners live far from school (see Section 1.6.1). The learners were using transport provided by the government. Thus, unlike in Grahamstown, in Idutywa teachers stressed that they were not able to support learners in the afternoons or over weekends. One Idutywa teacher said:

Learners come from different areas; far way ... they are transported by the government, so you cannot ask learners for an extra class in the afternoon, because they will not have transport to go home. Even on weekends, the department does not cater for them during the weekends to come to school. Only grade 12s because our principal begs them to come and live closer to the school. We are teaching in poor communities, and it is not easy for the learners to come rent in those areas closer to the schools ... For grade 10 and grade 11 is quite difficult, you cannot do anything. (DT3I)

The Grahamstown teacher said:

I tried to implement them in the morning classes ... when I try to teach them for example that there are direct and indirect causes of biodiversity loss. Some cannot hear what I am saying. Some, I am confusing them as I am talking. I tell them if you did not understand, please come back for extra classes, but they will not come back. But you will see when you are marking that they did not understand. Maybe they are shy. (GT1I)

The extract from the Idutywa teacher above echoes what the other two teachers in that PLC noted (DT3I; DT4I). They observed financial and contextual factors as constraints to their teaching of biodiversity. These teachers noted the impact as greater for grade 10 and 11s. This is a concern as most of the biodiversity content in Life Sciences is covered in grade 10 and 11 (D1; D9; D10; see Appendix 1). The Cape Town teachers did not mention anything related to afternoon or extra classes. In terms of contextual challenges, one Grahamstown teacher (GT1I) revealed that a lack of water was a constraint to the realisation of their teaching as shown by this extract. "At our school we can go for a week without water and it is very difficult, we need to break early because we have 1016 learners and we only have two toilets ... we leave at 11'oclock, and that means four periods down ... usually we are not finishing our syllabus" (GT1I).

7.3.2.5 Lack of resources

To enable teachers to realise their achieved functionings, the CAPS curriculum suggests the resources needed to teach certain topics (D1). Schools must make efforts to ensure that equipment is provided (D1). If equipment is limited, teachers must improvise (D1). It is important that learners develop required skills (D1). Teachers (DT3I; DT4I; GT1I - GT3I; GT5I; GT1E - GT3E; DT1E; DT3E - DT6E; CT1E; CT4E) noted lack of teaching resources as constraints to their teaching of

biodiversity concepts. As one teacher from Idutywa noted “it is not easy to get resources, we are only supplied with one textbook and you have to go out to find resources, which is not easy. So it would be nice to have more resources” (DT5I). A teacher from Grahamstown said:

It is not easy because if it is for example articles, I am not reading newspapers every day. So I have to go to the library and photocopy those articles if I find one good article, I have to come here at Rhodes and google so that I can download some articles, and sometimes you see that now I have run out of time, I don't have time to collect resources. so that is one challenge that we have, that we have plenty on our plates so we can't do it well, but sometimes we do have the time then we do it well. (GT1I)

In line with the CAPS documents, one teacher in Grahamstown maintained that if resources were not available she improvised. She said:

For resources I will improvise. Our principal is very supportive. If you need any resources he provides ... If you need anything he will provide. Even when I was asking you for a sperm germ and you said we could buy it in Pick n Pay, he gave the money ... He even get sponsors to get some of the resources. We have internet on the library computers; they (learners) can access it anytime if there is a teacher. (GT2I)

Evident in this extract is the support that some teachers (CT1I; DT2I; DT5I) received from their school to realise expanded capabilities. Supporting teachers with resources is one of the roles of schools (D4; D14). In Idutywa, during the first session teachers did not receive the PowerPoint presentations and video clips that were used in the PLC to unpack some of the biodiversity concepts (i.e. human impacts on biodiversity loss, responses to biodiversity loss) (also see Section 6.2.2.1). Even though the facilitators made an effort to send the resource materials, teachers did not get them in time to use in their actual teaching. That was reported as a constraint to teachers' expanded capabilities. One teacher said:

At the first session, [name withdrawn] promised to put the materials on the CDs and send it to us, but those materials never came because of the post office strike ... I was waiting to show my learners ... to say this is what I went to learn, these are the new concepts. I don't deprive them information ... the knowledge I got is not for me, I share with them ... even that video that you showed us about the depletion of the marine biodiversity, overfishing and so on, I could have projected it for them to see, it could have also impacted on them one way or another. But unfortunately, I did not get those materials at that time ... (DT5I)

It is evident in the above extract that political factors also impede on the quality of education. Teachers could not get the teaching and learning support materials because of the protests at the post office. As evident in the teacher's extract (GT2I), some teachers explained that their schools were well resourced with facilities such as the library, laboratories, internet and photocopying machines (DT2I; DT5I; GT2I). Teachers in Grahamstown revealed that they sought assistance from the Rhodes University Mobile Lab (see Chapter 5.2.4) and Albany museum. One teacher maintained:

The challenge is that we don't have these things that you are talking about, different plants, animals, insects and those things. That is why it will be nice if Fundisa for Change can bring those things to us so that our learners can observe them because we cannot take them to field trips, or I will show them pictures from books or internet as I usually do. (GT3I)

The above extract demonstrates the valued functioning of Fundisa for Change to support teachers with resources. Evident in this extract is also that external factors constrain teachers to change their teaching practice. In terms of material resources, one of the teachers (DT2I) in Idutywa expressed in great detail that the Chief of the Village in which her school was located, was very supportive. However the same teacher still recognised lack of resources as constraints to her realisation of some of the content learned in the PLC. She expressed:

We have a very effective Village Chief who is supporting Science ... He gave me DVDs, tools for practicals, microscopes, in fact a whole kit for Science. At our school we have a structure, the lab building but we did not have resources, so he managed to get us some things to keep us going, for Life Sciences, Mathematics and Physical Science. The school where I am teaching is called Mandela School or it was built by Mandela something like that ... he feels like he is also part of the school ... He come to the school and asks what teachers need, where do you think can I help? Even with the computers, he supplied the school with computers ... But of course there will be those things that are not there, even if we do have the structures, and some of the resources there are other things that we don't have, I can't say it is 100 per cent working ... (DT2I)

As mentioned in Chapter Five, teachers are expected to submit an assignment in the form of a portfolio of evidence to receive certificates of competence. The submission of the portfolio of evidence is in line with the draft document on guidelines for PLCs in South African schools (D14). This document highlights that as part of the PLC activities and SACE professional development points systems (see Section 2.4), all teachers will be required to record their professional development in a professional development portfolio (D14). The professional development portfolio can contain information on engagement in PLCs (number of meetings, dates, agenda...) as well as the outputs and outcomes of the PLCs. These can include lesson plans, notes of lesson observations and reflections (D14). This is in line with the Fundisa for Change requirements for the portfolio of evidence (see Appendix 7). The Fundisa for Change portfolio of evidence requires teachers to provide evidence on lessons taught, how they were taught, methods used, resources used, how learning was assessed and the teacher's reflection on the lesson (see Appendix 7).

The model used has been based on a principle of "work together" in the PLC, and then "work away" in classrooms on applied assignment. Through this approach, teachers have been implementing tasks aimed at improving their teaching practice. They try out new ideas and then reflect on this practice and report back in their meetings. This process of developing reflexivity contributes to the improvement of knowledge and teaching methods to support

sustainability practices and learning at school. The classroom practice is supported with resources. (D13:3)

In line with the Fundisa for Change model, the policy document on PLCs notes:

Teachers can discuss and learn something in a PLC, apply it in their practice and reflect on it during the next PLC meeting. PLC discussions that result in changes in practice can be followed up by monitoring that practice, for example through lesson observations and error analysis, enhancing coherence in professional development. (D14: 10-11)

As mentioned in Chapter Four (see Section 4.5.1), only one teacher in Idutywa submitted a portfolio of evidence (DT2P). None of the teachers in Grahamstown submitted. Cape Town teachers had a different task to do. The task was aligned to the Fundisa for Change assignment but it was also aligned to the Advanced Certificate Course (as noted in Chapters Four and Six, some teachers in Cape Town participated in the PLC activities as a developmental activity for the Advanced Certificate Course). Fundisa for Change makes provision for institutions of higher education to adapt the assignment depending on their institutional mandates (D13). It was evident that all the teachers in Cape Town completed the assignment. This could be because of their Advanced Certificate Course expectations and structure that enabled them to complete the assignment. One teacher (CT1) who participated in the Cape Town PLC activities but was not enrolled for the Advanced Certificate Course, in line with the assessment task, provided evidence for the lesson on animal diversity.

Despite the fact that all the teachers indicated in the evaluations that the assignment was challenging enough and was contributing to their learning, they found it an ominous or perhaps over-demanding task. Three of the teachers (GT2I; GT4I; GT5I) who had not submitted the assignment indicated other personal and occupational valued functionings as constraints to their completion of the assignment. The subject advisors in the Idutywa PLC confirmed teachers' workloads as constraints to completion of the assignment. One of the Idutywa facilitators said:

I will not be surprised if our assignments returns are low. For a variety of reasons ... the teachers might not see the significance or require those certificates at the moment, once they start to contribute to the SACE professional development points maybe they will see the importance of getting something like that achieved. I also think it might be linked to the fact they still don't feel that they themselves are confident to put this together. I think those assignment requirements are high level ... without more sessions, without more time spent with them, I would feel that the assignment component will be low. (NP1R)

The above extract reveals a few reasons why teachers had not submitted the assignment in Idutywa. Those could apply to the Grahamstown teachers as well. Reasons include individual teachers' valued functionings which might not include a certificate, and teachers' lack of confidence or over-determination of the assignment task. In line with the professional development points, two Fundisa

for Change partners (DP1; NP1) observed that teachers lacked trust in the SACE system. Commenting on the SACE point system one Fundisa for Change partner who was working at the national Department of Basic Education said:

From the administrative point of view, it should have been done differently, then we would be having our first cohort of teachers going through any kind of training like Fundisa training reaping the benefits of those professional points ... and you and I both know that, had you done something and you found it worthwhile you will want to go further ... (DP1)

However it was evident in two teachers' interviews (DT4I; GT1I) from Grahamstown and Idutywa that they did value certificates upon completion of the PLC activities. One teacher noted "I came here because the subject advisor said, at the end of the training you will have a certificate and I wanted that certificate" (GT1I). While the other teacher said:

At least after we have attended the whole training, there should be a certificate telling that this person have gone through this training. So that someone can know that you have been there and have done marine biodiversity, not only telling them verbally, there should be evidence that, I have attended this course or training. (DT4I)

However despite their valuing of the certificate, the two teachers did not submit their portfolios of evidence. GT1I was one of the teachers who had realised her achieved functionings (see Section 7.3.1 in this chapter). Among the teachers who did not submit the portfolios of evidence in Grahamstown one teacher said, "I will meet with GT2 during the holiday to discuss because the work for the term will be over ... but it is not easy, I am trying because I want it, but now I am busy with exams" (GT4I). Another teacher noted:

I did not know there will be an assignment. We want to be workshopped only; we don't want homework and assignments. I think that is what changed other people's minds about attending and those who did not come back; they don't want to do an assignment. We are busy and we are adults ... I have marking and it is a lot of work. (DT3I)

The extract from the teacher above seem to support what the Idutywa PLC facilitator noted about teachers not valuing certificates. This extract confirms that teachers valued PLC activities but also revealed that teachers would potentially stay away from the PLC activities because of the assignment. The point made in the above extract is in line with the facilitator of the Idutywa PLC who noted:

But then from the personal point of view one needs to look and say but what was my entire focus? Was my entire focus to assist teachers to become better teachers in that marine biodiversity component? Which of course the assignment assists them in that process or can I say that we have achieved it even if they don't get the assignment done? Fourth term is a very critical time for all teachers. They were keen to do it. We do know that in grade 10 it is in the fourth term that is why we chose to do it at that time, from the point of view that they will be able to include it in their teaching practice. At the end of the day, very few of them had

actually managed to teach that section. And some had said well we don't teach grade 10 ... (NP1R)

Evident in the above extract is still a need to reflect on teachers' real valued functionings in the PLCs. If they do not value the certificate they will not submit an assignment. The above extract confirms what was indicated earlier: the assignment is in line with the teachers' classroom practice. Some of the Fundisa for Change partners (NP1; UP6; NP2) mentioned that the assignment was challenging. Teachers may need to be further supported to complete their assignments (UP4; UP6). One of the Fundisa for Change partners who participated in the Grahamstown and Idutywa PLCs maintained:

I think there should be someone within the programme assigned to portfolios. Someone who will actually visit schools, talk to the teachers and hear what the problem is. Even the fact that teachers will know that there will be someone following up, they will compile the portfolios. That will be something that will motivate them. Now they see it as optional ... Is not something that takes the teacher out of what he or she does ... we train them on a particular topic which is already in CAPS which they have to implement. We are not asking them to do something out of context ... what we want is just the evidence to see how the training helped them out on teaching this topic. (UP2R)

The extract above further confirms that the assignment is aligned to teachers' actual practices. There is a need, however, for onsite visits and follow-ups to support teachers with their assignment. Supporting this, one of the facilitators in the Grahamstown PLC reflected "I don't think we have done enough ... we need to think about ways in which we can improve our processes, think about how we can support teachers in developing portfolios that are meaningful and include effective assessment strategies" (UP6).

7.4 Teachers' new valued beings and doings

At the end of the PLC activities all the teachers had new valued beings and doings related to biodiversity and Life Sciences. They expressed a need for more support from different stakeholders as discussed below.

7.4.1 Further support from Fundisa for Change

In the interviews and evaluations teachers expressed their new valued beings and doings related to biodiversity. The teachers' new valued functionings are discussed in detail below:

7.4.1.1 Support with more Content knowledge / biodiversity related concepts

They indicated that there were still some biodiversity concepts that they were not comfortable to teach. For example while in all three PLCs some teachers indicated that they were feeling comfortable to teach concepts engaged with in the PLCs (see Section 7.2.1 in this chapter), the following teachers wrote in their reflection tools the biodiversity concepts that they were still struggling with:

DT1R: Dichotomous key, ethical consideration of marine biodiversity, human impact on marine biodiversity.

DT2R: Species identification keys, determination of indirect roles of marine biodiversity, policy and legislation under responses and mariculture.

DT3R: Taxonomic keys.

DT4R: Marine trophic levels, ethical consideration, responses to biodiversity loss.

In Cape Town, two teachers wrote in their reflection tools:

CT1R: Classification, cultural services, ecosystems change, desertification.

CT3R: Ecological niche, ecosystem services, desertification, overexploitation.

In Grahamstown, two teachers wrote in their reflection tools:

GT1R: Dichotomous key I need more practice, conducting fieldtrips.

GT2R: Dichotomous key.

GT3R: Genetic diversity, dichotomous key.

GT4R: Dichotomous key.

It is evident that as much as certain teachers were comfortable teaching biodiversity concepts, some teachers still needed more support with particular concepts (see Section 7.2.1 in this chapter). As indicated in Chapter Five, in all three PLCs many activities were conducted to engage teachers with the concepts of dichotomous key and classification. But it is evident that teachers still need support with those concepts. This confirms the comments made earlier in this chapter by the facilitators on the need for more activities to expand teachers capabilities. In addition to support with the above mentioned biodiversity related concepts, all the teachers indicated that they needed to be supported with the topic of evolution as discussed in the next section.

7.4.1.2 Support with the topic of evolution

Interestingly, all the teachers in the three PLCs expressed in great detail the need for support on the topic of evolution. They indicated that the topic of evolution was very challenging, confusing and new in the curriculum. Two teachers, for example, said:

If Fundisa for Change can also tackle the topic of evolution the way it has tackled marine biodiversity. Take me to where this evolution is happening ... in the caves. So if they can organise a workshop like this ... This is a new topic in grade 12 and we are not familiar with it and it carries a lot of marks in the exams. That is why we want to know more about it ... What the department is doing is, it gives us books about evolution. Fundisa for Change can invite teachers of Life Sciences and teach them evolution ... It is good in equipping teachers; I clap hands for Fundisa for Change. (DT6I)

If you look at grade 11 or 12 syllabuses, you will find that our syllabus change every year. Whenever it changes, there are new topics added, just like evolution and genetics. Those topics are very difficult. We used to have monohybrid crossing in genetics now we have dihybrid crossing, and that dihybrid crossing is very difficult for me. Than it is very difficult to teach learners something that is very difficult for you to understand. Even evolution, most of the times I ask the subject advisors to come teach it for me. We did not get enough workshops or professional development on that. I am interested if we can be workshopped on that so that I can learn more about those topics. (GT3I)

In line with the teachers' extracts, the topic of evolution is covered in grade 12, term three and four under the topic of 'evolution by natural selection and the topic of human evolution' (D1). However it is linked to other topics in the curriculum such as human skeletons taught in grade 10 term two under the topic of support systems in animals (D1). The topic of evolution is allocated 44 per cent in paper two of grade 12 examinations (D1). In Grahamstown, teachers acknowledged the support that they received from the Department of Basic Education on the topic of evolution. However, they explained that the workshops are usually not interactive, do not engage them in any activities and thus they do not find them effective. One teacher said:

Our subject advisor takes us to the museum each year. I remember one of those workshops, I slept throughout. They just stand there and teach as it is. I go there thinking they will do some activities to keep us awake, I slept, I gained nothing, if they can be more active like Fundisa for Change, taking us out, showing us things, those fossils, not taking us to the museum opening the audio visual and we look at it. You are tired, so you just sleep. Here you teach us biodiversity; you took us to the stream showing us how to do the fieldtrip so that we can also do it with our learners. (GT1I)

The subject advisor who participated in the Grahamstown PLC activities did support the teachers and tried to assist with their lack of knowledge on evolution. He confirmed that teachers usually seek assistance from the subject advisors to teach the topic on their behalf. He also revealed that, some of the teachers are not comfortable teaching the topic because of their religious beliefs. He noted:

Our Life Sciences teachers are not comfortable with evolution. Myself and my subject advisor will teach that topic. I particularly don't go to the classrooms, but I do teach here at Albany museum where the schools can send their learners for the morning, and I will deal with the evolution theory with the learners. The teachers can also attend. But because of personal, religious or ethical reasons, they feel very uncomfortable with the topic, but as it is part of the subject curriculum, it has to be taught. (DP4)

7.4.1.3 To stay in touch with the learning community

The teachers expressed in detail the need for further support from the Fundisa for Change programme (to stay in touch with the PLC). They recognised that with most topics in the Life Sciences curriculum, there are certain aspects that are challenging. They therefore valued on-going support with the challenging topics in the curriculum. This support could be once a term. One

teacher from Idutywa said “for example biodiversity of microorganisms in grade 11 is the topic for first term. So if it can be possible, before we teach that topic in the first term, we convene somewhere, we arrange together with Fundisa for Change and we discuss that topic together” (DT4I). In line with (D2; D3; D14) the teachers recognised that it is the responsibility of the Department of Basic Education to ensure that they are capacitated and confident in their teaching. “Ideally it is supposed to be the department to conduct workshops of this nature, but realistically they are not. That is why I am saying if it could be possible to get more training like the one we got from Fundisa for Change” (DT3I).

One teacher in Idutywa (DT4I) expressed financial constraints to participating in professional development activities. He revealed “the problem that we have is that, when we attend these workshops, there should be accommodation and there should be transport, so it is not always possible to have those benefits” (DT4I). He therefore indicated that it will be an enabler if they can be supported financially to attend professional development activities that can be offered by the Fundisa for Change or any other stakeholders. All the teachers in the PLCs explained in detail in the interviews the further support they need from the Fundisa for Change. Echoing other teachers, one teacher from Grahamstown said:

Fundisa for Change can still help us and can give us more knowledge and more confidence, because as we come to attend we gain confidence. Fundisa for Change really did its part and I think it changed us. We can teach for the better now and we can teach so that the learners know more. It can change the situation we are in. Like I said our learners know but they cannot read. So I think those things need to be tackled by Fundisa for Change and in the clusters. (GT1I)

Like the other teachers she also mentioned the need to be supported on how to support learners with their reading skills. This is not surprising, given that a lot of research in South Africa points to learners’ lack of numeracy and literacy skills (D3). In line with this, one Fundisa for Change partner from the national Department of Basic Education said:

We are trying very hard at the department to make sure that we have language across the curriculum. Particularly English across the curriculum ... whether you are Life Sciences, Accounting, Woodwork or a Technology teacher, that you make sure that within your subject, learners are using language correctly ... Because in the past what used to happen and is still happening is that the teacher of the subject would say this is a language problem ... the language teacher must sort it out. The child can’t calculate ... the mathematics teacher must sort it out. So what we are saying is, to be effective in your subject, you need to make sure that the core competencies are in place. (DP1)

7.4.1.4 Support with practical activities

Four teachers (CT1E; GT1I; GT3I; DT2I) indicated a need for more support with conducting practical activities (as prior to PLC activities, Table 5.1 and 5.2). While two teachers’ (GT5I; DT2I)

valued functionings were to be assisted with assessment activities and resource development. As one teacher in Grahamstown said:

Teach us how to set up those activities. We had the activities set up; I had to take the knowledge and whatever I remember from that day to try to set similar activities. How about the facilitators actually take us through setting up the activities saying you take this and this and put it there to come up with this end product. And then worksheets, I feel that we should have been provided with more of those activities ... For me is more on resources and resource development ... I can stand and teach but developing sensible learning materials is a challenge. The types of activities that I can set up make a big difference. It should not just be the content, there are activities in the textbook, but for me they are not concrete enough for that biodiversity section and it takes one to be very creative, to actually have that in-depth understanding. (GT5I)

While the one teacher from Idutywa noted:

I need more workshops, if it can be conducted on forest ecosystem, because in the community in which the school is built, there are large forests. There is even a plantation which is a man-made forest and an indigenous forest. So, I want to know the species. The forest is close to the school and we will not need money to go there so that learners can observe and understand that those resources found in the forest are useful. So that they stop killing or taking out the roots all the time. They should know the impact of destroying the forest and the impacts of deforestation. (DT1I)

7.4.1.5 More time should be allocated to PLC activities

Teachers (CT41; CT4E; CT3E; DT2E; DT5E; GT4E) expressed that more time should have been spent on some of the activities and teaching methods to fully expand their capabilities. As one teacher from Idutywa said “there are more areas that needed to be discussed in more detail” (DT5E). They thus valued more support as shown by these citations: “I want more knowledge about new marine biodiversity or species, as they are being discovered” (DT6R). “You will never know enough, because there are always new things” (CT3I). “There is room for learning new things. When I attended the first session, I did not know about mangroves, but in the second session I was taught about mangroves” (DT6I). Two teachers in the Idutywa district also re-emphasised at the end of the PLC activities, as mentioned in Table 5.1 that they wish to study further on marine biodiversity. These teachers (DT4I; DT6I) therefore expressed in their interviews for Fundisa for Change to offer them bursaries to further their studies on marine biodiversity. Some teachers (GT3I; GT5I; GT1I; DT3I) needed further support with teaching resources. “After the Fundisa for Change I realised that I can do outings were we can identify and observe the insects we will find like we did with the wetland study in the training, but we do not have the identification manuals to identify the species” (GT2I).

7.4.1.6 Need for provincial and district spaces for PLC activities

All the teachers in the three PLCs noted that because of the motivational nature of Fundisa for Change, all teachers irrespective of what they teach, should get an opportunity to benefit from the programme. As expressed by teachers from Idutywa and Cape Town:

The comment is that, Fundisa for Change, if I speak in Xhosa, I will say “Phambili with Fundisa for Change”. This means that, this programme must travel a long way, not only to us here in the Idutywa district. This is the programme which is meant for teachers to take steps and do what they need to do. And Fundisa for Change must not only come once, and the time must be longer, maybe a week, so that we can get more. But we gained a lot, because even the word Fundisa, you teach and then you change. The way I use to kill the ants with my school, I would say they are boring and would kill them. But now I know that every species have an ecological niche. (DT1I)

I am very grateful that we were asked to do this course. I was happy and excited and of course it was free, we learned a lot. I think we got so much information and so many different ways of bringing it into the classroom, the only challenge that I still have is with the teachers. Because I believe that teachers must, whether you are teaching English or Afrikaans, Mathematics, you must have an understanding, thus will be good if Fundisa for Change can support all teachers. (CT3I)

Emerging from DT1I in the extract above is an unintended outcome: change in attitude. In the case of DT1I her expanded capability developed her agency to conserve species. Echoing other teachers (CT3I; CT4I; GT1I; DT5I; DT4I), she noted that the times chosen for the PLC activities were not right (see Section 6.2.2.4). For the Idutywa teachers, they noted that towards end of the year they were under pressure, trying to finish the curriculum and trying to prepare learners for examinations. “Timing for grade12 teachers (is not good) as we are preparing for trial exams, but (the workshops) are very valuable, we can sacrifice” (DT3I). Cape Town and Grahamstown teachers did not value participating in the PLC activities after school and over the weekends. “Time is a real challenge. Attending classes after working hours is not very easy. It will be better if we can attend the sessions over the holidays then it will give us enough time” (CT4I). However they maintained that they value PLC activities, and thus were prepared to sacrifice. “Personally ... if you tell me to come this weekend, I will be very reluctant because I have so many other things that I would love to do this weekend, but I will still get there” (CT2I). The policy document notes that PLCs are an instrument to engage in meaningful professional development and are therefore not an add-on to the existing tasks and responsibilities of teachers (D2; D3; D4; D14). Time for teachers to participate in PLCs should be scheduled into the school year (D2; D4; D14). PLC meetings can take place during the immediate pre- and post-term periods in order to minimise loss of teacher time (D2; D4; D14). Teaching schedules can be organised in such a way that teachers have some time during the school week to have a PLC meeting (D2; D4; D14). Despite the policy documents, teachers (CT4E; GT5E; GT2E; CT3E; GT1E) noted time as a main constraint to the PLC activities. The facilitators also

noted time as a potential constraint to PLC activities. One of the facilitators in the Cape Town PLC maintained:

Time is a problem to get the teachers. There are times that they are doing the marking and having exams in the third term. There needs to be some different way that we are engaging the teachers... to follow up with that, it is a problem for me ... With ACE it is easy because there is a structure, you have a regular cohort that you work with but you do not want to deny the other teachers the opportunity. (UP4R)

The extract above reveals the importance of having a structure in place that enables the PLC activities. The Advanced Certificate Course of three Cape Town teachers (CT2-CT4) provided an enabling structure. It allowed for further meetings and onsite visits from the facilitators. Like the teachers, all the Fundisa for Change partners noted a need for further support and onsite visits. However they recognised time, human capacity and financial resources as the main constraints (D5). Echoing the other partners, one Fundisa for Change partner expressed in detail:

Teachers have benefited from Fundisa for Change; the question is how to continue strengthening their work? It will be most valuable to know that now we have made a commitment, we trained them, they did an assignment, they got their accreditation, is not like they never want to hear from us again, they have already expressed desire to hear from us again ... You have invested in them your time, your expertise, your knowledge, your finances, so how can you continue to give them opportunities? They will probably be practising what they have learnt but for them to feel the Fundisa identity, they need to be kept close and be given opportunities for further learning. (NP2)

She further noted:

How do we balance between introducing new teachers to the programme and continue to support those who have gone through the programme? How do we continue to give them opportunities? Get more resources and information? That can happen through Eco-School coordinators but what about the teachers who are not in Eco-Schools? There is a need for coordination of PLC activities in Fundisa for Change to keep communication channels with teachers. The website is running but that is not enough. Teachers hardly visit the website. They need someone to be sending them text messages about opportunities and creating opportunities for them to meet and share. Having a provincial coordinator is needed to strengthen the PLC activities. There is a need for better support of teachers PLCs at local level department of education. This requires engaging school management in the PLC activities to help motivate teachers. Another thing that would enable the PLCs would be, if we do develop that principal's module. Which I think is key, because support from the principals will be another enabler.

Emphasis in the above extract is the valued functioning of further supporting teachers to expand their capabilities for biodiversity teaching. Emerging from the extract is also a valued functioning of Fundisa for Change provincial coordinators. This is critical, given that as mentioned in Chapter One, Fundisa for Change is a national programme (D5). PLC activities happen across South Africa in all provinces. Thus provincial coordinators could enable the PLC activities within the provinces.

At the time of the research, the programme only had one coordinator and given the activities and the teachers' new valued functionings, it will be an enabler to have more than one coordinator or alternatively as suggested to have provincial coordinators. This is also supported by another Fundisa for Change partner who said "it is too much for one person, because it happens in different provinces and within provinces in different regions. So there is a need for some kind of efficient management which could mean most of the project funding must be directed in that direction I think" (UP3). This explains why human resources have been mentioned as a constraining factor for further support of PLCs and for school visits.

In line with the extract from NP2 who noted a need for district level support and school management support for PLCs, the policy documents highlight that school management has a role to play in PLCs through ensuring an enabling environment for teachers to participate in PLC activities (D4; D14).

School leaders should give instructional leadership through encouraging and motivating teachers to participate, setting and monitoring the agenda, creating a culture conducive to collaborative learning, promoting enquiry and building capacity. However, PLCs also require distributed leadership. (D14:10)

According to the policy documents in South Africa, PLCs are initiatives at school level mainly, that enable teachers to determine and work on their own professional development needs (D2; D4; D14). The subject associations can strengthen PLCs with ideas, content and expertise (D2; D4; D14). Therefore, PLCs at school level need to interact with subject committees and subject associations (D14). The policy document recognises research as central to informing PLC activities. The documents further recognise a need for structural support and the importance of external expertise in PLCs resonates with the discussions in Chapter Six. In the interactions I had with teachers, there was not much evidence that showed that teachers were familiar with the policy on PLCs in South Africa. However, it is evident that teachers are keen to participate in PLC activities.

According to the policy documents on PLCs in South Africa (D2; D4; D14), the Department of Basic Education is the lead agent for implementing PLCs. For a better understanding of the implementation of the PLC policy in South Africa, I interviewed the Director of the Continuing Professional Teacher Development Directorate who confirmed that the policy focuses on establishing school-based PLCs. He said:

Remember the PLCs are meant to be established at school level, so what we have done as a national department is we have developed guidelines to support provinces in setting the PLCs up, we have developed that document²⁶ ... There have been a small number of schools that

²⁶ This is referred to as D14 in the study.

teachers have taken their own initiatives to establish PLCs and what we found is that we are having to put a lot of push from national and provincial to get teachers to participate and establish PLCs and that has been a challenge. In other countries, once the initiations have been done teachers tend to run with it, but in our case we are having to push from behind quite a bit.

He went on to say:

To indicate to you that the challenges that have been experienced are particularly in schools that are considered to be dysfunctional. The challenges have been just because the school is not functioning properly is not possible to get PLCs well established in those schools easily. The other challenge is that some of the leadership in some schools who are supposed to be running some for these structures don't have a sufficient understanding of how to run them. In other words how often, what should the teachers discuss, how best do the PLCs achieve their objectives... there is national programme to address this issue especially of dysfunctional schools but obviously it takes time.

It is evident from these extracts that the national Department of Basic Education was in the process of establishing PLCs and the challenges are also evident. In line with the teachers' new valued functionings to get further support from Fundisa for Change, he noted:

We have been to a couple of workshops that Fundisa for Change have run and they have some excellent materials. I think it will be good if Fundisa for Change can see what is happening in the provinces to enhance what is already there. My own sense is that Fundisa for Change have a very good model, thus it will be very useful if Fundisa for Change can work with each of the individual provinces to see how it can make the contribution.

It is therefore evident that there is a need for further support from Fundisa for Change.

7.4.2 Support from the Department of Basic Education

In the interviews and evaluations, teachers (GT5I; GT3I; GT1I; DT3I; DT5I; CT1I; GT3E; GT2E; DT4E; CT1E) indicated a need for support from the Department of Basic Education. They all acknowledged the support they received from the subject advisors. They however expressed that to transform their teaching practice; they need more support from the Department of Basic Education.

One Grahamstown teacher said:

We have a very good subject advisor who gets out of his way to try to make things happen ... people above him are not really as forthcoming. If there is no budget or transport allocated that is it. For him to end up giving us resources he needs to get (go) out of his way ... if we had more support in terms of the district and above the district in terms of resources and expertise ... So in a way we are on our own and it takes initiatives and passion on the part of the subject advisor to make things happen. He really just needs a supportive group I would say. The lady in charge of the subject at the provincial level is also passionate and does assist if given enough time to plan for a workshop, she does contribute. But it's individual based so there is a lot that need to be done. (GT5I)

The Fundisa for Change partners (NP1; NP2; DP2; DP4; DP3) recognised that some of the subject advisors had inadequate subject content knowledge. They therefore saw a need for subject advisors to be supported by Fundisa for Change to effectively support teachers. The subject advisors who participate in the PLC activities confirmed this point, as one said “subject advisors have gaps in terms of content, assessment and pedagogy. They do not always feel confident to support teachers ... because they do not get any formal training when they get appointed as subject advisors ...” (DP2). The subject advisor who was a participant in the Idutywa PLC noted:

I benefited a lot, especially when it comes to different teaching methods that seem to be very effective ... At times, you are asked by the teacher, to come and teach for that particular teacher a certain topic and the teacher will ask, now that you took me through this particular topic could you just come and demonstrate for me how I could teach it. Then there will a lot be innovative ways that I have learned from Fundisa for Change, which will even be more interesting for the learners. Because often when I am asked by the teacher, I go do demonstration for the teachers at schools ... I think my group have benefited a lot, and I am confident to continue supporting them. (DT3)

Evident in the extract above is an expanded capability of the subject advisors to be able to support teachers confidently. What is also evident in the extract from DP3 is that teachers seek support from the subject advisors to teach challenging topics for them. The same subject advisor also noted a need for more teachers to participate in PLC activities “if it was possible, you could have invited more teachers, the number of teachers that were invited were very few. But we will try our best to make sure that, even teachers that did not participate ... they will benefit through the support that I will give to them” (DT3). In line with the support that the Fundisa for Change programme can give subject advisors:

An iteration of the Fundisa for Change programme has also been developed for subject advisors. Here the content of the programme is similar, but the perspective shifts to assisting subject advisors in their work with supporting teachers in their region to achieve their goals ... (D13:2)

It is evident in the extract from the Fundisa for Change facilitators guide that provision is made by the programme to support subject advisors. Also from the Fundisa for Change programme reports.

As mentioned in Chapter Five (see Section 5.2.2), teachers in the Grahamstown area acknowledged the support they received from the Rhodes University Mobile Lab. They revealed that due to lack of funding the Mobile Lab was closing down. One teacher (GT3I) indicated that the Department of Basic Education should fund the project to continue supporting them with practical activities. But when asked at the time of the research whether they had expressed their concern to the department, the teachers had not done so. At the time of the research, they were protesting for salary increases

thus, through their union, were not allowed to meet with the Department of Basic Education. This was revealed by one teacher:

There is this non-cooperation; we are not supposed to cooperate with the department ... maybe next term because this non-cooperation will be over then we will be able to meet with the subject advisor. Today is a SADTU²⁷ meeting so they will report to us whether the non-cooperation is over or not ... If we demand something from the department and they don't give us like increment, we won't cooperate on anything until they give us what we want ... they gave us increment for six per cent instead of seven per cent on the 15th of this month, which is why now we can start cooperating. (GT3I)

In line with the teacher's extract above, one of the Fundisa for Change partners noted that for PLCs to be effective, teacher unions need to support them. He noted:

Unions need to support education ... when it becomes a labour issue is all about what you do and how you are remunerated. To give an example, in one of the Fundisa for Change training sessions, one subject advisor stood up and said, if I complete this course, what am I going to get in terms of remuneration? Okay, yes, if one has improved his or her qualification, one deserves a reward of some sort but at the same time, the capacity that is built on its own, if we can begin to see it as a reward also ... the power that the unions hold is something that needs looking into ... The unions are very strong and those are the people who play a critical role building the keenness in teachers. (PP)

The policy documents on PLCs also support the role of teacher unions in promoting teacher professionalism and encouraging teachers to participate in PLC activities “ ... supporting and encouraging teachers to access opportunities to identify and address their development needs ... advocate and support the establishment of PLCs and encourage teachers to access opportunities to participate actively and meaningfully in these” (D2:3). The Director of the Continuing Professional Teacher Development Directorate noted that the teacher unions have responded positively to the policy call on PLCs, he said “teacher unions have all played a role, they are running one or other form of PLC but SADTU have developed a manual”.

In line with teachers' valued functionings the policy documents on PLCs explicitly outline the roles of the Department of Basic Education at national, provincial and district level (D2; D4; D14). The role of the national department will be to keep PLCs informed about local and international good practices on PLCs; to assist with the development of meaningful activities to stimulate the development of PLCs; and to provide teachers with resources that help them to integrate their own professional knowledge with the latest research-based knowledge about content and practice (D14). The roles of the provincial departments are:

- To provide the enabling environment for PLCs;
- To provide external input to PLCs through subject advisors or trained mentor teachers;

²⁷ The South African Democratic Teachers Union is the largest trade union for teachers in South Africa.

- To provide support to PLCs through the development of expertise in the use of evidence-based assessments to determine teachers' own development trajectories;
- To monitor the implementation of PLCs in the province;
- To function as a hub for exchanging PLC practices within the province; and
- To inform and provide progress reports to the national level on matters pertaining to the implementation of PLCs. (D14:14)

The roles of district offices in PLCs are:

- To support PLCs with resources and expertise on facilitation skills, video analysis, development of teaching resources and the use of ICT;
- To highlight issues for discussion at provincial and national level;
- To function as a hub for exchanging PLC practices within the district;
- To create opportunities for follow up via PLCs in other professional development activities, such as workshops; and
- Provide annual progress reports of implementation of PLCs to the provincial level and to develop synergies between PLCs and district subject committees. (D14:13)

The policy documents on PLCs note that teachers' agency should be taken seriously in the establishment of PLCs (D2; D4; D14). They should be encouraged to establish PLCs and strengthen existing ones (D2; D3; D4). "Mentor teachers should be trained and enlisted to facilitate teachers setting up new PLCs, or give additional support to existing PLCs" (D3:82). At the national colloquium (see Section 1.5):

There was a clear message that PLCs are all about teachers supporting each other and being driven by them rather than functioning within some bureaucracy that determines the agenda. The idea is that the involvement of the Department of Basic Education and provincial departments of education should be restricted to the provision of support (funds where required, time-off for engaging in the PLC activities etc.). To subject PLCs under some bureaucratic structure has the potential to destroy the spirit that teachers might have regarding participation in PLCs. (D4:5)

It is thus evident in the extract above that even though different agents have a role to play in successful implementation of PLCs in South Africa, teachers are at the centre of determining the activities within the PLC, and therefore to ensure that the PLCs are a success. According to the policy documents, the activities of the PLCs include:

- Reading and engaging in action research results and using data that has been generated to feedback into teacher professional development;
- Joint planning, teaching and observation of lessons (collaborative teaching);
- Reflection of classroom practice/ pedagogy;
- Expose teachers to on-line resources;
- Analysis of reports on learner performance and carrying out error analysis of classroom tasks from learners;

- Developing expertise in the analysis of learners results on evidence-based assessment in order to determine teachers own developmental trajectories;
- Curriculum orientation activities;
- Working together to learn from video records of practice and other learning materials;
- Learning how to interpret and use the curriculum support materials such as the workbooks currently being developed and distributed to teachers and schools by the Department of Basic Education; and
- Organise conferences, workshops and other events. (D2; D4)

It is thus evident that some of the teachers valued functionings are in line with the policy documents. In line with the roles of the national, provincial and district department of education, I had asked the Director of the Continuing Professional Teacher Development Directorate on what progress had been made at the time of the research. He said:

What we have done is run an orientation workshop with each of the provinces and then we are going to be following that up with workshops – however, there are provinces that have begun setting up the PLCs, for example the Free State. According to their reports, they have actually set up a PLC system in every school. The workshops were with the head office officials who are involved with curriculum delivery and professional development and then in some cases we got district representation to the workshop as well. The purpose of workshop was orientation and efficacy, to make people aware of PLCs, why PLCs can make a difference, how to go about setting up them up ...

It is evident from the above extract that the national Department of Basic Education was in the process of implementing the PLC policy through orientation workshops. It is also evident that provinces are taking up the policy on PLCs seriously. In line with the roles of the provincial departments outlined above, the Director of the Continuing Professional Teacher Development Directorate noted that the provinces have been submitting progress reports on the progress of the PLC establishments and implementations (D4; D14). When asked about progress in the Eastern Cape and Western Cape provinces where the study was conducted, he noted a need to follow up with the two provinces. The policy documents on PLCs further indicated that structures will be put in place at national, provincial and district level to support the work of PLCs. among those are the establishment of District Teacher Development Centres, Provincial Teacher Development Institutes, National Institute for Curriculum and Professional Development (D2). Commenting on the progress of these structures, the Director of the Continuing Professional Teacher Development Directorate said:

National Institute for Curriculum and Professional Development has been set up – three directors have been appointed already and it will be their responsibility to support schools in running the PLCs. Provincial Teacher Development Institutes at the moment there is one in the Western Cape, one in Limpopo, one in Gauteng and one Kwazulu Natal, those are the once we are calling more advanced.

As indicated earlier, the policy documents noted that the district centres will be set up to act as a hub for coordination PLC activities in the districts (D2; D14). While the Director of the Continuing Professional Teacher Development Directorate did not particularly comment on the district structure, noted, however: “what we have got planned already during the course of next year are two times six days workshops in each of the provinces to specifically work with district officials to support them in their work to support schools in establishing PLCs”. In line with the further support from the Department of Basic Education and their roles in PLCs, the Fundisa for Change coordinator noted:

There is a need for district space to be created where teachers can meet and learn together and from each other. The department have centres and resources where teachers can meet ... Fundisa for Change does not have a mandate to create PLCs. The policy indicates that the department is the leading agency for initiating PLCs ...The department can draw from us to support the process and to support teachers further when they meet in PLCs, train and motivate them to see value in meeting and sharing but we cannot lead the development of PLCs. We have the resources and expertise ... PLCs would make our work easier. We can learn from teachers in terms of what it is required by the department ... for us to improve and help develop the quality of education. (UP1)

In line with the teachers’ new valued functionings, receiving support from the Department of Basic Education could then be realised, if as noted, the departments of education at national, provincial and district level fulfilled their roles in PLC establishment and management. And as the Fundisa for Change coordinator noted above, if those structures could be set up, formalised and coordinated then this will be an enabler for the programme to support PLCs.

7.4.3 Strengthen cluster activities

As described in in Chapter Two (see Section 2.6), cluster activities were developed in South Africa as part of the NEEP-GET project and the Learning for Sustainability project. These clusters still exist and they are mandatory for teachers. Some teachers recognised clusters as PLCs. Some teachers noted that cluster activities are not developmental spaces; they are simply for moderation of assessment activities. This was confirmed by the Fundisa for Change coordinator as she reflected on her own experiences of participating in cluster activities. She said:

In my experience of having been a teacher, I would not say we have called them PLCs but as teachers we used to meet in cluster meetings ... what we used to do was to come together to look at school based assessment tasks ... there were never any opportunities to share the difficulties we were experiencing in either a particular topic, or in setting the papers or in the kind of learners we had... there was no time for that, the time that was set was just to look at each other’s portfolios ... we only had that outside that particular meeting. If you had somebody that you were friendly with or have known for some time ... then you could informally share, I am struggling with this ... (UP1R)

However all the teachers saw clusters as potential for professional development. They indicated that for cluster activities to become developmental spaces there is a need for regular meetings, more resources, external support, proper schedules, better communication and structure. One teacher in Idutywa noted “it will be good for us, we come together; prepare lessons together and then follow a trend, and it will even help us teach confidently. Knowing that what I am doing at this time, my colleague in the next school is also doing the same thing” (DT5I). Another Idutywa teacher confirmed:

If we can have proper schedules for meetings, sometimes you are having questions that you do not know and you are far from other teachers. If we can maybe meet every three weeks to address our challenges, so that we can go to our schools feeling more confident. Now you will be progressing but having questions or challenges, things that you are not sure of. So if we can make it an obligation to say we are meeting at this time, maybe once a month, on the last day of month end or whatever, that will be useful. But it is difficult for it to happen, since not all of us are feeling the same challenges, some colleagues are fine with what they are doing. (DT2I)

One of the teachers in Grahamstown described the PLCs as part of the clusters:

There is a need to teach teachers how to set up PLCs better, not on the surface understanding of PLCs, expectations of what PLCs entails, educating everybody on PLCs ... that requires professionally and educated people like you to come to us, not me trying to explain about PLCs. Teachers need exposure. At the moment, my subject advisor will understand what a PLC is and the need for cluster support, I will understand, but everybody else does not have an understanding of the purpose of this regular meetings. If I am not there or if I happen to leave, there should be a continuation of meetings ... The reason that it is there is an understanding of one or two people not a collective. (GT5I)

It could be argued that the teachers’ valued functionings concerning PLCs imply transforming clusters into PLCs. Some of their valued functionings resonated with the characteristics of PLCs (D14). Successful PLCs require that members come together regularly (D14). Only by meeting regularly can the necessary depth of discussions, progressive gains in knowledge and sustainable effects on teaching and learning be achieved (D14). PLC sessions can be followed up with electronic communication means, reducing the need for face-to-face sessions (D14).

In Idutywa, all the teachers noted time and distances between schools as main constraints to their cluster activities. In Cape Town and Grahamstown, the challenge is the teachers’ attitudes and competitiveness among schools (CT1I-CT3I; GT3I; GT1I). One Cape Teacher said:

The subject advisor tried really hard to start a PLC here with no success. He recently started a PLC in Khayelitsha which is going amazingly well. Apparently the teachers’ pass rates (referring to learners pass rates) have gone up by 20 per cent for some of the schools because of the learning community were the teachers help each other ... The community in which I teach, the schools are extremely competitive. They don’t want to help each other ... I was actually schooling in one of them but I am teaching at another. And the other day I asked my

high school Life Sciences teacher who use to teach me to help me with something. She did, but there was just this ... you are from the other school thing, that competitiveness between the schools is not healthy. (CT11)

In terms of time and distance, the policy documents were encouraging school based PLCs (D2; D3; D4; D14). This is to minimise transport costs and organisational challenges (D2; D4; D14). However, PLCs can be organised between schools (D14). Some schools are too small and therefore would be best to team up with neighbouring schools (D14). If financial and logistical constraints can be overcome, inter-school PLCs can be a very effective way to exchange ideas and align organisational cultures between the schools (D14). Teachers did not indicate any evidence of existing or participating in school based PLCs, except one teacher from Cape Town who recognised an effective PLC at his school. He said:

We are four Life Sciences teachers at school, we work together really well ... We help each other a lot. Our classes are actually in a row, so what usually happens is, if you want to know something you just go to the next class quickly. You can even go in the middle of the lesson and say, okay how do I do this? What is this? Do you have some of these papers? And then of course we have subject meetings, were we all get together and then we talk about the work for the next few weeks, what we are planning for the test. And every time you set a test, you send it to the others for input. (CT11)

Teachers should regard participating in PLCs as integral to improving teaching practice (D14). The teachers have to decide on the leadership role such as facilitation, setting the agenda and defining outcomes in the PLCs (D14).

7.4.4 Support from other stakeholders

Five teachers (DT5I; DT3I; CT1I; GT5I; GT3I) also recognised that there are other organisations and institutions that can offer professional development support. They thus expressed a need for support from those stakeholders. One teacher from Idutywa noted:

There are a lot of NGOs that are involved in teacher professional development in this country. We could have direct links to these organisations, where we put our individual challenges across. Because most of the time, the support that we are getting comes as collective support which probably the subject advisor says, this is what I want my teachers to be taught ... it narrows the scope for the teacher to be really developed. We have individual challenges. So with other organisations coming from outside contacting individual teachers, I think will be more effective. Teachers will have their personal challenges addressed. Knowledge is something that is not acquired so easily, at times you need people to guide you. You might be a teacher in the classroom thinking that you are doing the right thing, unless someone tells you, if you can do it this way. (DT5I)

It evident in the extract above that teachers are individuals who have different capability sets, thus as discussed in Chapter Five (see Section 5.1), PLC activities should be responsive to individual teachers' capabilities. This resonates with policy documents on PLCs that teachers need to be

agents in their own professional development (D2; D3; D4; D24). Professional development for teachers engaging in PLCs will be more coherent and responsive to changes in practice than the traditional, one-off forms of professional development (D14). While all teachers expressed a need for professional development, they also assert that professional development activities should consider school contexts. One Cape Town teacher said:

Each school will teach differently. If you teach at a poor school, you won't be able to do a lot of practicals as you will be able to do at a well off school. You won't have a projector or a TV where you can show videos ... I will like to have more of this kind of spaces, something that the government can set up because there are a lot of teachers who don't have friends who are Life Sciences teacher. They could make use of those. And then you can have a more diverse group of people, with more differences in age and experience and type of schools they teach and so on. It will be a good idea. (CT11)

He went on to say:

A lot of the content we have to teach it would be good to know how certain people think about it. For example the herbal plants and the indigenous plants, it will be good to know how certain population groups feel about it. I can say yes, the Sangomas go and pick some of the wild flowers and they use it to help people, but do I really understand that? I don't think so. So to be able to talk to someone who really understand how that really works will help a lot.

The extract above confirms what teachers noted earlier, how school contexts could constrain the teaching of biodiversity. As discussed in Chapter Six, emerging from the extract is that teachers value diversity in professional development activities. Diversity enriches teachers' learning experiences in PLCs (D14; see Section 2.6; Section 6.2.1.1; Section 6.2.3.1).

Two teachers (CT11; CT21) also valued online spaces for professional development. These spaces will allow teachers to link up with other Life Sciences teachers, share experiences and resources. "Any teacher can start something like that and then get Life Sciences teachers to join. I am thinking of doing that once I am settled in and have been teaching for a year. I think that will be great, maybe upload your lessons and videos" (CT11). This is in line with the policy documents on PLCs that noted that the provincial and district department of education will set up structures that will capacitate teachers in computer skills, and allow them to engage through Information and Technology Systems (D2; D3). The teachers observed that face to face meetings are better, but distance and individual responsibilities at school constrain teachers. Online spaces could allow teachers to communicate with each other flexibly and are not geographically limited. Teachers from Cape Town had recognised an active online email list as a PLC. The online email system was initiated by the Department of Western Cape education and all Life Sciences teachers could join to participate in the email list. "you just sign up to be part of the list" (CT21). Teachers in Cape Town also noted that Western Cape Department of education was in the process of setting up a Moodle

programme. Teachers would use the Moodle network to upload questions and get resources. Learners would have access to the Moodle network too. “The question is do all our kids have access to internet? They will not be able to use it, how fair is that going to be? So these are the challenges but I think it’s time we move the negativity and stay positive” (CT2I).

Setting up online spaces will require teachers to enhance their computer skills (D2). As the subject advisor who participated in the PLC activities in Grahamstown observed, there is a need to enhance teachers’ computer skills. He said:

We as teachers are not technological driven, we are not information driven, so technological literacy, information literacy, all above, we are not addressing. And I think that is one of the key skills that we need, because of information explosion, because if you do not even know how to read selectively and intelligently, how will you be able to address the problems facing us. (DP4)

In line with support from other stakeholders, the policy documents on PLCs (D2; D3; D14), also note that South African Council for Educators (SACE) and subject-based teacher organisations have a role to play:

SACE have a role to play in promoting and supporting systems for identifying and addressing teacher development needs. SACE responsibilities in this regard include ensuring the providers of teacher development programmes are fully approved by SACE; and the professional development courses available for teachers are endorsed by SACE and can lead the accrual of Professional Development points on successful completion. (D2:3)

The role of subject-based teacher organisations is to bring in expertise and collaborate with other partners to develop diagnostic self-assessment tools that will help to identify areas of improvement for individual teachers. These areas of improvement can then be worked on within the PLCs: to develop, select and share materials and resources that can be used in PLCs; to develop an on-line clearinghouse where resources developed in PLCs can be shared; and to develop an on-line forum that can be used to facilitate follow-up discussions within PLCs and to create links between PLCs. (D2:3)

The above points to the role of other agents in PLC implementation including bringing in external resources and expertise. In line with the support that different stakeholders had played in implementing the PLC policy, the Director of the Continuing Professional Teacher Development directorate said:

At national level we are working with an international organisation called VVOB, they have been playing a key role in supporting the national office and provincial office to set up PLCs and then there are few subject committee associations ... each one of them have been playing a major role in getting teachers to work together.

It is evident in the extract above that there is enthusiasm in different stakeholders to support PLCs. Most of these stakeholders were part of the colloquium held in Pretoria in 2014 where Fundisa for

Change was also recognised as an association or network of providers with capacity to support PLCs (see Section 1.5).

7.4.5 Other new valued beings and doings

The environment in which learning takes place also needs attention. Quality teaching for sustainable schools does not only involve the actual pedagogical processes in classrooms. It also involves engaging with the school environment and the school- community context, so that school-based curriculum learning resonates with and extends into the school and its context. (D6:19)

The CAPS documents refer to a ‘healthy environment’. For this to be meaningful, the environment in which the learning takes place needs to be healthy (D6). “For example, if you are preparing excellent environmental lessons in your subject, but the school toilets are in a terrible condition, then there is a contradiction between your teaching and the hidden curriculum or the ethics of practice in the school” (D6:19). This requires extra-mural activities that can enrich what is taught in the classroom. In South Africa whole school development activities are offered by different organisations and government departments (D6). These include the Eco-Schools programme (D6). In line with whole school development, one facilitator in the Cape Town PLC emphasised a need for interventions at school level that will enhance the teaching of biodiversity. He said:

It will be useful if one could have something happening at the school, for example having Soil for Life or Eco-School supporting teachers to transform their actual environment ... In some schools in the Western Cape, SANBI worked with the schools. They attend courses and when they leave, part of the process is that they rehabilitate part of the veld and have some indigenous plants that they are able to use as a resource. ... develop water wise gardens, plant indigenous trees that are food plants for insects and birds ... rather than just having teachers teaching in the classrooms, yes we innovate and try to change the way they teach, but it still leaves the vacuum, so maybe if we used the bottom up approach of working with teachers. You find teachers and then you get a group of interested people working together... more certainly looking at the schools and see how you can link up with NGOs for whole school development. (UP4R)

It is evident in the extract above that school environments are not always conducive for biodiversity teaching. Thus it would be an enabler if teachers could be supported to transform their school environments, in ways that will improve their teaching practices. This would allow outdoor activities related to biodiversity (see Section 2.3.1). Whole school development activities can involve communities as has been shown in the national Eco-Schools programme (D6). This is particularly important as some of the teachers in the Idutywa district expressed a need to educate community members on biodiversity issues. Thus involving community members in projects and other interventions aiming at biodiversity conservation will raise awareness (see Table 5.1). One Idutywa teacher said:

Today I was going with this guy to the mangrove excursion; the driver, he asked what are you doing here? And I said it is a marine biodiversity workshop, and he asked, what is it about? I tried to tell him what it is all about and he said, this is serious because we do go to the beach and take mussels and sand for our purposes. But I told him, if you collect too much, this will cause loss of biodiversity. So awareness campaigns to the community, and learners can also tell their parents and other people to be aware about what is happening now and what will happen in the future if we are destroying the resources, or what the results of poor management of resources is ... (DT11)

The purpose of Integrated Quality Management System (IQMS) is to evaluate an educator's performance, identify specific needs for support and development, to provide support for continued growth, to promote accountability and, finally, to monitor an institution's overall effectiveness (D2; D3; D14). In this way, IQMS will help teachers identify their professional development needs. Teachers can then decide to engage in PLCs to address these needs (D14). Five Idutywa teachers (DT11-DT51) revealed that IQMS was ineffective for their professional development. To support what teachers noted, the Fundisa for Change coordinator also noted the ineffectiveness of the IQMS policy as she revealed:

As teachers you fill in the IQMS forms, I need development in this particular area ... which is called a personal growth plan, it is sent to the department at district level. The expectation will be, once the district officials have read teachers' professional needs, they would either run the training themselves or look for service providers who would run the training for the teachers to assist them with their professional growth plans, but ever since I started teaching, I have been filling those forms but I have never, not even once been called to attend training that was responding to the needs that I had indicate ... So I will say ... continuing teacher professional development is self-initiated. (UP1R)

One of the Fundisa for Change partners recognised a need for all stakeholders to support initiatives such as PLCs and Fundisa for Change. This was with the aim to improve the quality of education in South Africa. He noted:

To create an enabling environment for PLCs to really happen, governance is very key because in any profession, there are laws and regulations that we should comply with. It is key because that talks to the issue of rights. When you talk about education, there are different stakeholders and different interests, the learners, the teachers, the governance structure at district, province and national level within the education sector and the school governance bodies all have a part to play all that. (PP)

He went on to say:

To achieve the quality of education, concepts like PLCs must be taken seriously. Interventions such as Fundisa for Change that are supporting the establishment of PLCs need to be embraced and supported by everyone. We must make them work ... it will develop the skills we need to develop as a country ... the issue of quality everyone is talking about it. The Annual National Assessment results show that South Africa is performing bad in literacy,

arithmetic and other maths and science subjects, is always ranked very low, sometimes even in comparison to other developing countries ...

The extract above points to the need to support Fundisa for Change and other initiatives that aim to expand teachers' capabilities for biodiversity teaching, this has potential to increase the quality of education in South Africa. In line with the policy documents, the extract also stresses the role of other agents and structures in the implementation of PLCs.

7.5 Discussion

Chapter Five discussed the teachers' valued functionings related to biodiversity teaching. Chapter Six discussed the personal, environmental and social conversion factors that enabled teachers to achieve their valued beings and doings. Therefore it emerged that teachers' subject content knowledge, pedagogical practices and assessment practices had been expanded. As discussed in Chapters Two and Five, the *Minimum Requirements for Teacher Education Qualifications* advocate for different types of knowledge and learning (disciplinary, pedagogical, practical, fundamental, situational) that are required for good teaching (South Africa. DHET, 2011). It emerged that through the PLC activities, teachers had acquired integrated and applied knowledge. As noted in Chapters Three, Five and Six, the capability approach stressed that individuals differ in how they convert their bundle of resources into functionings (Sen, 1992). Thus it emerged that although the teachers shared similar capability sets, they had expanded their capabilities for teaching biodiversity but not at the same level. This was mainly evident in the reflection tools. For example, at the end of the PLC activities, some teachers (CT1I; CT3I; DT1I; DT2I; GT2I; GT1I) reflected feeling comfortable teaching (see Section 7.2.1) the concepts and content they had wanted to learn about in the PLCs (see Section 5.2.1), while some teachers were still not comfortable with teaching those concepts (see Section 7.4.1).

To demonstrate teachers' expanded capabilities for integrated and applied knowledge, Table 7.2 shows teachers' realised functionings.

Table 7.2: Teachers' realised functionings

Teachers	Realised functionings				Other
	Teaching new knowledge	Use/ modeled new teaching practice	Shared achieved functionings with colleagues who were not part of the PLC activities	Teaching and learning support materials	
PLC 1					
DT1	√	√	√	√	√
DT2	√	√		√	
DT3					
DT4					

DT5	√				
DT6					
PLC 2					
GT1	√	√		√	
GT2		√	√		
GT3	√				
GT4	√				
GT5			√	√	
PLC 3					
CT1	√	√	√	√	√
CT2			√		
CT3	√	√		√	√
CT4					

This was mainly through teaching some of the biodiversity concepts (i.e. dichotomous keys, ecological niche, classification) they had not taught prior to the PLC activities (see Section 7.4). Teachers (DT1I; DT2P; GT1I; GT2I; CT1I; CT3I) further demonstrated the use of pedagogical approaches learnt in the PLCs. These were in line with active learning, place-based, situated, creative and critical learning approaches (see Section 2.3.1; Section 5.2.2; Section 5.3; O’Donoghue, 2015). As in the PLCs, teachers (CT1I; DT2I; DT2P; CT3I; GT2I; GT1I) modelled some of the pedagogical approaches in their own teaching. For example, situational learning was modelled through the use of local ecosystems to engage learners with concepts of biodiversity by CT3I and DT1I. This is in line with the C.A.P.E Conservation Education Programme framework (see Section 2.3.1, Figure 2.3). The C.A.P.E framework encouraged inquiry based methods that allow learners to investigate their local biodiversity. This provides opportunities to engage learners in analysing local biodiversity, making learning relevant and meaningful (see Section 2.3.1). Learners develop a deeper understanding of biodiversity, better research skills and an interest in protecting and conserving local natural resources and biodiversity (see Section 2.3.1; Hopkins, 2012).

In realising their expanded capabilities, teachers were aware of the learners’ learning abilities. For teachers to understand learners’ capabilities is advised for good teaching (Shulman, 1986; South Africa. DHET, 2011). It emerged that learners’ abilities constrained teachers to realise their expanded capabilities, as they could not teach some of the learned biodiversity content and concepts because of the learners’ abilities and/or inabilities. In some cases (DT2I; CT3I) it was evident that teachers used transmission methods instead of participatory methods to teach the biodiversity concepts learned. These types of methods may serve a purpose for some of the learners who learn best through listening but transmission methods are not fully adequate for emancipation (see Section 2.3.1). Ramadoss and Poyyamoli (2011) in India found that participatory methods

encompassed learners' cognitive and affective development related to the conservation of biodiversity. They thus stressed the need for teachers to use teaching methods beyond the classrooms to increase learners' knowledge, skills and interest to protect the local biodiversity. Thus for teachers to develop learners' critical thinking skills and problem solving skills, participatory methods are advised. If learners' abilities are constraints to these types of methods, teachers should find ways to scaffold learning in a way that will be within the learners' Zone of Proximal Development, but at the same time will develop their critical thinking skills. According to Lotz-Sisitka et al. (2013), education should not only be about reproduction of knowledge but also focus on emancipation.

PLCs have developed teacher's agency. This was mainly through social interactions – learning from the capable and knowledgeable peers (see Section 6.2.4; Vygotsky, 1987). Teachers' developed agency led to development of learners' agency. This was demonstrated by evidence of teachers changing their roles to facilitators in teaching (CT1I; CT3I). This changed learners' roles from being passive recipients to active participants in learning (Sen, 1999). This is in line with Wood (2007) who pointed out that learners should be constructors of knowledge rather than recipients of others' knowledge. The abilities of some of the teachers (DT1I; DT2I; DT2P; DT5I; CT1I; CT3I; GT1I; GT2I) to realise their achieved functionings is in line with Sen (1999): providing the individuals with the same opportunities and freedoms will not ensure that they will achieve the same functioning.

It is widely written that PLCs should allow teachers to reflect on their classroom practices (see Section 2.6.3). The Department of Education in South Africa noted that teachers in South Africa lacked the ability to reflect on their own practice (South Africa. DoE, 2006). It emerged that teachers (CT1I; GT4I; DT1I; DT5I) sought support from their knowledgeable colleagues to teach some of the challenging curriculum content. Through the process, they observed what and how the knowledgeable colleagues were teaching. This demonstrates evidence of learning from practice which is part of Work-Integrated Learning (South Africa. DHET, 2011; South Africa. DHET & DBE, 2011a; 2011b). It was thus evident that in line with these policy documents, the PLCs enabled teachers to reflect on the classroom practices (see Section 6.2.3.1). As reported in Section 6.2.2.3, in Cape Town, evidence of Work-Integrated Learning also happened through school visits conducted by the facilitators to observe teachers' classroom practices. Through the process, together with the facilitator, the teachers reflected on their lessons. This provided spaces for further learning.

The Fundisa for Change portfolio of evidence allowed teachers to reflect on their teaching practices (see Appendix 7). As indicated in this chapter (see Section 7.3.2), most teachers did not submit their portfolios of evidence. Nevertheless, it was evident in the interviews and the submitted portfolio of

evidence that teachers (DT2P; see Section 7.2) were able to reflect on their practice. For example, the teacher who submitted a portfolio of evidence taught a lesson on ‘what is biodiversity’. In her realisation of this expanded capability, she used information transfer, experiential and investigative methods. She reflected on the lesson noting:

Learners needed to be given an assessment which fulfils the specific aims. What I could do in another activity was to let learners conduct the investigation on human impacts on biodiversity where learners will have to identify the hypothesis, collect, and analyse data to make informed decisions on how to rectify the problem, determine the variables and how to control them, decide on recording ways and presentation of their findings and lastly to make conclusions on what to do about the problem. This will help in developing investigating and manipulative skills. (DT2P)

Based on the lesson on biodiversity, the teacher had also realised her expanded capabilities on assessment practices. She had given learners a test which she reflected on by noting: “learners could have been given a research project to do in town. How have the housing development or business centres affected the local fauna. Have fragmentation and edge effect been created by the deforestation?” (DT2P). It is thus evident that the PLC activities had expanded teachers’ capabilities to reflect on their teaching practice. This resonates with Schön’s (1983) ideas on teachers as reflective practitioners not technicians implementing others ideas. Teachers need to be continuously reflecting on their own practice to improve their classroom practice for learners’ achievement (see Section 2.6.3).

As noted earlier, even though some (DT4I; GT1I) of the teachers valued certificates, they did not submit their portfolio of evidence. Some (GT3I; GT5I) teachers did not value receiving certificates; their valued functionings, as mentioned in Chapter Five, were to expand their capabilities for biodiversity teaching. In line with this, Sen (1992) argued that what we should equalise is not resources and not outcomes such as every teacher leaving with the certificate. He argued that what we should equalise are human capabilities, that is what people are able to be and to do (ibid.). Thus if teachers valued expanding their capabilities for teaching biodiversity, that would seem to be what counts.

In addition to the teachers’ achieved functionings, it emerged that in the PLCs activities led to unintended outcomes. Those include teachers’ capabilities on their pastoral role and their role as researchers. The pastoral role of the teachers is highlighted in the National Policy Framework for Teacher Education and Development (South Africa. DoE, 2007). This policy document noted that a competent teacher is required to be a professional who plays a pastoral role in teaching. An expanded capability to conduct research on biodiversity aspects reflects Stenhouse’s (1975) notion of teacher as a researcher. He argued that teachers are expected to be researchers of their own

practice in aspects that contribute to quality teaching such as pedagogical content knowledge and knowledge resources.

Resonating with a study that was conducted in the United States by Luft (2007), it emerged that teachers' motivation, enthusiasm and commitment to implement what they know about biodiversity can be diminished by other factors such as learners' inabilities to read and write. Teachers received considerable teaching and learning support materials in the PLCs (see Section 6.2.2.1). Despite that, some teachers still mentioned lack of teaching resources as constraints to realising their expanded capabilities. In line with the Life Sciences CAPS curriculum document, some teachers had exercised their agency to improvise on teaching materials. One could thus assume that some teachers had continued to rely on the textbook to teach biodiversity. As discussed in Chapter Five this is inadequate for biodiversity education (see Section 5.2.4; Section 5.3). Isaacs (2015) noted that there was an assumption in South Africa that textbooks would meet the Specific Aims of the curriculum and this was one of the factors that led to poor implementation of biodiversity components in the CAPS curriculum. However Sen (1983) noted that material goods such as teaching and learning support materials are not important because of their commodity value. The importance of material good is because of the capabilities they enhance for other important functionings, such as in this case, scaffolding teaching on biodiversity (Sen, 1983). This can further enhance teachers' capabilities for biodiversity conservation (see Section 5.2).

Despite teachers' expanded capabilities, in line with the international literature presented in Chapter Two, teachers showed a need for on-going PLC activities. This is to expand capabilities that were constrained in the PLCs or to achieve their new valued functionings. It has been highlighted in Chapter Six that some conversion factors were constraints to teachers' valued beings and doings. These conversion factors need to be reconciled to become expanded capabilities. Interestingly in all three PLCs under study, resonating with Holtman (2010), all the teachers expressed in great detail the need for support on the topic of evolution. In the Life Sciences CAPS curriculum, human evolution is a topic under the Knowledge Strand of Diversity, Change and Continuity (South Africa. DBE, 2011a). Teachers expressed that evolution is a new topic in the curriculum and it is challenging to teach. Their new valued functioning is therefore for Fundisa for Change to support them with content knowledge on the topic of evolution as well as pedagogical approaches (see Section 7.4.1). In addition, teachers recognised that biodiversity knowledge is ever changing. They thus pointed to a need for further support on new biodiversity knowledge, for example as new species are being discovered. This new valued functioning could be related to the concept of aspiration for 'uncertain futures' (Cundill et al., 2014). This means teachers' valued functionings are in line with anticipated risks and problem related to biodiversity loss i.e. global warming,

climate change. This implies a need for anticipatory competencies (Wiek et al., 2011). Anticipatory competence is the “ability to collectively analyse, evaluate, and craft rich “pictures” of the future related to sustainability issues and sustainability problem-solving frameworks” (Wiek et al., 2011: 207). Anticipatory competencies will thus allow teachers to teach differently. Participatory anticipatory approaches and scenario methodologies are some of the methodologies needed to develop anticipatory competencies (Wiek et al., 2011).

Teachers recognised that biodiversity is not an issue that needs to be addressed in the school curriculum only; it needs to go beyond the school context to community members. This is in line with whole school development. What this may entail is interventions and projects focusing on biodiversity conservation, involving teachers, learners and community members. This can help bridge the gap between school knowledge and the community knowledge (Hopkins, 2012). Such interventions have potential to engage teachers, learners and communities in ethical deliberations about biodiversity concerns (see Section 2.3.1). Fundisa for Change (2013) also recognised that quality teaching requires taking cognisance of the environment in which teaching and learning is happening. Engaging with communities will allow learners to engage with local and surrounding school communities (Shava, 2000).

As discussed in Chapter Five (see Tables 5.1 and 5.2), teachers’ valued beings and doings in the PLC increased their confidence in teaching biodiversity. As reported in Section 7.2.4, it emerged that PLC activities increased teachers’ confidence and professionalism. This is in line with policy documents that noted a need for professional development activities to enhance teachers’ confidence, improving their professionalism, teaching skills, subject knowledge (South Africa. DHET & DBE, 2011a; 2011b). Education 2030 documents from the World Education Forum noted:

Quality education fosters creativity and knowledge, and ensures the acquisition of the foundational skills of literacy and numeracy as well as analytical, problem-solving and other high-level cognitive, interpersonal and social skills. It also develops the skills, values and attitudes that enable citizens to lead healthy and fulfilled lives, make informed decisions, and respond to local and global challenges through education for sustainable development (ESD) and global citizenship education (GCED). (UNESCO, 2015a:2)

This quote demonstrates that for quality education to be achieved in South Africa, teacher education and particularly professional development models have to foster teachers’ different types of knowledge and pedagogical practices that will promote analytical, problem solving skills and other higher cognitive level skills. PLCs should not overlook these issues including paying attention to numeracy and literacy. Lotz-Sisitka (2011) observed that in South Africa much attention has been placed on improving literacy and numeracy. These are central to fundamental learning (see Section 2.3.1; South Africa. DHET, 2011). The CAPS Life Sciences curriculum also aims at developing

learners' language skills; their reading and writing skills (ibid.). However it is evident in this study that more attention is needed to develop teachers' capabilities to address learners' numeracy and literacy skills.

As indicated earlier, the policy documents in South Africa outline the key roles that different agents will contribute to PLC activities including external expertise for subject content knowledge (see Section 7.4; South Africa. DBE, 2015). However Stevenson (2007) particularly warned that external agents usually have an agenda and their assumptions about teaching and learning may contrast with the traditional role of education. He observed that many organisations are experienced with practical skills but lack the understanding that learners need to be independent in their own learning, which is considered necessary for transformational learning. This is one of the benefits of programmes like Fundisa for Change; organisations can join and offer their expertise. This, as discussed in Chapter Six, allows for collaborative learning that enriches learning. Thus to expand teachers capabilities through valued on-going PLC activities, there need to be better links and understanding on what the real purpose of the different stakeholders are. As evident in this chapter, teacher unions and subject association committees support the policy on PLCs through engaging teachers in one or other form of PLC. Those need to be better coordinated, not only because they can be overwhelming for teachers, but also to be of maximum benefit to teachers.

To support collaborative learning, lesson study approaches can be used to encourage collaborative lesson planning. However as demonstrated in the study from the Cape Town PLC example, systemic issues are potential constraints to the lesson study approach. However the lesson study approach is encouraged as it provides teachers with a learning structure, to reflect on their own practice, build a shared knowledge base, foster intrinsic motivation and build a culture that emphasises continuous improvement and collaboration (see Section 2.5; Lewis & Hurd, 2011). They noted that the lesson study model allows teachers to seek answers from one another, from outside specialists, from research and from carefully studying their students during lessons. This is in line with the proposed activities for PLCs in the policy documents (South Africa. DBE, 2014; 2015). Lesson study is primarily about developing the knowledge, disposition, relationships and windows into each other's classrooms that is needed to improve instruction and to make schools places where teachers continue to learn (see Section 2.5). Among other researchers, Cordingley et al. (2003) have supported collaborative models as a means to expand teachers' confidence, enthusiasm and commitment to changing practice. They reported teachers as being willing to try new things (ibid.). The value of collaborative learning among teachers was evident in this study (see Section 6.2.3.1).

In line with collaborative learning structures, emerging from the study are teachers' perceptions about the cluster activities as potential models for their professional development. Teachers (DT11-DT5I; GT5I) expressed a need for better structure, more support, regular meetings, and agendas for cluster activities. This reflects research on clusters in South Africa (see Section 2.6), where it has been noted that most clusters do not function as expected (De Clercq & Phiri, 2013). Cluster meetings should be structured as a framework that can allow teachers' engagement, continuous interaction, innovation and creativity in a mutually beneficial process (Mphahlele, 2012). This will result in teachers sharing resources, expertise and other facilities in their communities (ibid.). Jita and Ndlalane (2009) noted that many clusters had become bureaucratic structures that teachers are mandated to attend. But it is evident in the policy documents in South Africa that PLCs should be spaces that are determined by teachers themselves, not bureaucratic structures that are controlled by external agents (South Africa. DBE, 2014).

Evident in the teachers' interviews was the need for online spaces to expand their capabilities for biodiversity teaching. Teachers noted that online spaces would enable them to collaborate and share knowledge resources with colleagues. Thus as Lotz-Sisitka (2011) noted, there is a need for the Fundisa for Change online spaces for teachers' professional development. It is also highlighted in the policy documents on PLCs that Provincial Teacher Development Institutes (at provincial level) and district teacher development centres (at district level) will be established. Among other roles, these structures will develop and maintain an Information and Communication System platform to enable quality professional development opportunities accessible to teachers all over the country (South Africa. DHET & DBE, 2011a; 2011b). Online platforms such as web.20 are also being explored as spaces for professional development (Yendol-Hoppey & Dana, 2010; Mayer & Lloyd, 2011). In line with the arguments made by teachers in this study (CT1I; CT21), researchers have noted that using online spaces provides flexibility for communication between teachers in PLCs. But in South Africa, many teachers still lack computer skills, thus in view of the ISPFTEED (2011-2025), teachers need to enhance their computer skills (South Africa. DHET & DBE, 2011a). Needs for computer skills point to the need for fundamental learning (South Africa. DHET, 2011). Thus in the interest of this study professional development initiatives such as Fundisa for Change could consider setting up online spaces for teachers to share knowledge on biodiversity or they could model online PLCs as options for Life Sciences teachers' continuing professional development.

As indicated earlier, teachers' confidence had been increased in the PLCs. I argue that to sustain the confidence, teachers need to continue engaging in the PLC activities. This is in line with their new valued functionings (see Section 7.4). External factors are noted as potential constraints to teachers' on-going participation in the PLC activities. These include contextual factors, financial and time

constraints. To reconcile these constraints, the policy documents noted that to enable teachers' participation in the PLCs, time will be scheduled in their school timetables (South Africa. DHET & DHE, 2011a; South Africa. DBE, 2014; 2015). It was evident that despite the launching of the ISPFTED in 2011, at the time of the research no provision was made at schools or at district levels in terms of time off for teachers to participate in PLC activities. Thus despite the policy indication that weekends and school holidays are not ideal for professional development activities (South Africa. DBE, 2015), PLC activities happened over weekends. In line with the teachers' new valued functionings, the ISPFTED recognised that the more frequent the PLC meetings, the more teachers gained from them (South Africa. DHET & DBE, 2011). It is also well documented in literature that in order to build trust and create the group dynamics necessary for PLCs to succeed, members should regularly meet (see Section 2.6.3). As mentioned in Chapter Five, professional developments need to be responsive to individual teacher's needs. This is in line with Sen's (1992; 2009) arguments that people as individuals value different lives. Teachers should therefore "lead the kind of lives they value and have reason to value" (Sen, 1999:18). This is through being agents in choosing to participate in PLC activities that are responsive to their individual needs.

7.6 Conclusion

This chapter has discussed the teachers' achieved functionings in the PLCs. The chapter has further discussed how some teachers had realised some of their achieved functionings in their actual practices. It emerged that even though the teachers had expanded their capabilities for teaching biodiversity, in some cases school contexts constrain teachers from realising their achieved functionings. The South African Department of Basic Education has outlined structures that will be put in place to support the establishment and implementation of PLCs. It emerged that these structures have been developed at national and provincial level but are yet to be implemented at district level. These have the potential to enable the further support that Fundisa for Change can give to teachers in PLCs.

Chapter 8: Causal processes surrounding teachers valued beings and doings; summative perspectives, recommendations and conclusions

8.1 Introduction

In Chapters Five, Six and Seven, the capability approach has provided an understanding of the teachers' valued beings and doings, as they relate to the teaching of biodiversity. The capability approach has further provided an understanding of what the personal, social, and environmental conversion factors were in the PLCs that allowed for teachers' valued functionings to be achieved and to be realised. However, the capability approach has not provided a fuller understanding and explanation as to how the enabled and constrained capabilities lead to the empirical actions of the Life Sciences teachers related to biodiversity teaching. As noted in Chapter Three, the capability approach is not a theory that offers these types of explanations. The capability approach is a normative framework which conceptualises inequalities and poverty. Using critical realist theory of causation demonstrates how the valued beings and doings, conversion factors and capability sets account for underlying mechanisms. According to critical realists it is the underlying mechanisms that generate observed accounts such as teachers' observed practices. This chapter is thus an attempt to use a critical realist theory of causation to demonstrate how the valued beings and doings, conversion factors and capability sets identified, account for underlying mechanisms related to the teaching of biodiversity. The chapter further provides summative perspectives of the study as well as the main contribution of the study. Finally the chapter provides recommendations for further research and conclusions of the study.

8.2 The causal processes surrounding teachers valued beings and doings as they relate to biodiversity teaching

As discussed in Chapters Three and Six, capabilities can be both expanded or constrained by conversion factors. Three types of conversion factors have been discussed in Chapter Three: personal, social and environmental factors (Robeyns, 2005a). In this study it emerged that there were different factors that enabled or constrained the teachers to achieve their valued beings and doing (see Chapter Six). However, it has also been discussed in Chapter Six that social, environmental and personal conversion factors that constrain capabilities, if reconciled, can become enabling of expanded capabilities. In this study, the teachers' expanded capabilities would be evaluated either on the capabilities they have available to them or on the functionings that they choose to realise in their actual teaching of biodiversity (Sen, 1999; 2009). Chapter Seven discussed the outcomes of the teachers' expanded and/ or constrained capabilities. Having given those conceptualisations in those chapters (Five, Six, and Seven), here I attempt to explain the causal links between teachers' valued functionings, conversion factors and the observed actions

(observed in the PLCs, and the teachers interpretations of what they experienced in the PLCs and in their actual classroom practices) of the teachers actual teaching practices related to biodiversity.

Tao (2013a; 2015) has argued that when located within a critical realist theory of causation, teachers' valued functionings can be viewed as the causal mechanisms that generate much of their actions as they relate to the teaching of biodiversity. She further argued that the various conditions which have been referred to as conversion factors throughout this study constrain what the teachers value being and doing. Teachers' reflexive deliberations then determine whether they choose to comply with constraints by not achieving their valued functionings or whether they will contend with them. As argued in Chapter Three, Tao (2013a; 2015) has developed an analytic framework that helps explain how causal mechanisms can lead to realised achieved functionings or not. Thus using Tao's (2013a; 2015) analytic framework here will provide an explanation on how the causal mechanisms within teachers in the PLCs can lead to realised functionings or not. Figure 8.1²⁸ shows a visualisation between critical realism and the capability approach. "Causality is understandable in terms of unobserved structural factors conditioning agency, which will have contingent outcomes, rather than in terms of putatively indefinitely occurring correlations per se" (Cruickshank, 2003:159).

²⁸ In this visualisation the environmental, social and social conversion factors were different for individual teachers but for the purpose of the visualisation they are presented as if they are the same. Similarly, the outcomes in the visualisation are different for the individual teachers but for the purpose of the demonstration have been presented in the same way.

Figure 8.1: A visualisation of critical realism and capability approach

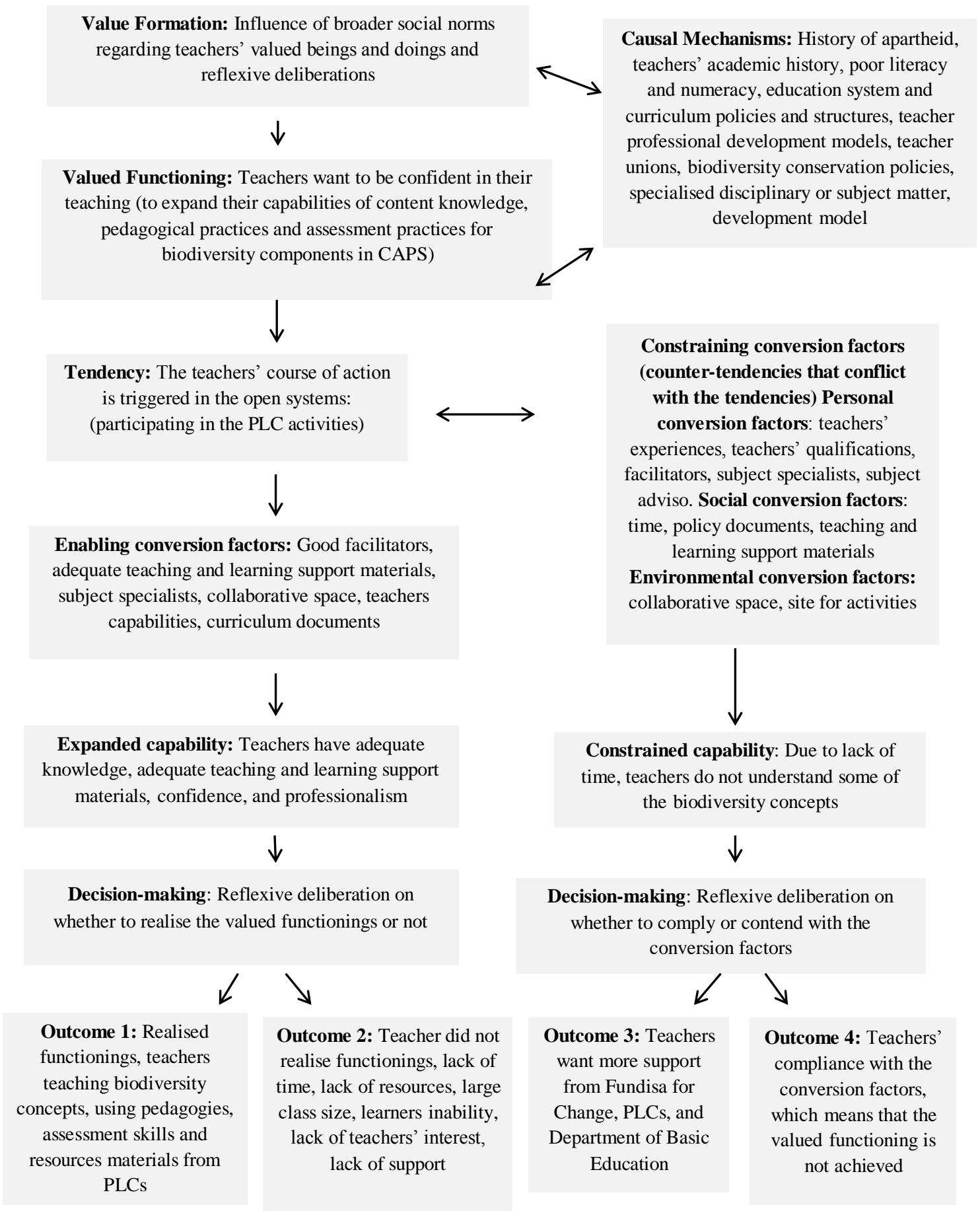


Figure 8.1 outlines a process that begins at the level of the *real* with the dialectical process between structure and agency that produces the valued functionings of teachers as they relate to the teaching of biodiversity. Critical realists argue that causal mechanisms whether they are exercised or not (see Section 3.5.2.2; Sayer, 2000). In this study the interplay was between Life Sciences teachers (agency) and the policy documents (structures) on teaching practice and professional development (particularly related to biodiversity), such as the Life Sciences CAPS documents and the opportunity to participate in the PLCs. Teachers engaging in a reflexive deliberation process determined to what extent as individuals they wanted to be knowledgeable Life Sciences teachers with improved practices on biodiversity. As shown in Figure 8.1, it is thus evident that the teachers' valued beings and doings related to biodiversity have been caused by the interplay between structures and agency. As discussed in Chapter Five, the teachers' valued functionings were mainly to expand their content knowledge, pedagogical practices and assessment practices related to the teaching of biodiversity. Teachers' valued functionings were also to improve their confidence for teaching biodiversity, to receive teaching and learning support materials and to expand their other capabilities such as getting a 'good looking' curriculum vitae and supporting students and a community to be knowledgeable on biodiversity (see Table 5.1 and 5.2). It is however evident in Chapters One, Two and Five that in South Africa, contributing to teachers' lack of biodiversity knowledge is that post-1994, schools and teacher education curricula were implemented in a country with poverty and social inequalities (see Section 1.5; Section 1.8). It is also evident in Chapters Two, Five and Seven that unsuccessful or poorly monitored education policies such as the IQMS contribute to teachers' lack of biodiversity teaching (see Section 2.3; Section 5.2.1; Section 5.3; Section 7.4). Another causal mechanism for teachers' lack of biodiversity knowledge is the on-going curriculum change in South Africa (see Section 1.4; Section 5.2.1; Section 5.3). The curriculum changes in South Africa introduce concepts and content that teachers are not trained to teach (See Section 1.4; Section 5.2.1; Section 5.3). This thus implies that, the education policies and education system in South Africa are some of the generative mechanisms that influence teachers' valued beings and doings as they relate to the teaching of biodiversity.

As noted in Chapter Three, critical realism bases explanations of how people experience a phenomenon on mechanisms that operate at deeper levels of reality. The three levels of reality in critical realism are the empirical, the actual and the real (see Section 3.5.2.1). At the level of the *actual*, the causal mechanism triggers a person's tendency for action (Tao, 2013a). As discussed in Chapter Three, people's courses of action are triggered in open systems (see Section 3.6). In this study, as indicated in all the earlier chapters, the individual teacher's course of action was triggered in an open system which entailed teachers participating in the PLC activities to achieve their valued beings and doings. As discussed in Chapter Three, tendencies operate within the open system

(Collier, 2005; Shipway 2011; Sayer, 2000) (i.e. in the PLCs) of the social world amongst counter-tendencies, which are “counteracting forces [that] can override and conceal the effects of the operation of a particular mechanism” (Collier, 2005:110). In this study, as discussed in Chapter Six, in the PLCs there were personal, environmental and social conversion factors.

As discussed in Chapter Six, the personal conversion factors in the PLC were good facilitation, teachers’ qualifications and experiences (teachers capabilities), and the presence of subject specialists (scientists and subject advisors). In South Africa, due to the apartheid legacy and social inequalities, teachers have different qualifications (see Table 6.1). Some practising teachers do not have formal qualifications for the subjects they teach (South Africa. DBE, 2011b). This was also confirmed by three Fundisa for Change partners (UP1; UP3; PP), as two of them noted:

In South Africa, we are still dealing with the legacy of the past. The majority of teachers were trained under the apartheid dispensation of which the issue of quality of education that they got versus what we want to do when we think about this concept of PLCs, there is a gap that needs to be bridged because they are at certain levels. The education and knowledge generation has moved so much that they are not at par with what is happening. That is one of the greatest challenges that actually need to be bridged otherwise it could come as another stumbling block in establishing the PLCs. (PP)

In South Africa you still have teachers who are practising, who have grade 12 ... so they have not really been forced to study. Maybe the fear is that, once they put that in place, then there won’t be enough teachers for the classrooms and at the same time also considering this issue that the teaching profession, if I may call it a profession, teachers have been unionised a lot. So issues of labour will take centre stage if teachers were forced to study and maybe lose their jobs. (UP1)

It is evident in the quotes from the Fundisa for Change partners above that the teachers’ different qualifications have been influenced by the apartheid legacy (see Section 1.8). It is further evident in the quotes from UP1 above that the teaching profession in South Africa has been unionised which contributes to teachers’ lack of qualifications. This has an impact on both the teachers’ lack of biodiversity knowledge and the quality of education in South Africa. It is therefore evident that teachers’ different experiences and qualifications that were reported in this study as personal conversion factors for their biodiversity teaching was therefore also caused by the apartheid legacy and unequal education systems prior to South African’s democracy (before 1994). In addition, the apartheid legacy is one of the contributing factors for poor numeracy and literacy results in South Africa (see Section 2.3; South Africa. DBE, 2011b). This was evident from one of the Fundisa for Change partners: “... the issue of quality, everyone is talking about it. The Annual National Assessment results show that South Africa is performing bad in literacy, arithmetic and other maths and science subjects, is always ranked very low, sometimes even in comparison to other developing

countries ...”(PP). According to Lotz-Sisitka (2011) many interventions in South Africa have therefore been aiming at increasing teachers’ literacy and numeracy skills. This has led to teachers’ environment and sustainability knowledge i.e. biodiversity knowledge being neglected, leading to teachers’ lack of biodiversity knowledge (ibid.).

In Chapter Six, good facilitation was discussed as another conversion factor that enabled teachers to expand their capabilities for biodiversity teaching in the PLCs. The Fundisa for Change partners who facilitated the PLC activities (UP1; UP2; UP4; UP6; DP2; NP1) had different experiences and qualifications that enabled them to facilitate the PLC activities, as shown in Table 8.1 below:

Table 8.1: PLC facilitators’ experiences and qualifications

Facilitator	Qualifications	Experiences
UP1	Diploma in Senior Teaching, Advanced Certificate in Education, Honours in Education, Masters in Environmental Education, enrolled for a PhD in Environmental Education	11 years of teaching, Fundisa for Change coordinator since 2013
NP1	Masters in Environmental Education	Teacher professional development since 1999
UP2	Bachelor of Science, Postgraduate Certificate in Education, Honours that Postgraduate Diploma in Education, enrolled for a Master’s degree in Environmental Education	Ten years of teaching experience (seven of those in South Africa)
UP4	Bachelor of Science, Honours degree, Postgraduate Certificate in Education, was busy completing an MPhil	25 years teaching experience. Education specialist focus is on teacher professional development
UP6	Bachelor of Science, Masters in Environmental Education , PhD in Environmental Education	Over 15 years in tertiary education.
DP2	Bachelor of Science, Higher Diploma in Education, Bachelor in Education, Masters in Environmental Education	Deputy Chief Education Specialist/ subject advisor for Life Sciences

Table 8.1 above indicates that the facilitators of the PLCs had various qualifications in education. The qualifications range from the Advanced Certificates in Education to a Doctor of Philosophy (PhD) in Education. These qualifications are mainly in Sciences (mainly at undergraduate level) and Environmental Education (mainly at postgraduate level). Some of the facilitators were still studying (UP1; UP2; UP4). It is also evident in Table 8.1 that the facilitators were experienced in working as teachers and working with teachers (either as teacher educators or through professional development activities). The facilitators’ experiences and qualifications have therefore been contributing factors to the facilitators’ good facilitation skills.

In addition to teachers’ capabilities and good facilitation (see Section 6.2.1.1; Section 6.2.1.2; Figure 8.1), it was evident that in the Cape Town PLC, another personal conversion factor that enabled teachers to expand their capabilities for teaching biodiversity was the subject specialists. As

discussed in the *Minimum Requirements of Teacher Education Qualification in South Africa*, different subjects have different disciplinary or subject matter knowledge (see Section 2.3.1). Disciplinary or subject matter knowledge can “be presented in two components within a teaching curriculum, namely the study of education and its foundations, including but not limited to the philosophy, psychology, politics, economics, sociology and history of education; and the study of specific specialised subject matter that is relevant to the academic disciplines underpinning teaching subjects or specialisations” (South Africa. DHET, 2011: 8). Therefore, subject specialists who are knowledgeable in the subject matter in the PLC enabled teachers’ capabilities for teaching biodiversity.

In the PLCs, the social factors that enabled teachers to achieve their valued functionings were the teaching and learning support materials and the policy documents. It is evident in Chapter Five that in South Africa good teaching and learning resource materials are rare (see Section 5.2.4). This has been caused by teachers’ lack of support for developing quality teaching and learning support materials (Fundisa for Change, 2013). In some institutions of higher education, teachers have not been adequately prepared to design their own resources for teaching and learning (South Africa. DBE, 2011b). In professional development, one of the Fundisa for Change partners recognised that in some cases, there is a lack of curriculum understanding among those who support teachers with their professional development needs. She noted:

... some do not have the education background. They lack the curriculum understanding. The support they offer to teachers has been ad hoc, lacking consistency in resources and the training. There is no quality control of standard support offered to teachers. There is a need for Fundisa for Change to capacitate them. (NP2)

As discussed in Chapter Six, the environmental conversion factors that enabled teachers to achieve their valued functionings in the PLCs were collaborative spaces, sites for PLC activities (the presence of the botanical garden, the wetland and the ocean) and the actual beings and doings (the activities) in the PLCs. The collaborative space is associated with the teachers’ professional modalities that encourage teachers to share best practices together (see Section 2.4; Schmoker, 2006). As discussed in Chapters One, Two and Five, in South Africa, once-off models and the cascade model were among the popular models used for teachers’ professional development (see Section 1.5; Section 2.4; Section 5.4). These models have not fully transformed teachers’ practices, in fact they have contributed to teachers’ lack of biodiversity knowledge. This has further led to the introduction of the policy on PLCs in South Africa, which have been explored in this study (see Section 1.5; Section 2.6; South Africa. DBE, 2015).

Like in most countries, in South Africa biodiversity is lost or threatened with extinction (see Section 1.3; Section 1.8). This has been due to the development model used in the country (Abdu-Raheem, 2010). Land has been cleared for development purposes and most natural resources have been used for construction such as sand and shingles, leading to loss of habitats that have led to loss of biodiversity and/or species being threatened with extinction (Abdu-Raheem, 2010). Some areas, particularly in the Eastern Cape province, have a long history of occupation as a settlement. Therefore human activities have had impacts on the natural habitats in those areas leading to habitat destructions (ibid.). Even though there is legislation at both the international and national level that aims at conserving biodiversity, some of the policies have not been fully implemented (see Section 1.3). Poor policy implementation has thus led to on-going biodiversity loss, and has led the South African government, like in other countries, to integrate the concepts and content of biodiversity in the formal school curriculum including in the Life Sciences CAPS curriculum (see Section 1.4).

The personal, environmental and social conversion factors discussed above enabled the individual teachers' tendencies in the PLCs. Archer (2007: 20) noted:

If there is a congruent relationship between an individual's tendency with concurrently operating tendencies, there is enablement of action: but if there is incongruence, there is a constraint. At that point, an individual has the power to reflect upon one's circumstances and to decide what to do in them or to do about them; and this reflexive deliberation may result in compliance to counter-tendencies (in which original course of action is negated), or evasion of it (in an attempt to realise the action, albeit in a constrained way).

The above quote illustrates that if there is a congruent relationship between a teacher's tendency with the social, personal and environmental conversion factors then the teacher's capabilities are expanded. It has been demonstrated in Chapter Six that some of the conversion factors in the PLCs were constraining capabilities. Furthermore, it has been discussed in Chapter Six that with the enabled conversion factors, the teachers had expanded capabilities for the teaching of biodiversity (see Chapter Six or evidence on how these conversion factors were enablers in the PLC activities, and how they enabled teachers to achieve their valued beings and doings).

Thus, as discussed in Chapter Six, teachers, through reflexive deliberations, had to decide what to do with their enabled or expanded capability of teaching biodiversity. It was evident in Chapter Seven, that most teachers had realised their achieved functionings that have resulted from expanded capabilities (*empirical* outcome 1). Tao (2013a) noted that if teachers' valued functionings are expanded they are likely to be actualised. As evident in chapters Five, Six and Seven, the expanded capabilities were in line with teachers' valued functionings, thus some teachers had actualised their expanded capabilities. This, as discussed in Chapter Seven, was mainly through teaching some of

the biodiversity concepts they had learnt in the PLC, and the use of pedagogical approaches and assessment practices learned in the PLCs. Thus, they transformed their actual classroom practices related to biodiversity teaching.

As shown in Figure 8.1 and as discussed in Chapter Seven, some of the teachers who had expanded capabilities did not realise their achieved functionings (Outcome 2). This was mainly because of external constraints such as lack of teaching and learning support materials, lack of finances to take learners for fieldwork, large class sizes, too much CAPS content which allowed little time for teaching biodiversity concepts and learners' lack of abilities to read and write. It is arguable that teachers not realising their achieved functionings is also due to their lack of agency (or passive agency). For example, in terms of teaching and learning support materials', they had received many materials (see Section 6.2.3) which they could use to realise their achieved functionings. Alternatively as noted in the CAPS curriculum, they could have improvised to realise their achieved functionings. However, as noted by some of the facilitators in the PLCs (see Section 7.2.3), some teachers were still not feeling confident to realise their achieved functionings. Even though teachers did not mention lack of confidence as one of the reasons for not realising their expanded capabilities, it might be implied in the valued new functionings (see Section 7.4).

As shown in Figure 8.1 or as discussed in Chapter Six and Seven, within the PLCs some individual tendencies were met by counter-tendencies or conversion factors that constrained capabilities. Social environmental factors such as lack of time spent on the activities were the main conversion factor that constrained teachers' capabilities (see Section 6.2.8). Thus, some of the teachers did not expand their capabilities to teach some of the biodiversity concepts. Through reflexive deliberation they decided to contend with the conversion factors by expressing a need for further support in the PLCs to expand their capabilities of the biodiversity concepts not expanded (see Section 7.4) (outcome 3). As evident in Table 5.1, some teachers' valued functionings were to explore study opportunities on marine biodiversity. That valued functioning was not achieved in the PLCs, thus, as shown in Figure 8.1, teachers contended with this valued functioning by expressing a need for funding from the Fundisa for Change programme to study marine biodiversity further (outcome 3; see Section 7.4).

Alternatively, as shown in Figure 8.1, through reflexive deliberations, teachers could have complied with the conversion factors and a constrained form of the valued functioning is achieved (outcome 4). An example of this outcome would be teachers giving up on the PLC activities or not expressing a need for more professional development activities to expand their constrained capabilities related to the teaching of biodiversity. However, as shown in Figure 8.1, there was no evidence in the

teachers' data that pointed to a compliance of a constrained capability (or I might have overlooked that evidence through my interpretation of data from the teachers and Fundisa for Change partners).

It is thus evident that through the above visualisations (Figure 8.1), the critical realism theory of causation offered an explanation as to why the teachers in the PLCs value on-going support for their professional development (see Section 7.4). It is also evident in the visualisation, as discussed in detail in Chapter Six and Seven, that in the PLCs the same causal power can produce different outcomes, according to how the conditions for closure are broken (Sayer, 2000). Critical realists argue that because "events are not pre-determined before they happen but depend on contingent conditions, the future is open – things could go in many different ways" (Sayer, 2000:15). This implies that the same causal mechanisms will not necessarily produce the same outcomes in the future. Thus, even though teachers in this study have expressed the on-going need to participate in the PLCs to expand their capabilities for biodiversity teaching, their on-going participation could lead to different outcomes (from the ones reported in Chapter Seven). Also, as evident in Chapter Seven, "the same mechanism can produce different outcomes according to context, or more precisely, according to its spatio-temporal relations with other objects, having their own causal powers and liabilities, which may trigger, block or modify its action" (Sayer, 2000:15). However, it is also evident in Figure 8.1 and in Chapters Six and Seven that some structures are more important than others in shaping particular outcomes (Sayer, 2000).

However, by identifying that one of the key causal mechanisms in the PLCs are the teachers' valued functionings, and that conversion factors mediate their effects, we can increase the chances of improved teachers' practice on biodiversity components in the Life Sciences CAPS curriculum through addressing these mechanisms (valued functionings) and/or their accompanying conversion factors. According to Danermark et al. (2002):

If we have knowledge of mechanisms and social structures, we can identify the driving forces behind the event we are observing. Doing so we can also in a more qualified manner estimate the possibilities, deficiencies and limitations of the actions we plan. Without this kind of knowledge, the analysis of phenomenon will always be superficial or even incorrect. (p. 208)

It is therefore not enough to criticise teachers' poor teaching practices in relation to biodiversity content in the Life Sciences CAPS curriculum generated by valued functionings such as lack of content knowledge. This requires understanding the root causes of the observed practices i.e. what caused teachers' lack of biodiversity knowledge or why teachers are not confident in their teaching of biodiversity. In this study the causal power that has led to the teachers' poor content knowledge, pedagogical approaches and assessment were discussed in Chapter Five and in this chapter (i.e. inadequate training, lack of professional development support, on-going changing curricula, apartheid legacy, social inequalities, lack and/or poor policy implementations, education quality). It

is clear that relying on empirical observations of teacher actions is only helpful in offering an understanding to what extent a particular action occurs, but drafting policy on teachers' poor teaching practice, for example, will require a deeper understanding of the mechanisms that create the observed practices.

Unpacking teachers' practices related to biodiversity, and understanding the underlying structures, mechanisms, tendencies, and counter-tendencies that produce the teachers' observed practices is important. This provides information for programmes such as Fundisa for Change on what support teachers need to expand their capabilities to transform classroom practices. Programmes such as Fundisa for Change can then see what interventions to put in place to ensure that teachers' teaching practices related to biodiversity are improved. As discussed in Chapter Five and Seven, it is important that the interventions consider teachers' causal mechanisms because these are the valued beings and doings that, as Sen (1999) described, are central to the types of lives the teachers would like to lead. If interventions are aligned to teachers' valued beings and doings, such as the Fundisa for Change programme, then this could lead to improved teachers' practices on biodiversity (Chapter Seven). It is also important that interventions aim to address the constraining conversion factors (counter-tendencies) such as time constraints. In this study, teachers noted time to be the main constraint to their achieved and realised valued beings and doings. It is thus arguable, that if professional development activities do not consider teachers' causal mechanisms (valued functionings) and the constraining conversion factors, then they are less likely to positively impact on the teachers' teaching practices as they relate to biodiversity.

8.3 Summative perspectives

In summary, responding to undertheorising of the new policy concept on PLCs in the field of environmental education (see Section 1.1), this study sought to investigate the conversion factors, functionings (valued beings and doings), agency and structures in PLCs for Life Sciences teachers' biodiversity knowledge. This was done through both the national and international literature (Chapter One and Chapter Two). This research used a qualitative case study research methodology underpinned by the critical realist theory of causation. The study used quotes as thick descriptions to report on the cases in Chapters Five, Six and Seven. Chapter Five explored the teachers' valued beings and doings in the PLCs. It used four categories that were identified by the teachers as their valued beings and doings: subject content knowledge, teaching practices, assessment practices, teaching and learning support materials and one category that reported the teachers' 'other' valued beings and doings in the PLCs. These valued functionings were discussed in light of the beings and doings in the PLCs. Chapter Six followed with a description and discussion on the conversion factors that were associated with the teachers' valued beings and doings in the PLCs. These were discussed in detail in line with the capability approach's environmental, social and personal

conversion factors. This chapter was followed by a report and discussion of the teachers' achieved, realised and new functionings in the PLCs (Chapter Seven). The discussions of the teachers' valued beings and doings and conversion factors associated with these doings and beings were explained within the conceptual framework of the capability approach. Similarly, the discussion on the teachers' achieved, realised and new functionings were discussed with concepts of the capability approach. However the capability approach could not provide a full enough explanation to accommodate the issues of constrained capabilities, and to illuminate how and to what extent the Life Sciences teachers' empirical actions are related to these. Thus the concepts of the capability approach discussed in Chapters Five, Six and Seven were underlaboured with critical realism's causal view of human action. Chapter Eight therefore attempted to demonstrate how the teachers' valued beings and doings, conversion factors and capability sets can account for the underlying mechanisms. The in-depth discussion in Chapters Five, Six and Seven drew on the perspectives of professional development within social learning theory and the conceptual frameworks of the capability approach in Chapters Two and Three. The key findings of the study are:

- ***Teachers valued expanding their capabilities for biodiversity teaching through improving subject content knowledge, pedagogical and assessment practices.***

Sen (1999; 2009) viewed education itself as a basic capability that affects the development and expansion of other capabilities. In his work he also noted that people are agents who act in the world to, and choose to, do things that they have reason to value. As agents, teachers had different valued functionings for biodiversity teaching. The Life Sciences CAPS curriculum covers a considerable amount of biodiversity content and concepts (see Section 2.8). Teachers find it challenging, however, to identify some of the biodiversity concepts in the Life Sciences CAPS curriculum (see Section 5.2.1; Section 7.2.1). Therefore teachers valued being supported with conceptual progression (see Section 5.2.1, Section 7.2.1; Section 7.2.4). This was to expand their capabilities to work with the Life Sciences CAPS curriculum. The teachers' poor conceptual progression was due to their lack of biodiversity content knowledge (Section 5.2.1; Fundisa for Change, 2013). This was mainly because initial training did not prepare them well for biodiversity teaching (see Section 2.3.1; Section 5.2.1; Section 5.3). Contributing to the teachers' lack of biodiversity content knowledge were the on-going curricula changes, lack of and/or ineffective professional development and poor policy implementations (see Section 1.4; Section 2.3.1; Section 5.2.1; Section 7.2.1). The complexity of biodiversity concepts and content also contributed factors to teachers' poor content knowledge (Section 2.3.1; Section 5.2.1; Section 5.3). Teachers' valued functionings were therefore to enhance their subject content knowledge related to the teaching of biodiversity. The valued knowledge and learning were aligned with the different types of knowledge (disciplinary, pedagogical, practical, fundamental and situational) foregrounded for

quality teaching good quality teaching (Table 5.1 and 5.2; Section 5.2.1; Section 5.3; South Africa. DHET, 2011). This was to expand capabilities to teach biodiversity content and concepts in the Life Sciences curriculum in an integrated and applied way (Section 5.2.1; Section 5.3). To achieve these valued functionings, in line with Fundisa for Change framework, the different types of knowledge required for quality teaching were explored in the PLCs in an integrated way (Section 5.2.1; Section 5.3).

Teachers recognised that biodiversity concepts are complex (Section 2.3.1; Section 5.2.1; Section 5.3). Working with such complex content requires certain types of pedagogical approaches (Section 2.3.1; Section 5.2.2; Section 5.3). Therefore teachers' valued functionings included different pedagogical approaches for biodiversity teaching (see Section 5.2.1; Section 5.3). Among the valued pedagogical approaches were experiential methods, fieldwork leaning, place-based pedagogies, situated and other critical learning approaches that will support learners to engage with local and global biodiversity issues and associated risks (see Section 2.3.1; Section 5.2.2; Section 5.3; O'Donoghue, 2015). These pedagogical approaches are aligned to the Life Sciences CAPS curriculum (South Africa. DBE, 2011). Among others, the Life Sciences curriculum requires teachers to explore local biodiversity and conduct field inquiry on the different aspects of biodiversity such as biomes, human impact to biodiversity loss and ecosystems services (Appendix 13; South Africa. DBE, 2011). Teachers' valued functionings were therefore to enable them to engage learners with local biodiversity. However, as noted in Chapter One (Section 1.3), biodiversity is a global phenomenon, thus valued pedagogical approaches would also expose learners to global biodiversity issues and associated risks (Section 2.3.1; Section 5.2.2; Section 5.3). To expand teachers' capabilities for teaching biodiversity content and concepts in the curriculum, different pedagogical approaches were examined and explored in the PLCs (Section 5.2.2; Section 5.3).

As much as biodiversity knowledge requires active, critical and creative and situated approaches, and environmental education researchers, it also requires certain types of assessment practices (Section 5.2.3; Section 5.3). Biodiversity content knowledge requires assessment practices that will assess learners' high order thinking skills, problem solving skills and critical thinking skills (Section 5.2.3; Section 5.3; O'Donoghue, 2015). The Life Sciences CAPS curriculum requires assessment tasks that cover Bloom's taxonomy cognitive levels (Section 5.2.3; South Africa. DBE, 2011). Teachers lacked the capability to develop and design assessment tasks that cover all the cognitive levels of Bloom's taxonomy as required by the CAPS curriculum (Section 5.2.3; Section 5.3). They therefore valued being supported to expand their capabilities of compiling assessment tasks, particularly those that promote high order thinking and critical thinking skills (Section 5.2.3;

Section 5.3). This would enable them to assess biodiversity content and concepts beyond facts (Section 5.1). To expand teachers' capabilities for assessing high order and critical thinking skills, different assessment strategies were explored in the PLCs (Section 5.2.3; Section 5.3). Analysis of assessment tasks helped to explore different types of questions at different cognitive levels (Section 5.2.3; Section 5.3).

In South Africa, teachers express a dire need for teaching and learning resources to enable their teaching of biodiversity aspects in the curriculum (Section 5.2.4; Fundisa for Change, 2013). Many teachers rely on textbooks for their teaching of biodiversity (Isaacs, 2015). However, textbook knowledge is described as unquestionable, which makes them inadequate to teach the biodiversity knowledge that is questionable and ever changing (Section 5.2.4; Fundisa for Change, 2013). The Fundisa for Change programme provides teachers with high quality teaching and learning resources (Section 5.2.4; Section 5.3; Section 6.2.2.1) which consider the different types of knowledge required for competent teaching (disciplinary, pedagogical, practical, fundamental and situational) (Section 5.2.4; Section 5.3; Songqwaru & Shava, in press). The materials are aligned with teacher education policy and critically engage with the "complex dynamics of the curriculum knowledge brought forth by the changing nature of knowledge and the associated social-ecological conditions which produce the needs for engaging with such forms of knowledge" (Lotz-Sisitka, 2011:55). In the PLCs, teachers were exposed to the Fundisa for Change teaching and learning resource materials and locally relevant resource materials for meaningful teaching and learning (Section 5.2.4; Section 6.2.2.1). In addition to expanding content knowledge, pedagogical and assessment practices, engaging with teaching and learning resource materials also helped to develop teachers' agency to develop their own teaching and learning resource materials (Section 5.2.4; Appendix 7).

Sen (1999) wrote that education is a capability that expands other capabilities. In line with this argument, teachers valuing of biodiversity content knowledge was to help achieve their other valued functionings such as expanding learners' capabilities on biodiversity (Section 5.1; Section 5.2.5). Teachers valued being educated and this also fulfilled the instrumental role of having good curriculum vitae or exploring further study opportunities (Section 5.1; Section 5.2.5; Section 5.3). Teacher professional development activities are meant to increase teachers' professionalism, confidence and capabilities to teach (South Africa. DHET & DBE, 2011). Therefore in line with this policy document, teachers valued achieving content knowledge, pedagogical and assessment practices to be confident and capable in their teaching of biodiversity (Section 5.1; Section 5.2.5; Section 5.3).

- ***Processes that happens in the PLCs are conversion factors that expands teachers capabilities for biodiversity teaching***

In the PLCs there were conversion factors that dictated how much use teachers could get out of the available resources (Section 3.3.2.3; Robeyns, 2005b). These conversion factors were personal, social and environmental (Section 3.3.2.3; Chapter Six). Teachers in the PLCs had different capabilities for teaching biodiversity (Section 6.2.1.1). The diversity among teachers in the PLCs were personal conversion factors. This allowed teachers to share their experiences and learn from each other good practices in terms of subject content knowledge and pedagogical practices (Section 6.2.1.1). Other personal conversion factors in the PLCs were the well trained facilitators (Section 6.2.1.2). The facilitators were from institutions of higher learning, environmental sectors and Department of Basic Education (Section 4.3.1; Section 6.2.1.2). These facilitators were knowledgeable and had different expertise in terms of subject content knowledge, pedagogical and assessment practices (Section 6.2.1.2). The subject advisors were experienced with working with the curriculum. They therefore were enablers to teachers' understanding of the curriculum and assessment *for* and *of* learning as stipulated in the CAPS documents (Section 5.2.3; Section 6.2.1.2). Other personal conversion factors in the PLCs were the presence of the subject specialists (external expertise) (Section 2.6.3.6; Section 6.2.1.3). The subject specialists brought in diversity which enriched the PLC activities expanding teachers' capabilities for subject content knowledge and scientific investigation skills (Section 6.2.1.3).

The PLCs provided a conducive collaborative learning environment (Section 2.6.3; Section 6.2.3.1). The collaborative space was a social conversion factor as it allowed teachers, facilitators, subject advisors and subject specialists to learn through social interactions (Section 2.6.3.3; Section, 2.6.2; Section 6.2.3.1). Those whose content knowledge was at a higher level offered assistance to their colleagues through discussions and debates of the biodiversity concepts (Section 6.2.3.1). These interactions within the PLCs promoted the co-construction of new knowledge (Section 2.6.3; Section 6.2.3.1). These allowed teachers to develop their Zones of Proximal Development through learning from their capable other (Section 2.6.1.1; Section 6.2.3.1). Teachers were free to express themselves and they valued each other's opinions (Section 2.6.3; Section 6.2.3.1). This allowed them to reflect on their classroom practices and to critique each other assumptions about teaching and learning (Section 2.6.3; Section 6.2.3.1).

The context in which the PLC activities happened included environmental factors that enabled teachers to expand their capabilities for biodiversity teaching (Section 6.2.3.2). The PLC activities happened in different contexts. In one site there was a wetland. The second site, the Wild Coast, was close to the ocean. The third site was at the South African National Botanical Institute

Kirstenboch Botanical Garden and the University Of Cape Town Department Of Biological Sciences (Section 6.2.3.2). The presence of the ocean, the Botanical Garden and the wetland enabled fieldwork activities which expanded teachers' capabilities for conducting investigation and subject content (Section 6.2.3.2). The uses of the Biological Sciences laboratories were environmental conversion factors that expanded Cape Town teachers' content knowledge and pedagogical knowledge (Section 6.2.3.2).

- ***Expanded capabilities transform classroom practices related to the teaching of biodiversity***

PLC activities aim at improving teachers classroom practices (Section 2.6.3; South Africa. DBE, 2015). The structure and function of the PLC activities expanded teachers' capabilities for teaching biodiversity. That was through learning new subject content knowledge, improved pedagogical and assessment practices (Section 7.2.1; Section 7.2.2; Section 7.2.3). Teachers new subject content knowledge, pedagogical practices and assessment practices were realised in their actual teaching practice, therefore transforming their classroom practices (Section 7.2.1; Section 7.2.2; Section 7.2.3). Teacher agency was developed in the PLCs that allowed for confidence and improvisation of teaching and learning resources to teach biodiversity (Section 7.2.2; Section 7.2.4).

- ***Constraining capabilities can be reconciled to become expanded capabilities for biodiversity teaching***

The capability approach notes that in real life "two people with identical capability sets are likely to end up with different types and levels of achieved functionings, as they have made different choices from the effective options (Robeyns, 2005b:14). It was clear that even though the teachers' capabilities to participate in the PLCs were to expand their capabilities for teaching biodiversity, it was evident that the teachers' achieved functionings were different depending on their ability to convert the available resources into achieved functioning (Section 7.2; Section 7.3). Teachers' realisations of the achieved functionings were different depending on their agency (Section 7.3.1). Social conversion factors in the PLCs, such as lack of time on tasks, constrained teachers to achieve some of their valued functionings (Section 6.2.8). Some of the activities used in the PLCs did not engage teachers and/or were not aligned to the teachers' practices (Section 6.2.2.2; Section 6.2.1.3). Reconciling these constraining capabilities would expand teachers' capabilities for biodiversity teaching (Section 6.2.1.3; Section 6.2.2.4; Section 6.2.2.2). External factors were constraints to teachers' realisation of their achieved functionings (Section 7.3.2; Section 7.4; Section 8.2). Among these were lack of time, lack of teaching and learning resource materials, learners' inability to read and write and large class sizes. Reconciling these constraining factors would enable teachers to realise their achieved functionings, therefore transforming their teaching practices (Section 7.3.2; Section 7.4; Section 8.2).

- *Continuing professional development programme processes are conversion factors that expands teachers' capabilities in the PLCs*

PLC in this study is used in the sense of a course-based PLC (Section 1.8.5). The course used as a PLC in this study was a Fundisa for Change continuing professional development course/ training (hence in the quotes used in Chapters Five, Six and Seven it was referred to as Fundisa for Change/ training/ workshop/ course). It is therefore important at this point to reconcile that the good facilitation, teaching and learning support resource materials, collaborative space, and external expertise were all conversion factors that were provided by the Fundisa for Change programme. As indicated in Chapters Five and Six, Fundisa for Change is a structured programme that focuses on improving teachers' content knowledge, pedagogical practices and assessment practices (Section 1.5; Section 5.1). The three components of Fundisa for Change are central to quality teaching. Despite the structure that the Fundisa for Change programme provides for professional development, it does also allow for teachers to shape activities appropriate to their contexts. This allows for individual teachers' valued functionings to be achieved (Section 5.1). There is thus no doubt that with all the evidence in Chapters Five, Six and Seven that a continuing professional development programme is an enabler to PLC activities. The Advanced Certificate in Education also proved to be a conversion factor to Cape Town teachers' expanded capabilities. The course provided enabling structures for the teachers to achieve their valued functionings, thus also points to the effective role that professional development programmes can play in PLC activities (Section 7.4.1).

The above findings provide insights into how the PLCs may work in the 'real world' in contexts such as those presented in the three PLCs under study. The findings have implications for Fundisa for Change which was used a case study in this study, to other continuing professional development programmes and to the South African policy concept of PLCs. This are discussed below as recommendations.

8.4 Recommendations

This section provides recommendations emerging from the study. The recommendations are based on the insights gained from the work of the three PLCs, and are not meant to be generalised to the broader population of PLCs. However, these recommendations can be drawn on for further analysis or research on PLCs, as is the tradition in case study research. The recommendations in this study have implications for Fundisa for Change, continuing professional development, and PLC policy in South Africa. These are discussed in turn.

8.4.1 Fundisa for Change

8.4.1.1 On-going support of teachers and facilitators through the PLC model

Some of the teachers' valued beings and doings were achieved in the PLCs. In addition to this, there were unintended outcomes achieved in the PLCs i.e. the pastoral role of the teacher, teacher as researcher which are all part of what is required in competent teachers. Some of the valued functionings related to the teaching of biodiversity were not achieved. These were expressed by teachers as new valued functionings in the PLCs. There is therefore a need for further support from the Fundisa for Change programme and for the programme so that it can continue to offer this support. This will further expand teachers' capabilities for biodiversity teaching. As discussed in this study biodiversity knowledge is new, ever changing and contested. For teachers to keep up with the new knowledge, they need on-going support from the Fundisa for Change programme (implying a need for on-going PLC activities). The support could be offered quarterly or annually. The on-going PLC activities should capacitate teachers to teach other environmental topics as well.

According to the South African Council of Educators (SACE), as from 2016, the teachers will accumulate professional development points. Teachers will be expected to submit portfolios of evidence for the professional development activities they participate in (South Africa. DBE, 2015). As noted in Chapter Five, in line with this policy document, teachers are expected to complete an assignment in the form of a portfolio of evidence. It was evident in this study that teacher workloads are high and that they hardly have time to work on their portfolios of evidence. Further support and onsite visits (school visits) have potential to support teachers to successfully complete the portfolios of evidence. Other structures could be put in place to enable teachers' development of portfolios of evidence. A good example was the Cape Town PLC: through structures provided by the Advanced Certificate Course, teachers were able to complete their portfolios of evidence. Eco-School coordinators in provinces, where they exist, can also support teachers with the development of portfolios. Alternatively, other forms of assessment could be explored to replace the portfolios of evidence. For example, teachers could do oral presentations during the PLC activities based on what they have learned. They could then submit examples of tasks given to learners without having to spend too much time putting together a portfolio of evidence. Another suggestion would be to support Fundisa for Change partners to observe teachers' classroom practices. In the presence of the Fundisa for Change partner, the teachers can then reflect on their classroom practices. Then the Fundisa for Change partners can report back to the programme on the evidence based on their observations and discussions with teachers.

Cluster activities could be used by the Fundisa for Change programme to further support teachers to achieve their valued beings and doings and to successfully complete their portfolios of evidence.

This would involve teachers belonging to different Department of Basic Education clusters. During this research process, when teachers participated in the PLC activities, they came from different clusters. For example, the Idutywa teachers who participated in the PLC activities belonged to three different clusters, as well as the Grahamstown teachers. Based on their learning experiences in the PLCs, they expressed a need for Fundisa for Change to support their clusters directly, rather than inviting only a few teachers from each cluster. Therefore Fundisa for Change has the potential to strengthen cluster activities and to transform them into professional development spaces (rather than simply spaces for moderation of assessment tasks as most teachers described them). Strengthening cluster activities will improve teachers' classroom practices.

As noted in Chapter One, Fundisa for Change is a national programme. It operates in all the provinces in South Africa, and within the provinces it operates in different districts. But the Fundisa for Change programme currently has one coordinator. This is too much work for one person. There is thus a need for provincial coordinators to monitor and support PLC activities in the provinces. Among other roles, the Fundisa for Change programme can also support on-going PLC activities in the provinces. The provincial coordinators can further play a role in keeping communication channels open between the Fundisa for Change programme and the teachers who have benefited from the programme activities. It is important to further explore and provide learning opportunities for teachers to build on what they have learnt in the PLCs.

The Fundisa for Change programme supports the facilitators through the training of trainers meetings. This training proves to be a very effective forum for facilitators to share best practices. As evident in this study, the facilitators' implementation of the programme activities differs. Some practices prove to be more successful than others. It also emerged that facilitators work with teachers in different contexts. They therefore learn from the various teachers' experiences. On-going training of trainers' activities will therefore provide space for facilitators to reflect on their experiences of working with teachers in different contexts and can share best practices. This will support facilitators to continuously improve their practices for the benefit of the PLCs.

8.4.1.2 Support teachers' realisation of achieved valued functionings for transformation of classroom practices

The aim of the PLCs is to improve teachers' classroom practices (see Section 2.6). Some teachers experience challenges at schools to realise their expanded capabilities (see Section 7.4). There is therefore a need to support teachers onsite to enable them to translate what they have learn in the PLCs into their actual classroom practice. Supporting teachers' onsite will provide space for teachers to reflect on their classroom practices (based on their realised expanded capabilities) in the presence of the experienced Fundisa for Change partner. This will allow for learning beyond the

PLC activities. Onsite visits will further strengthen the work-integrated learning that the South African policy documents aim to achieve. There seemed to be an understanding that subject advisors are in better positions to support teachers' onsite. But emerging from the study is that subject advisors are also limited in terms of subject content knowledge, pedagogies and assessment practices. Moreover, through informal discussions I have established that many subject advisors are overworked. In areas such as Idutywa districts some of the schools are as far as 200km from the district office, and some subject advisors do not have transport. Therefore if Fundisa for Change partners can be supported to support teachers onsite, this would provide relief to the subject advisors. This has potential to improve the quality of teaching.

8.4.1.3 There is potential to reconcile constraining capabilities to expand teachers' capabilities for biodiversity teaching

This study found that even though the teachers' capabilities to participate in the PLCs were specific to teaching biodiversity, the achieved functionings were different depending on their ability to convert the available resources into achieved functioning. Teachers' realisations of the achieved functionings were different depending on their agency. Social conversion factors in the PLCs, such as lack of time on tasks, constrained teachers to achieve some of their valued functionings. Some of the activities used in the PLCs did not engage teachers and/or were not aligned to the teachers' practices. Reconciling these constraining capabilities would expand teachers' capabilities for biodiversity teaching. External factors were also constraints to teachers' realisation of their achieved functionings. Among these were lack of time, lack of teaching and learning resource materials, learners' inabilities to read and write and large class sizes. Reconciling these constraining factors would enable teachers to realise their achieved functionings, thereby transforming their teaching practices.

Fundisa for Change is a national partnership programme, and the Department of Basic Education is one of its partners. However, to ensure the on-going support from Fundisa for Change to PLCs, the partnership between the programme and Department of Basic Education needs to be strengthened. Critical are the partnerships at provincial level because this is where PLCs are initiated, and then of course at district level for daily operations. Strengthening the partnership between Fundisa for Change and the provincial departments can better align Fundisa for Change activities to the Department of Basic Education activities, making access to teachers easy. Establishing provincial coordinators in Fundisa for Change would be a good start. Provincial coordinators can then liaise with the provincial departments of education.

8.4.2 Continuing professional development

8.4.2.1 A PLC model for continuing professional development can strengthen teachers' reflexivity and improve teachers' classroom practices

Teaching is a complex practice and as noted in this study, biodiversity knowledge is ever changing. Thus for professional development activities to have a positive impact on teachers' classroom practices, they need to be happening regularly. Teachers also seem to try in their classroom practices what they have 'just' learnt and what has sparked interest, curiosity and creativity. Therefore regular professional development activities are likely to sustain teachers' interest and have the potential to transform their teaching practices and ultimately improve learners' performances. Regular professional development activities will allow teachers to continuously reflect on their classroom practices. Quality teachers are reflective and reflexive of their practices.

This study has shown that contextual and personal factors constrain teachers to participate in face to face professional development activities. Among these are workloads at schools, family responsibilities, lack of time, distances between schools and places where professional development activities are held. Thus, as much as teachers value professional development activities, there are personal and external factors that constrain their participation in the few available professional development activities. There is therefore a need for online platforms for professional development activities. This will require teachers to be supported with computer skills to expand their capabilities for using online spaces. Online spaces have unlimited potential to enable teachers to participate in professional development activities. Online spaces are not geographically limited, thus are able to allow teachers across the country to share best practices and best resources.

8.4.2.2 Professional development activities should be responsive to teachers' valued beings and doings

Professional development needs to be responsive to individual teachers' valued functionings. Teachers have different valued functionings, therefore for professional development to be of maximum benefit to teachers, it should be aligned to their valued functionings. Subject knowledge, pedagogical practices and assessment practices are core valued functionings thus should be central to all professional development activities. But teachers value subject knowledge, pedagogical approaches and assessment practices differently and thus these need to be responsive to individual teacher's needs. In addition, teachers' value teaching and learning resource materials thus they should be provided with these in professional development activities. This will allow teachers to move beyond relying on textbooks. These activities should enhance teachers' capabilities to develop their own teaching and learning resource and materials. This study has shown that teachers have different capabilities for teaching biodiversity. The teachers' individual capabilities are mainly determined by their experiences as Life Sciences teachers and their qualifications.

The study has further shown that teachers value professional development activities that are interactive and engaging. Teachers do not want to be 'lectured' in professional development activities. Rather, they should be actively engaged. Effective professional development activities are also those that model pedagogical practices and assessment practices. Thus, for professional development activities to be effective, they should model different pedagogical practices that teachers can use in their actual classrooms.

This study has also shown that teachers find it difficult to access good quality teaching and learning resources for their teaching. Therefore they resort to using the textbooks which are inadequate, especially for biodiversity knowledge that is described as complex, new and ever changing. Teachers therefore need to be supported with teaching and learning resources. Professional development activities should also enable teachers to develop their own teaching and learning resources.

8.4.2.3 To be effective, professional development activities should be aligned to curriculum policies

This study has shown that there are different policies at both international and national levels that aim at conserving biodiversity. These policies have influenced the integration of biodiversity content and concepts in the different subjects of the formal curriculum. It is evident in this study that for professional development activities to be effective, they need to be aligned to curriculum policies. Environmental topics are integrated across the curriculum (see Section 1.4). For teachers to

be fully knowledgeable in teaching the environmental topics in the subjects they teach, professional development activities need to be aligned to the curriculum policies.

8.4.3 PLC policy in South Africa

8.4.3.1 PLC activities should be responsive to teachers' valued beings and doings

The policy documents on PLCs in South Africa clearly indicate that teachers should be at the centre of PLC activities. However, these policy documents do not explicitly highlight the role of teachers in PLCs. This study found that as individuals, teachers have individual valued functionings related to their teaching of biodiversity. The study further found that teachers value PLC activities that respond to their individual valued functionings, and as a result they were even willing to participate in such activities over weekends and after school hours. It is thus no doubt that for PLC activities to be of value to teachers, they should respond to individual teachers' valued beings and doings. This has potential to transform teachers' classroom practices. As mentioned earlier, teachers value different types of knowledge (disciplinary, pedagogical, practical, fundamental and situational) in good quality teaching. They further valued pedagogical approaches and assessment practices for biodiversity teaching. Thus, for PLC activities to be effective and to be beneficial to teachers teaching of biodiversity, they should be aligned to the individual teachers' valued beings and doings. This study has also shown that there are different causal mechanisms for teachers' valued beings and doings as they relate to the teaching of biodiversity. Thus, for PLC activities to be of great benefit to teachers, they should also consider the root causes of teachers' valued beings and doings related to the teaching of biodiversity.

8.4.3.2 PLC activities should be aligned with school activities and structures

The policy landscape recognises time as crucial for teachers' participation in PLC activities. Evident in the study is that there was no time available to participate in PLC activities. They had to engage in PLC activities over weekends and after school which was a challenge and a sacrifice among their other personal valued functionings. Teachers noted that this had an impact on their full participation, thus constraining some of their capabilities. It is thus evident that for PLCs to make a positive impact on teachers' teaching practice, South African policy needs to be translated into reality. Making time available for teachers to participate in PLC activities will enable teachers to receive support from programmes such as the Fundisa for Change. To ensure the effectiveness of the PLC's activities, the Department of Basic Education could consider aligning Fundisa for Change with the teachers' schedules.

This study has shown that PLCs exist at different levels in South Africa (multi-layered). Both teachers and different stakeholders have shown determination in supporting PLCs. Different PLCs have different purposes and interests; however there is a need for better alignment. Not only can it

be overwhelming for teachers to participate in many PLCs, but aligning the different PLC activities can strengthen the activities and therefore maximise the benefits for teachers' practice. Alternatively, schedules can be set up in such a way that some PLC activities will be annual, others quarterly and weekly meetings could be school-based. Fundisa for Change activities can also link up with other PLCs for on-going support. It also emerged that the success of the PLC activities depends on the specific contexts. Therefore the support offered to PLCs should depend on the specific school contexts. Evident from this study is that PLCs that are established in rural areas require more support to be successful. It is therefore important that the Department of Basic Education is among others stakeholders that are responsible for establishing and supporting PLCs to provide more support in these areas.

8.4.3.3 PLC activities should consider conversion factors that enable teachers to expand their capabilities

Teachers value participating in PLCs, but what would really enable their professional development would be a formalised structure where they could meet and share their knowledge and experiences. Formal structures and space for teachers to meet will also enable Fundisa for Change programme to support teachers in their PLC activities. The space should however take contextual constraints into consideration. The policy documents on PLCs encourage school PLCs to ensure that teachers are not constrained by space, time finances and other contextual factors to meet in PLCs. However, teachers value meeting in the PLC where they meet with teachers from other schools for diverse opinions and richer experiences. To meet with other teachers requires space and formal structure and a formal schedule. Teachers value subject and phase specific PLCs. In some schools there are only one or two teachers teaching Life Sciences, thus school based PLCs will be limiting in terms of amount and quality of knowledge shared between teachers. The policy documents point to making external expertise available through trained mentor teachers and subject advisors; however during the time of this research there was no evidence of trained mentor teachers. Most teachers and subject advisors were not even aware of policy on PLCs in South Africa. Thus if PLCs are to make a difference to teachers' practices, in cases where across-school PLCs cannot be supported, then mentor teachers and subject advisors should be made a reality.

It was also evident in this study that skilled facilitators and knowledgeable subject specialists enable teachers to expand their subject content matter required to teach their subjects. Thus for PLCs to be effective spaces for professional development, subject specialists and good facilitators should be considered for PLC activities.

8.5 Limitations of the study and recommendations for further research

8.5.1 Limitations

One of the most critical contributions of this study is its ability to shed light on the structuring and operations of the teachers' PLCs as opportunities for teachers to expand their capabilities for teaching biodiversity. It is clear that PLCs improved teachers' content knowledge, pedagogical approaches and assessment practices, and thereby begin to reshape their classroom practices. It is evident from the study that teachers' PLCs begin to provide opportunities for teachers to meet and discuss classroom practices and knowledge gaps with their peers, in the presence of the facilitators and external expertise. However, it is important to note that not all teachers will learn in the same way from the PLCs. Therefore PLCs do not offer identical benefits to participating teachers. It has been evident in this study that individual teachers needed different resources to expand their capabilities of teaching biodiversity content in the PLCs. Even though all teachers indicated that they had achieved their functionings to teaching biodiversity, it was evident that some teachers still lacked agency to be innovative to realise their achieved functionings in their actual practices. This was due to external constraints that need to be reconciled to enable teachers to improve their teaching practices. The policy on PLCs in South Africa therefore needs to take into account the differential benefits of the PLC activities to the participating teachers. It is over three years since the implementation of the *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011-2025)* but it is evident that implementation was mainly at stakeholders' consultation level. If the teachers are core agents to the success of this policy implementation, advocacy at school level and district level among other issues, need to be translated into reality.

The PLCs that were used in this study were professional development courses that took place over a specific period of time. The Cape Town PLC activities took place over two consecutive weekends. The Grahamstown PLC activities were scheduled in three sessions spread over five months. The Idutywa PLC activities took place in two sessions spread over three months. The success of these PLC activities has provided evidence reported in this study that Fundisa for Change has been successful in establishing PLCs of teachers to enhance their biodiversity knowledge. The gap in the literature is lack of evidence as to how long it takes for PLCs to be established. However, it is evident in literature that PLCs are on-going activities. I cannot claim that the PLCs in this study are on-going but what I have argued is for the potential of the established PLCs to be on-going to further support teachers' professional needs and the value in this. A limitation in the study is therefore that the PLCs used were newly established and envisaged to be on-going. Their 'newness' was a limitation in terms of the depth of data provided. If on-going PLCs or well-established PLCs were selected for the study, more evidence might have been provided on what really constitutes a PLC.

This point needs to be highlighted because the PLCs in international literature have usually been in existence for years, which was different for the PLCs in this study.

This study was conducted three years after the implementation of the *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011-2025)*. This poses another challenge or limitation to understanding PLCs in South Africa. However, the study has contributed to how the *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011-2025)* can be implemented to make a positive impact to teachers' practice.

Another limitation was that even though the study has provided evidence of teachers' realised functionings in their actual classroom practices, there were no classroom observations to confirm teachers' realisation of the achieved functionings. Classroom observation would have shed more light on the contextual factors that constrain teachers' realisation of achieved functions. Even though this was not the core focus of the study, observing classroom practices had potential to provide more in-depth understanding of teachers' practices in biodiversity. This may have provided a more in-depth understanding of teachers' valued functionings.

Finally, this thesis has been written as a single story on what happens in three PLCs and describes how the expanded capabilities are realised (or not realised). However, as indicated throughout this study, teachers are individuals with their own capabilities, thus presenting this research as a single story does not give reflections into individual teachers' stories. Quotes and data often came from the same teachers in the study which is evidence that some teachers had learnt more, some were more confident, but it could also be due to other personal conversion factors (some teachers were not as expressive in their interviews, reflection tools and evaluations). The 'silent voices' in the study could have been studied further in terms of pointing to the issues of validity of the claims made in the study.

8.5.2 Further research

Although this study has provided significant insights into how PLC activities can be successful structures that expand teachers' capabilities for biodiversity education, the study provided little information on how other groups of individual teachers may respond to participating in PLC activities and the opportunities that PLC activities presents for teaching. While the study has begun to outline a theory of the effectiveness of the PLC activities, there is still limited knowledge as to how such a theory could interact with other theories of learning or identity theories in order to maximise benefits to individual Life Sciences teachers. It has been argued that individuals differ and they experience life differently depending on their individual beings and doings. Thus teachers

will experience professional development activities such as PLC activities differently. *Therefore further research needs to be conducted into how individual teachers experience PLC activities in relation to their teaching of biodiversity. Alternatively the same study could be done with different theoretical frameworks to explore teachers' learning experiences in the PLCs.*

Furthermore, it is important to contextualise the teachers' PLCs in this study within the Eastern Cape and Western Cape provinces of South Africa, and to consider how they are situated within the web of structural and organisational relationships existing within the education system. In this study there has been evidence of what kinds of relationships are valued for effective PLC activities, however it is not clear what type of relationships will be most suitable for the emerging PLC structures. It was also evident that several structures support teachers to improve their teaching practice on biodiversity, even if they are not fully effective. This calls for a restructuring of some sort to accommodate and support the establishment, functionings and sustainability of PLC activities in South Africa. Further work is therefore needed to explore the structuring and sustainability of the PLC structures in South Africa. As indicated earlier, the PLCs in this study were course-based. The Fundisa for Change programme provided structural conditions to enable the success of the PLC activities. This has been in specific subjects and phases in South Africa. It has emerged that Fundisa for Change is limited in terms of financial and human resources, which constrains on-going support for the PLCs while at the same time supporting more teachers. *Thus further work needs to be done to explore how Fundisa for Change can continue to support the PLC activities for teachers' biodiversity knowledge. It also needs to be considered how Fundisa for Change can be supported to enable the programme to further support teachers' biodiversity content knowledge, pedagogical and assessment practices.*

Finally, it was evident that teachers felt confident and enthusiastic after the PLC activities. However the study has provided little insight into how teachers sustain this enthusiasm. The study was conducted a few months after the PLC activities and teachers were still enthusiastic and some were still looking forward to realising their achieved functionings. However it is not known how long teachers remained enthusiastic and confident in their teaching of biodiversity. *There is therefore a need for further research work to explore the teachers' realisation of their achieved functionings and how and what can be done to sustain enthusiasm of teachers for biodiversity teaching.* The international literature recognises that PLCs go through different stages; thus it is significant to gain an in-depth understanding of the teachers' learning at different stages in the PLCs and how this influences their teaching practice.

A considerable amount has been said in the literature about what constitutes PLCs, their purpose and attributes. There is no doubt that this study has contributed to those debates; however what is

not evident in literature or in this study is at what point can it be said that a PLC has been established. Research on the establishment and sustainability of PLCs would be useful.

8.6 Conclusion

This study has described and discussed teachers' achieved functionings in PLCs. The study demonstrated how some of the teachers exercised their agency to realise some of their achieved functionings. The main aim of the study was not only to explore whether teachers came together in the PLCs, but also how such opportunities were created for teachers to uncover and share their content knowledge, pedagogical and assessment practices with the aim of improving their confidence and professionalism and improve classroom practices. The discussions and dialogues leading to sharing, challenging and reflecting on classroom practices seem to have provided useful opportunities for teachers to challenge and change their biodiversity content knowledge, pedagogical approaches and assessment practices. The success of the PLC activities in expanding teachers' capabilities for biodiversity teaching depends largely on the teachers' commitment to the collaborative learning and support in the PLC activities as peers. In this study the collaborative space was provided by the Fundisa for Change programme, with experienced and trained facilitators who provided external expertise in the form of subject specialists and knowledge resources. The collaborative learning in the PLCs was based on mutual trust, respect and giving teachers the confidence to share their views and opinions as well as share their challenges related to their teaching of biodiversity, with the aim of improving their teaching of biodiversity. This study has therefore provided a window on why and how teachers PLCs enable Life Sciences teachers can expand their capabilities for teaching biodiversity, and thereby their classroom practice. *In short, this study shows that if professional development programmes take account of underlying mechanisms and respond to teachers' capabilities i.e. their valued functionings for biodiversity teaching in the Life Sciences curriculum, the professional development programmes²⁹ can be an important conversion factor that enables the expansion of teachers' capabilities (especially their biodiversity knowledge, pedagogical and assessment practice but also other capabilities) in ways that have the potential to reshape teachers' classroom practices related to the teaching of biodiversity.*

²⁹ Such as the Fundisa for Change Programme examined in this study.

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Appendices

APPENDIX 1

Biodiversity is in the Diversity, change and continuity strand and the environmental studies strands

GRADE 10	
Strand 3: Environmental studies	Term 3
	Content
<p>Biosphere and ecosystems</p> <p>6 Weeks (24 Hours)</p>	<p>Biosphere</p> <ul style="list-style-type: none"> *The concept of biome *The interconnectedness with and components of the global ecosystem: the hydrosphere, lithosphere and atmosphere (<i>link 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 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> <p>. Abiotic factors</p> <ul style="list-style-type: none"> - Physiographic (aspect, slope, and altitude) -Soil (pH , humus content, texture, water retention capacity and air content) -Light (day length and seasonal changes) -Temperature (effects of day/ night and seasons) -Water (water cycle and the importance of wetlands) -Atmospheric gases (<i>link to pollution grade12</i>) <p>And</p> <ul style="list-style-type: none"> -Wind (<i>link to transpiration</i>) <p>. Biotic factors which include (links to grade 8)</p> <ul style="list-style-type: none"> -Producers -Consumers -decomposers <p>.Energy flow through ecosystems and relationship to trophic structure (food pyramids)</p> <ul style="list-style-type: none"> - 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 <p>(Names e.g., nitrates are required but no detail of chemistry is necessary)</p> <p>*Ecotourism:</p> <ul style="list-style-type: none"> -Economics -Ethics -Opportunities
Strand 4: Diversity, change and continuity	Term 4
<p>Biodiversity and classification</p>	<p>Biodiversity</p> <p>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> <p>*Classification schemes</p>

<p>1 Week (4 Hours)</p>	<p>Classification schemes are a way of organising biodiversity</p> <p>*Brief history of classification: scientists attempt to classify organisms based on shared features. As information increases classification changes.</p> <p>One of the currently accepted classification systems is the five-kingdom system: Animalia, Plantae, Fungi, Protista and Monera (Bacteria)</p> <p>*The naming in science: species concept and binomial system. Focus on Linnaeus (Carl von Linne) and his role in classification systems: why do we use Latin?</p> <p>*Differences between prokaryotes and eukaryotes (<i>link to cell structure</i>)</p> <p>*The main grouping of living organisms, diagnostic features of each</p> <ul style="list-style-type: none"> -Bacteria - Protista - Fungi -Plants -Animals
<p>GRADE 11</p>	
<p>Strand 1: Diversity, change and continuity Term 1</p>	
<p>Biodiversity and classification of microorganisms</p> <p>3 Weeks (12 Hours)</p>	<p>Biodiversity</p> <p>*Microorganisms: basic structure and general characteristics of the following groups (<i>links with grades 9 and 10</i>)</p> <ul style="list-style-type: none"> -viruses -bacteria -fungi -protista <p>(Macroscopic organisms in the Protista and fungi should only be mentioned – not studied in any detail)</p> <p>*Mention roles of that these groups play in maintaining balance in the in the environment and web of life</p> <p>*Symbiotic relationships, including nitrogen fixing bacteria in plants and <i>E. Coli</i> in the human intestine (<i>link with grade 10</i>)</p> <p>*The effect and management of one disease from each of the four groups:</p> <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) <p>*Immunity, including plants and animals’ immune responses of against the infecting microorganism vaccinations (briefly).</p> <p>*The use of drugs, e.g. antibiotics, effect on microorganisms</p> <p>*The use of microorganisms to produce medicines (e.g. insulin and antibiotics)</p> <p>*Traditional technology to produce, e.g. beer, wine and cheese</p> <p>Grouping of bryophytes, pteridophytes, gymnosperms and angiosperms according to the presence/ absence of:</p> <ul style="list-style-type: none"> -vascular tissues (xylem and phloem) -true leaves and roots -seeds or spores -fruit <p>Decreasing dependence on water for reproduction from Bryophytes to Angiosperms</p>

	<p>*Asexual and sexual reproduction, name advantages and disadvantages of each</p> <p>*Flowers as reproductive structures Adaptations for pollination through (different pollinators) wind, insects, and birds (South African examples only) differences and similarities.</p> <p>*The significance of seeds -seed banks -seeds as a food source; and -endemic species in South Africa</p> <p>*The relationship between the body plan and grouping of animals phyla. The concept of phylum *Six phyla (out of 30 in the animal kingdom) -Porifera -Cnidaria -Platyhelminthes -Annelida -Arthropoda -Chordata *Key features in respect of body plans: -Symmetry and cephalisation; -The number of tissue layers developed from embryo; -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)</p>
Strand 3: Environmental studies	Term 3 and Term 4
<p>Population ecology 4 Weeks (24 Hours)</p>	<p>*Population size Immigration, emigration, mortality, births, fluctuations. Limiting factors and carrying capacity. Logistics and geometric growth curves with phases *Interactions in the environment -Predation: two South African examples of predator-prey relationship -Competition -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 on 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</p>

	<p>(hunting); dominance; and the division of tasks (castes) (mention only)</p> <p>*Community change over time: Succession</p> <p>Primary and secondary succession and possible end points depending on environmental fluctuations (mention only)</p> <p>Human population</p> <p>Reasons for exponential growth</p> <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>Strand 3: Environmental studies (continued) Term 4</p>	
<p>Human impact on the Environment: Current Crises for Human Survival: Problems to be Solved Within the Next Generation</p> <p>7 Weeks (28 Hours)</p>	<p>Causes and consequences of the following (relate to conditions and circumstances in South Africa):</p> <p>*The atmosphere and climate change</p> <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 <p>* Water</p> <p>*Availability</p> <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 of aquifers -wastage -cost of water <p>*Quality</p> <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> <p>*Food security (link with population ecology dynamics)</p> <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 <p>*Loss of biodiversity</p> <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;

	<p>-poaching e.g for rhino horn, ivory and ‘bush meat’;</p> <p>-alien plant invasions: control using mechanical, chemical and biological methods; and</p> <p>-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></p> <p>*Solid waste disposal</p> <p>-managing dumpsites for rehabilitation and prevention of soil and water pollution;</p> <p>-the need for recycling;</p> <p>-using methane from dumpsites for domestic use:heating and lightning; and</p> <p>-safe disposal of nuclear waste.</p>
Grade 12 Diversity, Change and Continuity Term 2	
<p>Genetic and Inheritance</p> <p>4 Weeks (16 Hours)</p>	<p>* Genes: Dominant and recessive genes and alleles. Mention of Mendel , father of genetics</p> <p>*Inheritance and variation</p> <p>-Monohybrid crosses: phenotype and genotype, homozygous and heterozygous (pure bred and hybrid); examples of complete, incomplete/partial dominance and codominance;</p> <p>-Dihybrid crosses: phenotypes and genotypes</p> <p>*Sex chromosomes</p> <p>Sex-linked diseases</p> <p>*Mutations</p> <p>-Harmless and harmful mutations: examples of diseases, disorders, gene mutations and chromosomal aberrations; and</p> <p>-useful mutations, link with natural selection</p> <p>*Genetic engineering: Stem cell research, genetically modified organisms, biotechnology and cloning.</p> <p>*Mention mitochondrial DNA and the tracing of genetic links</p> <p>*Paternity testing and DNA finger print (forensics)</p>
	<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>

APPENDIX 2

Name Gender.....

Province/ district.....

Years of teaching experience.....

Subjects teaching/ taught.....

School (urban, rural or semi-urban).....

Qualifications.....

What kind of support do you receive for your professional development? From whom?
.....

What more support do you need for your professional development?
.....

Are you part of any professional learning community? Please explain.

How did you become part of the Fundisa for Change training?
.....

What are/were your expectations from the Fundisa for Change training?
.....

Would you say your expectations have been met? Please explain.
.....

If any, what more support would like to receive from Fundisa for Change?
.....

What do you think can be done by Fundisa for Change to benefit you more?
.....

What did you like most from the training? Please explain
.....

What did you like least from the training? Please explain
.....

Any general comments or recommendations you would like to make regarding your professional development activities in general or Fundisa for Change.
.....

APPENDIX 3

1. Short profile (name, experience, qualifications...).

Professional development and Professional Learning Communities (PLCs)

2. Briefly describe what professional development support you receive or activities you participate in.
3. What would you say are some of the challenges that you experience in professional development or in wanting to be part/ participate in professional development activities?
4. Despite the challenges, what would you say enable/ makes it possible for you to participate in the professional development activities?
5. What is your role (s) in the professional development activities?
6. What do you understand by the term PLC?
7. Are you part of any PLC? Please explain. (What is your role?)
8. What activities happen in these PLCs, if in any way how does that benefit you?
9. Who support the PLCs and what type of support do they offer to the PLC?
10. How effective would you say is the support offered to you as an individual?
11. If in any way, how do you think could this PLCs be structured to benefit you more?

Teacher's biodiversity knowledge, CAPS, support and professional practice

12. How do you describe your biodiversity knowledge? (before and after the Fundisa for change training)
13. Have you previously participated in workshops and/or courses that deal with biodiversity knowledge and concepts? Please provide the details.

Fundisa for Change and its influence on the PLC/ teachers professional development

14. What were your expectations from the Fundisa for Change training? Were they met?
15. If in any way, how would you say Fundisa for Change would have benefited you more?
16. How do you describe your role in the Fundisa for Change training?
17. What challenges do you still have in working with biodiversity knowledge and concepts? How did you work with these in your implementation of biodiversity?
18. If you were to attend another Fundisa for Change training session what more professional development support would you still need? Please explain.
19. Any general comments or recommendations you would like to make regarding your own professional development/ PLC/ and/ or Fundisa for Change?

APPENDIX 4

Fundisa for Change partners interview schedule

1. Please briefly introduce yourself (full name, qualification, experience ...).
2. Generally if any way, how does your organisation support teachers for their professional development?

Fundisa for Change (FfC) and Professional Learning Communities (PLCS)

3. How would you describe the activities of Fundisa for Change to date?
4. What is your role in FfC or how would you say have you contributed to the FfC activities?
5. What would you say is/are your expectations from FfC? Are they being met? Please explain.
6. Fundisa for Change aims at strengthening the concept of PLCs, in your understanding what do you think does that really mean?
7. How would you describe the support FfC offer to teachers to date?
8. If any, what would you say enables the FfC activities and support rendered to teachers?
9. If any, what would you say constraint the FfC activities and support rendered to teachers?
10. If in any way, how do you think could teacher trainings be structured to benefit more from FfC?
11. If in any way, how do you think could FfC be structured to benefit from PLCs/ teachers activities?
12. Any general comments and/or recommendations regarding Fundisa for Change, and/ or teachers PLCs or your personal/ organisational involvement in the FfC activities?

APPENDIX 5

1. What was your general impression about the PLC activities?
2. Fundisa for Change aims at enhancing teachers' knowledge, pedagogies and assessment practices, would you say those were achieved in the PLC (s)?
3. If achieved, what would you say enabled the Fundisa for Change objectives to be achieved in the PLC (s)?
4. If any, what would you say constrained full effectiveness of the PLC activities?
5. If in any other way, how would you say could the PLC activities be improved to enable teachers achieve their valued beings and doings related to the teaching of biodiversity?
6. How do you describe your role in the PLC (s)?
7. How would you describe the teachers' roles in the PLC (s)?
8. Teachers seem to find it challenging to submit / complete the portfolio of evidence, what do you think can be done going forward to ensure teachers submit their portfolio of evidence?
9. If any? What could be done to improve the PLC (s)?
10. What would you say determined the choice of the PLC, participants, venues, facilitators, models used for the PLC? If in any way did they contribute to the effectiveness of the PLC activities?
11. What was your impression about the level of teachers marine/ biodiversity knowledge in the PLC (s)?
12. Did you provide any further support to the teachers (either as individuals or as a group) after the PLC activities? Please explain
13. Going forward, if at all in what way will Fundisa for Change or you as an individual continue to engage with the teachers from the PLC? Please explain.
14. Any other comments regarding the PLC activities and the support Fundisa have offered or the teachers' participation in the training?

APPENDIX 6

Name of PLC	
Date of PLC activities	
Number of teachers	
Focus	
Facilitators	
Other participants	
Resources	
Teachers' roles (as individuals)	
Teachers' roles (as a group)	
Facilitators' roles	
Other participants' roles	
Activities	
Enablers	
Constraints	
Other	

APPENDIX 7
Guidelines for developing a portfolio of evidence

Part 1: Know your learners

1.1. **Contextual analysis: Develop** a 1, 5 page description of the class that you teach.

Discuss some of the following aspects:

- ⤴ What was the overall academic performance of this group of learners last year?
- ⤴ What type of scientific knowledge are learners entering your class with?
- ⤴ What key areas and concepts in the Life Sciences curriculum are the learners struggling with?
- ⤴ How do learners at your school access new knowledge e.g. through internet libraries, radios etc?
- ⤴ What types of extra-curricular or co-curricular activities are the learners involved in that supports their knowledge about Life Sciences?
- ⤴ What types of learning activities do you see the learners benefit the most from?
- ⤴ What types of assessment questions and methods do the learners do well at and what do they struggle with?

HINT: You may like to design a questionnaire to use with your learners

NB: Reflect on what this information would mean for your teaching?

20 MARKS

Due date: 1st day of next session _____

Part 2: Know your subject

2.1. Analyse the diagram (Appendix 7a – extracted from Johnson, Dempster and Hugo, 2011) which illustrates an analysis of the Revised National Curriculum Statement for Life Sciences: Grades 10-12. The diagram shows conceptual progression from grade to grade and connectedness across the key content areas of a) Tissues, cells & molecular studies; b) Structure, control & processes; c) Environmental studies; d) Diversity, change and continuity. The solid arrows represent cases where the curriculum made explicit links between concepts and the dotted arrows represent cases where the authors noted an implicit connection between concepts (but this connection had not been made explicit in the curriculum). From this analysis Johnson et al noted that:

Conceptual hierarchies were hard to find, foundational concepts were seldom laid down, and

nowhere were connections between topics explicitly drawn. This was particularly evident in the handling of evolution, biology's highest ordering concept, in that no foundational material was provided before Grade 12, nor was there any logical sequence to the list of topics specified. A further feature of the RNCS was a tendency towards repetition rather than knowledge progression, particularly between the Knowledge Areas "Environmental studies" and "diversity, change and continuity" (Johnson et al, 2011, pg. 49).

- a) Draw a similar diagram representing conceptual progression and connections (explicit or implicit) across key content areas for the CAPS. You can use the table on conceptual progression in the CAPS (Appendix 7b) to guide the design of your diagram.
- b) Use a highlighter to indicate the concepts that relate in some way to biodiversity
- c) Use your diagram to describe the progression of concepts related to biodiversity and the interconnectedness between different concepts (1 page).

20 MARKS

2.2. **INFORMATION RESEARCH:** Select one of the key concepts related to biodiversity highlighted in 2.1. Find at least three knowledge resources that deal with this topic to extend the content knowledge AND to highlight the human-environment relationships integral/relevant to this topic. Fill in the table (Appendix 7c) summarising your resources.

NOTE: You should have at least one knowledge resource from each of the following:

- a) Textbook
- b) Internet or newspaper
- c) Field guide, poster, magazine, journal, or other information source

* NB! Attach your resources as appendices to the assignment

20 MARKS

2.3. **SUMMARY:** Read through these knowledge resources critically and prepare a two page fact sheet summarising information from these resources. **(2 pages)**

20 MARKS

2.4. **CRITICAL REVIEW:** The core text for this course explains that *environment and sustainability knowledge is generally considered as 'new knowledge', and ... is rapidly changing and transforming as scientists work to generate new and better understandings of environmental issues and possible solutions and alternative practices". The core text adds that "Environment and sustainability knowledge is also contested and in many cases we remain uncertain about the full scope, extent and implications of environmental issues. Environment and sustainability content knowledge is therefore also partially uncertain. Not everything is known, and both teachers and learners need to work with knowledge that is contested, as well as knowledge that is incomplete. This is an*

important feature of knowledge in the 21st century, and failing to expose learners to such an understanding of knowledge is to offer them an incomplete education.

Comment critically on **one** of your chosen knowledge resources in the light of the nature of environmental knowledge as described above **(1 page)**

20 MARKS

Due date: 1st day of next session _____

Part 3: Improve your teaching practice

3.1. Plan a series of three or four lessons to address the specific concept that you worked with in Part 2, **taking care to include reflection on human-environment relationships in at least one of the activities**. As one of the resources you should use the fact sheet you prepared in 2.3. Use an appropriate lesson plan framework that you are working with for your regular lesson preparation (include this lesson plan as an Appendix to this part of the assignment). Ensure that the lesson plan has adequate depth and explanation of what you plan to do in the classroom. Make sure that you select a method (or methods) appropriate to the content and concepts that are included in the CAPS document and that is relevant to the context of learning.

20 MARKS

3.2. Implement the lesson plan with a group of learners. Ask a colleague to photograph the activity (you will need about 10 photographs of the lesson). Print out the photographs and organise them to show the chronological unfolding of the lesson. Provide a 5-10 line explanation of the learning interactions (i.e. what is happening, who is saying what and why etc.) for EACH of the photographs. This explanation should include reference to the Specific Aims of the Life Sciences curriculum and describe (using evidence provided in the activity) the relationship between the activity and the skills relevant to these specific aims.

20 MARKS

3.3. Explain what was happening using your booklet entitled 'Methods and Processes' to help you think critically about the activity outcomes. Were the methods and resources you used useful and appropriate (draw on the pitfalls and possibilities sections in the '*Methods and Processes*' booklet)? Did you find you were able to work with and meet curriculum requirements? Did you develop the knowledge, skills and values as prescribed by the curriculum? What could you have done better? What would you do next time? **(2 pages)**.

20 MARKS

Due date: 3.1: 1st day of next session _____

3.2 – 3.3: _____

Part 4: Improve your assessment practice

Explore the assessments that are required for Life Sciences Grade 10-12 as outlined in the three Specific Aims (pages 13-18 of the Life Sciences curriculum document) and the skills and suggested verbs for assessing these.

4.1. Using appropriate verbs:

- a) Design two 10 mark examination questions for one of the activities in your lesson plan (presented in 3.1).
- b) Also design an assessment task that is not a test or exam that relates to one of the activities presented in 3.1.

Present these two forms of assessment and annotate them (make neat margin explanations) explaining which Specific Aims and skills are being addressed in each part of the assessment. Also highlight which of your questions elicit low, medium or higher order thinking. NB! Between your two assessments you should assess skills related to a minimum of two out of the three Specific Aims.

15 MARKS

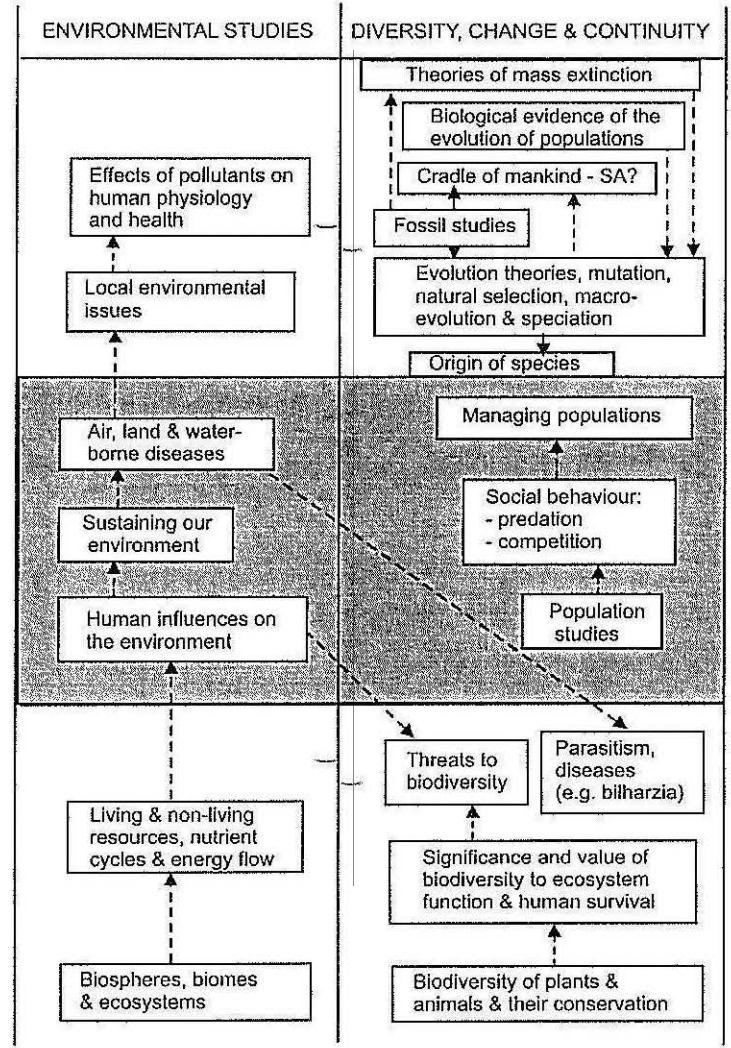
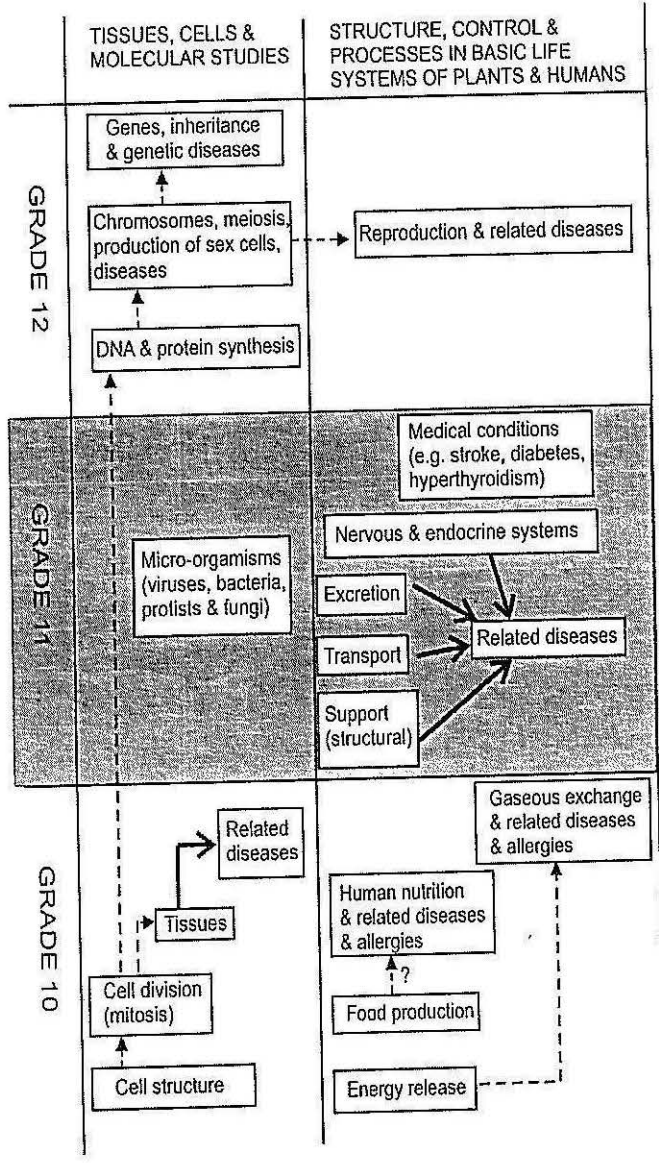
4.2. Implement the assessment activities (the 'exam' questions can be given to the learners outside of an exam situation as a revision or exam preparation exercise). With reference to some of the learners' results (included as appendices), critically review your assessment practice and its cognitive weighting. Indicate how you would improve the assessment activity in future.

15 MARKS

4.3. Considering your reflection on environmental knowledge as *partially uncertain, contested and incomplete* (Section 2.4); reflect on how this affected your assessment activities and the learners' engagement with these.

10 MARKS

Due date: _____



Appendix 7b (Extract from Department of Basic Education, 2011)

Life Sciences: Concept and Content Progression

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 <ul style="list-style-type: none"> - Inorganic compounds - Organic compounds • Cell - unit of life • Cell division (mitosis) • Plant and animal tissues 	<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"> • Biosphere to ecosystems
Grade 11		<ul style="list-style-type: none"> • Energy transformations to support life: photosynthesis • Animal nutrition • Energy transformations: respiration • Gas exchange • Excretion 	<ul style="list-style-type: none"> • Biodiversity - classification of microorganisms • Biodiversity - plants • Reproduction - plants • Biodiversity - 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

Appendix 7c

Resource 1:

Title	
Date	
Author	
Source: Publisher (if textbook, book, poster, field guide) OR Newspaper/magazine name (if article) OR website address (if from internet)	
Summary of main ideas	
Features, strengths and weaknesses of the resource. Consider depth and scope of knowledge, what is missing, to what degree is the resource focused on what things are (structure), and/or what they do (function) and/or how things work (processes) and/or how they relate to human lives (application)	

Resource 2:

Title	
Date	
Author	
Source: Publisher (if textbook, book, poster, field guide) OR Newspaper/magazine name (if article) OR website address (if from internet)	
Summary of main ideas Consider depth and scope of knowledge, what is missing, to what degree is the resource focused on what things are (structure), and/or what they do (function) and/or how things work (processes) and/or how they relate to human lives (application)	
Features, strengths and weaknesses of the resource. Consider depth and scope of knowledge, what is missing, to what degree is the resource focused on what things are (structure), and/or what they do (function) and/or how things work (processes) and/or how they relate to human lives (application)	

Resource 3:

Title	
Date	
Author	
Source: Publisher (if textbook, book, poster, field guide) OR Newspaper/magazine name (if article) OR website address (if from internet)	
Summary of main ideas Consider depth and scope of knowledge, what is missing, to what degree is the resource focused on what things are (structure), and/or what they do (function) and/or how things work (processes) and/or how they relate to human lives (application)	
Features, strengths and weaknesses of the resource. Consider depth and scope of knowledge, what is missing, to what degree is the resource focused on what things are (structure), and/or what they do (function) and/or how things work (processes) and/or how they relate to human lives (application)	

APPENDIX 8



REFLECTION TOOL

	DEEPENING YOUR OWN KNOWLEDGE	KNOW YOUR SUBJECT (CONTENT KNOWLEDGE and PROGRESSION)	IMPROVE YOUR TEACHING PRACTICE	IMPROVE YOUR ASSESSMENT PRACTICE
LEARNING UNIT 1: What is biodiversity?	Concepts I am comfortable with	How did this Learning Unit link to your subject? What knowledge does it build on and what concepts are built on from here?	What did you learn about teaching this topic/these concepts?	How would you assess knowledge of this topic/these concepts?
	Concepts I am still struggling with			
LEARNING UNIT 2: What roles does biodiversity play?	Concepts I am comfortable with	How did this Learning Unit link to your subject? What knowledge does it build on and what concepts are built on from here?	What did you learn about teaching this topic/these concepts?	How would you assess knowledge of this topic/these concepts?
	Concepts I am still struggling with			
LEARNING UNIT 3: What causes biodiversity loss and how do humans respond?	Concepts I am comfortable with	How did this Learning Unit link to your subject? What knowledge does it build on and what concepts are built on from here?	What did you learn about teaching this topic/these concepts?	How would you assess knowledge of this topic/these concepts?
	Concepts I am still struggling with			

APPENDIX 9

SN: Please briefly introduction about yourself.

JS: Alright, I am Janet Snow, I work as an independent through Environmental Learning and Teaching is the organisation's name. And I have been involved in various forms of environmental education since 1999 and have become more and more involved with teachers' supervision, and not necessarily only supervision but teacher involvement, teacher programmes, and developing environmentally orientated projects with teachers over many years and run various projects

SN: Could you give some of the details around some of the programmes you have been running with teachers specifically?

JS: With teachers specifically, training: We go and we conduct, I am trying to think of some of them that do not fit specifically Fundisa for Change. Started running teacher training at a school that is funded by an external organisation, for running with rural teachers, and we ran this training courses or workshops rather than courses for about seven years now that we have been doing that. It is basically a school that is well resourced, independent school that offers support to the teachers in the greater community stretching in an area of about at least 100-150 km radius around that school and all in the environmental sector. That was all of them; I have been working with teachers in the well-resourced, independent schools as to how they would establish their own environmental programmes. For instance if they wanting to run a water study, they would set up a process that works with how would we go about this, than we work together to develop a programme that will be curriculum linked, and then we look at the different focus area that we are trying to educate about. Than I have developed resources for different organisations

SN: Having done teachers training and support for the past years, what would you say were some of the challenges experienced?

JS: One of the challenges is often working in a bit of a silo effect, were one has the assumption that you are doing the right thing, but it actually without having the support of a greater community of practice, you find that it is very easy to get into where you are running with the assumption that, this is the correct way but you are not actually challenging yourself to rethink your educational methods. Fortunately I did my Masters here at Rhodes University in 2007 and 2008 and that gave me the ability to understand the significance of the community of practice and that they could influence my thinking and my ability to work with the teachers.

SN: What were some of the enablers of working with teachers?

JS: I think the enthusiasm of the teachers, and my passion to be able to work with them appropriately. I thoroughly enjoy it, from the personal point of view; I get a lot of satisfaction out of seeing the growth of the teachers, from when they start with something, and I get a lot of enthusiasm.

SN: How do you measure/ see their growth of the teachers during the support process?

JS: Is a very difficult one to measure growth and I think experience tells that. A lot of the time it is, although I can try and do an evaluation, I haven't followed a strict monitoring and evaluation process. I take it on a personal view of seeing the growth within them, experience that I see the way we work through things over time, particularly if I see teachers on a repetitive process, when they will come for about three years in a row, and then I can see the growth that they had in their time. So a lot of it is subjective, understand it is subjective, is not as objective as I would possibly like but time constraints don't allow for too many objective evaluation processes but it is more subjective seeing the growth within the understanding of where we are teaching.

SN: On average, how long do you normally work with the teachers?

JS: It depends, in occasions there will be once off workshops that will go on for three days. This is before prior to Fundisa for Change, then it could have been that, and then they will come back a year later, some of them don't come back, only through circumstances, not necessarily that it is a once off, or I am planning to do a once off only or they don't get invited, but if for instance on the 27th I ran a foundation phase workshop, and in October 27 I will run an intermediate.

SN: So you work with teachers at all phases?

JS: Yes, all phases and all subjects. But now with Fundisa for Change, I am pre-dominantly focusing on the Life Sciences and Natural Sciences for no other reason but that is where my original training came from, but that does not mean we cannot work with any of the other. The foundation phase; I had such fun with the foundation phase.

SN: I understand you were one of the people who were on the Fundisa for Change programme since the beginning, can you briefly explain what Fundisa for Change is, its aims, objectives, how it have been rolled out to date, and whether what you have originally conceptualised is what is happening, or how it have evolved to date etc.

JS: I do believe that, there is no one figure that can say right from the beginning, this is what our perspective was, and this how we have come to now, it has definitely evolved, it have definitely change. There have been a lot of change in everybody's thinking as we gone on along, but that is the beauty of it, it has been the ability for everybody to come together and brainstorm, what is it that we are trying to achieve. I might have forgotten what our original objective. It was basically as far as I understood it; we are all working separately with teachers' training how can we work together? So we came together and started to make some sense of it. And I do believe if we were able to go back into our records, the first initial thinking is completely different to what we have here only from the point of view that we have allowed it to progress and to be moulded, we have taken a shape, we have changed it as we go along. To me, I know we will have straplines; you will be able to get the information as to what are the objectives, the visions, the statements and everything else. But to me the most important point that comes across, the desire here is to have confident and competent teachers. But underlying principle that I enjoy thoroughly about Fundisa for Change is that the teacher feels confident to achieve the teaching pedagogy, the content that is involved and also the ability to assess that component or that specific topic.

SN: What would you say is/are the benefit/s of being part of Fundisa for change?

JS: From an individual point of view, it makes incredible difference, it makes the ability to work as a network of people, gaining the strength from each other, where we can run far together, the African proverb that says "if you want to run fast, run alone, if you want to run far, run together" and I want to run far with this. And to really operate on one's own, you don't have the depth of understanding, you don't have the support to work in the national fieldwork, you are working in the small group of people, and it influences, not only your thinking, your ability to be professional, but it also influences what products you are producing. Having been involved with the Fundisa for Change, I am confident to go to the various organisations and say, this is what I am involved in, and it makes an incredible impact with a national network rather than, I would like to be somebody who can to offer you something, and I do not have a national backing that goes with it. My funders who are funding my projects, also feel that they are then getting good quality for what they are paying for, they don't believe that they are just supporting me as an individual, they are supporting this whole background that can support me to make sure that I do the appropriate work.

SN: Fundisa for Change aim to strengthen or pilot the concept of PLCs, in your opinion what is your understanding of that?

JS: Professional learning communities, I think is one of those things that it might not have initially been one of the focuses but have become a major focus, and major advantage and a major benefit, in that, we are able to draw on and the collective intelligence, and current thinkings. Whereas, as I was

working as a silo on my own, I wouldn't have exposure to as much of the research, background research as much as the current thinkings, for instance when we first started there wasn't the concept of transformative learning, hadn't been brought into in the general information. As we have gone on, this is what has been brought to my attention, it might have been known within the education, the high education institutions, it wasn't known within my system, with my knowledge and I have learned from that. I think also the ability to work as a unit to develop different modules, has made a big difference. I am able to draw on the modules that have been developed by other members of our community of practice. We are able to work as a united representative in the different organisations like Department of Basic education, department of environmental affairs. Instead of working as individuals, we are working together to achieve mutual outcomes. So the concept of were when one gains, we all gain, if we obtain funding, it is distributed, so it is about intelligence but it is also about the practical implications as well of putting the projects together, is how I see it working.

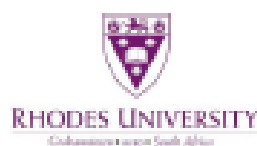
SN: You indicated earlier that, the objective of Fundisa for Change is to develop a confident and competent teacher, what would you say have been the Fundisa for Change activities to date that contribute to achieving that objective?

JS: Because we have worked together on defining the curriculum requirements, we then worked together to develop this modules. I am now capable of taking those and presenting them to the teachers in the professional manner, with the correct backing to it and the correct understanding. The time that I have spent at the training of trainers, the time that I have spent in the meetings, have made me more confident to be able to teach the teachers the appropriate work that they will need to know. So it is the knock on effect that, I am now able to take those materials to them. The pre-dominant influence that it has had on me, because I was already conducting teacher training, the effect it has on me, is that very definite shift, into how do we link it with the curriculum, the new curriculum, and how do we align it with what teachers are having to do. Although I have already been and have worked with teachers for many years, and in schools environments, and I have worked with the curriculum where the teachers have asked me to work with the curriculum, in the well-resourced schools, and we will work together on projects, when I was conducting training I did not necessary follow that pattern and whereas now with Fundisa we have been encouraged to follow that pattern.

SN: Would you say the new shift is making a difference?

JS: Very definitely, it makes a very big difference and quality. If you are wanting a competent teacher, and competent within the sections of that curriculum requirement. That competent teacher, if you link it with what they are asked to teach, and they then have a greater understanding of those three components, the content, the assessment and the pedagogical processes. Once they have a full confidence in that, they become competent or otherwise the other way around, when they become competent they become confident in their teaching. So very definitely it has an effect, if I were to put it in a percentage manner, I would say it makes 80% difference in their lives.

APPENDIX 10



CENTER FOR HIGHER EDUCATION RESEARCH, TEACHING AND LEARNING
P.O. Box 94, Grahamstown, 6162, South Africa
Email: chert-admin@ru.ac.za
Tel: +27 (0)44 833 8171/2
Fax: +27 (0)44 833 8982

4 April 2014

To whom it may concern

Approval of PhD proposal and ethical clearance:

Sirkka Tshiningayamwe (student number g11t2934)

This letter confirms that Ms Tshiningayamwe's PhD proposal was approved at a meeting of the Faculty of Education Higher Degrees' Committee on 5 December 2013. Her study is provisionally entitled:

Exploring the conversion factors, functionings, agency, and structures in teacher professional learning communities (PLCs): A case study of Science and Biodiversity Education Professional Learning Communities in the Fundisa for Change CPD programme.

In the event that the proposal demonstrates an awareness of ethical responsibilities and a commitment to ethical research processes, the approval of the proposal by the committee constitutes ethical clearance. This was the case with Ms Tshiningayamwe's proposal and the committee thus approved ethical clearance.

Ms Tshiningayamwe's supervisors are Professors H Lotz-Sisitka and R O'Donoghue as supervisors.

Yours sincerely

Prof S. McKenna
Chairperson of Education Higher Degrees' Committee
s.mckenna@ru.ac.za

APPENDIX 11

Dear Teacher

RE: PERMISSION TO PARTICIPATE IN A STUDY ON PROFESSIONAL LEARNING COMMUNITIES.

I, Sirkka Tshiningayamwe is fulltime doctoral student at Rhodes University. I am in the Faculty of Education, specialising in Environmental Education. My career experience is in high school teaching (with majors in Biology and Geography). Thus out of interest and reflections as a teacher, my research interest is in teachers professional development. My research topic is: Exploring capabilities and teacher agency in science and biodiversity teacher professional learning communities. My specific research questions are:

1. What beings and doings (functionings) are evident amongst teachers in the Science PLC, and how are they valued, especially also as these relate to biodiversity teaching?
2. What conversion factors, structures and agents are associated with functionings in PLCs for Science teachers' professional development?
3. How do conversion factors, structures, agents and functionings in PLCs contribute to Science teachers' professional development (or not)?
4. What are the relationships between the conversion factors, agents, structures and functionings of CPD programmes with the associated conversion factors, structures, agents and functionings in Science teachers PLCs?
5. How can and does a CPD programme act as a conversion factor that expands and/or constrains the structures, agents and functionings in Science teachers PLCs?

To successfully answer some of the above questions, I need to work with Science teachers PLCs that have received support from Fundisa for Change in the Eastern Cape and Western Cape Province, as well as Fundisa for Change partners. Your position as a teacher who has been supported by Fundisa for Change thus makes you an important person in my study. My research proposal have already been approved by the Rhodes University Education Higher Degrees Committee, and obtained ethical clearance from the Ethics Committee. I have however also received ethical clearance/permission from the Eastern Cape/ Western Cape provincial offices to conduct the research.

It is my wish to be transparent during the research process and to ensure that all participants in are aware of my purpose of study, especially during the PLC meetings. I will treat all information with confidentiality and will not reveal names in any part of the study, unless negotiated. Your participation is voluntary and you may withdraw from participating at any time. I will however also

give you an opportunity to verify the information; to make sure what is recorded and/or interpreted is a true reflection of what you said in the questionnaires, interviews, focus group discussions and what was observed. I therefore, hereby would like to request you to participate in my study. Your participation will mainly be to interview you, but could also involve observing Science teachers PLCs that you might be part of and/or focus groups.

If you agree to participate in my study then please sign below:

.....

If you have any queries, please contact me (at sirkka.ts@gmail.com / 071 551 3979) or my supervisor Professor Heila Lotz-Sisitka (h.lotz-sisitka@ru.ac.za).

Your assistance will be greatly appreciated.

Yours truly,

S. Tshiningayamwe

APPENDIX 12

Dear Fundisa for Change partner

RE: PERMISSION TO PARTICIPATE IN A STUDY ON PROFESSIONAL LEARNING COMMUNITIES.

I, Sirkka Tshiningayamwe is fulltime doctoral student at Rhodes University. I am in the Faculty of Education, specialising in Environmental Education. My career experience is in high school teaching (with majors in Biology and Geography). Thus out of interest and reflections as a teacher, my research interest is in teachers professional development. My research topic is: Exploring capabilities and teacher agency in science and biodiversity teacher professional learning communities. My specific research questions are:

1. What beings and doings (functionings) are evident amongst teachers in the Science PLC, and how are they valued, especially also as these relate to biodiversity teaching?
2. What conversion factors, structures and agents are associated with functionings in PLCs for Science teachers' professional development?
3. How do conversion factors, structures, agents and functionings in PLCs contribute to Science teachers' professional development (or not)?
4. What are the relationships between the conversion factors, agents, structures and functionings of CPD programmes with the associated conversion factors, structures, agents and functionings in Science teachers PLCs?
5. How can and does a CPD programme act as a conversion factor that expands and/or constrains the structures, agents and functionings in Science teachers PLCs?

To successfully answer some of the above questions, I need to work with Science teachers PLCs that have received support from Fundisa for Change in the Eastern Cape, Western Cape as well as Fundisa for Change partners. Your position as a Fundisa for Change partner thus makes you an important person in my study. My research proposal have already been approved by the Rhodes University Education Higher Degrees Committee, and obtained ethical clearance from the Ethics Committee.

It is my wish to be transparent during the research process and to ensure that all participants in are aware of my purpose of study, especially during the PLC meetings. I will however treat all information with confidentiality and will not reveal names in any part of the study, unless negotiated. Your participation is voluntary and you may withdraw from participating at any time. I will however also give you an opportunity to verify the information; to make sure what is recorded and/or

interpreted is a true reflection of what you said in the interview. I therefore, hereby would like to request you to participate in my study. Your participation will mainly be to interview you.

If you agree to participate in my study then please sign below:

.....

If you have any queries, please contact me (at sirkka.ts@gmail.com / 071 551 3979) or my supervisor Professor Heila Lotz-Sisitka (h.lotz-sisitka@ru.ac.za).

Your assistance will be greatly appreciated.

Yours truly,

S. Tshiningayamwe

APPENDIX 13

Directorate: Research



Audrey.wyngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20150130-42703

ENQUIRIES: Dr A T Wyngaard

Miss Sirkka Tshiningayamwe
Environmental Learning and Research Center
PO Box 94
Rhodes University
Grahamstown

Dear Miss Sirkka Tshiningayamwe

RESEARCH PROPOSAL: EXPLORING THE CONVERSION FACTORS, FUNCTIONINGS, AGENCY AND STRUCTURES IN TEACHER PROFESSIONAL LEARNING COMMUNITIES (PLCS): A CASE STUDY OF SCIENCE AND BIODIVERSITY EDUCATION PLCS IN THE FUNDISA FOR CHANGE CONTINUOUS PROFESSIONAL DEVELOPMENT PROGRAMME

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **01 February 2015 till 30 July 2015**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services

Western Cape Education Department

Private Bag X9114

CAPE TOWN

8000

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wyngaard

Directorate: Research

DATE: 30 January 2015

APPENDIX 14



Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 608 4773/4035/4537 • Fax: +27 (0)40 608 4574 • Website: www.ecdoe.gov.za

Enquiries: B Pamla

Email: baba.wa.pamla@edu.ecprov.gov.za

Date: 21 May 2014

Miss SAN Tshiningayamwe
Environmental Learning and Research Center
Rhodes University
Box 94
Grahamstown
6140

Dear Miss Tshiningayamwe

PERMISSION TO UNDERTAKE A DOCTORAL THESIS: EXPLORING THE CONVERSION FACTORS, FUNCTIONINGS, AGENCY AND STRUCTURES IN TEACHER PROFESSIONAL LEARNING COMMUNITIES – A CASE STUDY OF SCIENCE AND BIODIVERSITY EDUCATION PROFESSIONAL LEARNING COMMUNITIES IN THE FUNDISA FOR CHANGE CPD PROGRAMME

1. Thank you for your application to conduct research.
2. Your application to conduct the above mentioned research that involves 30 educators at Cluster Centres and/or places where teachers meet for cluster meetings or activities in the Eastern Cape Department of Education (ECDoE) is hereby approved on condition that:
 - a. there will be no financial implications for the Department;
 - b. institutions and respondents must not be identifiable in any way from the results of the investigation;
 - c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Chief Directors and Directors before any research is undertaken at any institutions within that particular district;
 - d. you will make all the arrangements concerning your research;



- e. the research may not be conducted during official contact time, as educators' programmes should not be interrupted;
 - f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;
 - g. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;
 - h. your research will be limited to those schools or institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;
 - i. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.
 - j. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.
 - k. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.
 - l. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.
 - m. you comply with your ethical undertaking (commitment form).
 - n. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation.
3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.
 4. The Department will publish the completed Research on its website.
 5. The Department wishes you well in your undertaking. You can contact the Chief Director, Mr. GF Mac Master on the numbers indicated in the letterhead or email org.macmaster@edu.ecprov.gov.za should you need any assistance.



MR. GF MAC MASTER

CHIEF DIRECTOR: STRATEGIC MANAGEMENT MONITORING AND EVALUATION

FOR SUPERINTENDENT-GENERAL: EDUCATION

APPENDIX 15

Field activity on the mangrove ecosystems:

Study a local mangrove ecosystem and answer the following questions:

1. Using the field guide on mangrove and/ or hand-out, list the plant and animal species found in the mangrove ecosystem.

2. Giving examples from (1), explain why those species are found in the mangrove ecosystems.

3. Using the information in (1), draw a food web of the mangrove ecosystem species.

4. Identify any evidence of human activities in the mangrove ecosystem.

5. Discuss any positive or negative human impact on the ecosystem.

6. Suggest ways on what can be done to help protect mangrove swamps and their inhabitants.

7. Using the information in (1), construct a dichotomous key for animal or plant species identified

