Exploring the views of Pre-Service Science Teachers about how they learn to teach environmental education

By

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DECLARATION

I, Oluwakemi Ayodeji Adebayo declare that:

(i) The research reported in this thesis, except where otherwise indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any other university.

(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

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a) Their words have been re-written but the general information attributed to them has been acknowledged; and

b) Where their exact words have been used, their writing has been placed within quotation marks, and referenced.

(v) The work described in this thesis was carried out in the School of Education, University of KwaZulu-Natal, from February 2014 to November 2014 under the supervision of Dr R. Mudaly (Supervisor) and Mr T. Chirikure (Co-Supervisor).

(vi) Ethical clearance No. HSS/0405/014M was granted prior to undertaking the fieldwork.

Signed: _____ Date: _____

As the candidate's supervisor I, Dr Ronicka Mudaly, agree to the submission of this thesis.

Signed: _____ Date: _____

As the candidate's co-supervisor I, Mr Tamirirofa Chirikure, agree to the submission of this thesis.

Signed: _____ Date: _____

DEDICATION

This thesis is dedicated to the memory of my late father, Emmanuel Adebayo Abidogun.

ACKNOWLEDGEMENTS

First and foremost I would like to thank the Almighty God, for giving me the grace to begin and complete this study.

Special thanks go to my supervisor Dr Ronicka Mudaly who groomed me and moulded my research skills and abilities. You are an erudite academician and a mentor to me. I also express appreciation to Mr Tamirirofa Chirikure, my co-supervisor, for his constructive critique and comments during the period of my study. The tutelage gave me inspiration and courage.

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ABSTRACT

There is a global urgency to engage with environmental education (EE), based on, among other things, environmental crises related to climate change and environmental degradation. School curricular are viewed as one way of making citizens more conscious of environmental issues. EE is a relatively new knowledge and skill area for South African teachers. Curriculum policy stipulates that environmental problems be addressed in a specific manner. The views of pre-service science teachers about their experiences when they learn to teach EE were central to this study.

The purpose of this research was to explore how pre-service science teachers learn to teach EE. The focus of this study was to gain insight into the content and pedagogical content knowledge of these pre-service science teachers when they worked with topics related to EE. Twenty five pre-service science teachers, who were training to teach in the intermediate and senior phases (Grades 4-9) of the South African School System, were purposively selected to participate in this qualitative study.

This work was located in the interpretive paradigm, and an understanding of pre-service science teachers' views of their practice within a South African teacher education context was sought. Qualitative data were generated using focus group interviews, individual interviews and reflective diaries. Vygotsky's Zone of Proximal Development, and theoretical constructs embedded in constructivism, informed the analysis of the data.

Pre-service science teachers who participated in this study expressed the views that teaching EE was important due to human dependence on the environment, the need to transform societies and consideration of the current environmental challenges. The challenges which participants experienced when learning to teach topics related to EE included integrating indigenous knowledge systems and EE in Natural Sciences, designing practical work, limited foundational knowledge, insufficient exposure to EE, inadequate resources, and inability to experience teaching EE

during Teaching Practice or Work Integrated Learning (WIL) periods, amongst others. In spite of these challenges, the pre-service science teacher participants suggested various ways of overcoming the challenges of learning how to teach EE in Natural Sciences, including working in groups, collaborative learning with peers, independent research, use of digital technology (internet), engaging with external human resources and improvisation. These suggestions demonstrated scaffolding which helped the pre-service science teachers to move to their Zone of Proximal Development (ZPD) in learning and development as described by Vygotsky. Recommendations that evolved from insights emanating from this research will be significant to teacher education institutions, university lecturers and Non-Governmental Organizations (NGOs).

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

CAPS:	Curriculum and Assessment Policy Statement
DBE:	Department of Basic Education
DEA:	Department of Environmental Affairs
DHET:	Department of Higher Education and Training
EE:	Environmental Education
IKS:	Indigenous Knowledge Systems
NCS:	National Curriculum Statement
NS:	Natural Sciences
NSM 2:	Natural Science Method 2 module
PCK:	Pedagogic content knowledge
RNCS:	Revised National Curriculum Statement
TP:	Teaching Practice
UKZN:	University of KwaZulu-Natal
WIL:	Work Integrated Learning
ZPD:	Zone of Proximal Development

CHAPTER 1

Orientation of the study

1.1 Introduction and background

> Today, as never before, the future of life on our planet has become a matter of great concern. As we move into the 21st century and the third millennium, we are confronted with warnings concerning the growing fragility of the earth's life-support systems. Humans have had a tremendous impact on the environment. As our human population has grown over the years, our activities and technological abilities have introduced a number of environmental problems. …it is important that in our environmental education, we make our learners aware of such challenges (De Beer, Dreyer and Loubser, 2005, p. 1).

These words are relevant to our society almost a decade after they were first pronounced.

According to Gough (2013) environmental issues became prominent in the 1960s as a result of the industrial revolution which brought pollutants to the environment. Gough argues that due to increased public consciousness on the dangers of environmental pollution, the field of EE emerged around that time. EE became recognized in 1977 at Tbilisi, during the United Nations Educational, Scientific and Cultural Organization / United Nations Environment Programme (UNESCO/UNEP) conference, where a resolution was passed to include it in formal education *(ibid)*. The myriad of environmental crises confronting our society underscored the importance of increasing awareness of environmental issues through the education system.

In South Africa, the need for EE is enshrined in the curriculum. One of the principles of the National Curriculum Statement Grades R-12 is: "Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa" (Department of Basic Education [DBE], 2011, p.5). The

government's aim is to teach citizens to be environmentally conscious. This can primarily be achieved with competent teachers in the classrooms.

1.2 Purpose and focus of this study

The purpose of this study was to explore the views of pre-service science teachers about how they learn to teach EE while training for the intermediate and senior phases (Grades 4-9) of the South African schooling system.

The study focused on the experiences of 3rd year pre-service science teachers while they learned to teach EE during the study of the Natural Science Method 2 (NSM 2) module in the university. NSM 2 is a first semester module aimed at preparing students to teach Natural Sciences at the intermediate and senior phases. The content of this module included 'Learning theories, Practical Work, Improvisation, Laboratory Safety, Problem Solving, Concept Mapping, Indigenous Knowledge Systems' as they relate to Natural Sciences. According to Heimlich, Braus, Olivolo, McKeown-Ice, and Barringer-Smith (2004, p. 20-21), "the 'best fit' for incorporating EE into teacher-preparation programs overall appears to be within methods courses". Thus they contend that EE requires a lot of resources and integrating it with method modules will enhance knowledge through the content embedded in such modules.

The views of the pre-service science teachers were derived from their insights and experiences while preparing and presenting microteaching lessons on EE related topics in Natural Sciences. Their thoughts, challenges, ways of addressing these challenges and what enabled them to learn to teach EE are emphasised in this study. Findings that emerged will be relevant to the teacher training institutions and curriculum developers. There is a scarcity of literature with regards to how pre-service science teachers learn to teach EE in South Africa. This research intends to contribute to the body of knowledge to fill some of the gaps in the field.

1.3 Rationale for the study

The rationale for this work is based on three concerns. Firstly, the imperative to explore EE within pre-service science teacher training is based on global concerns around environmental issues. Secondly, my experience of learners being unconscious about environmental issues has given impetus for this study; and

thirdly, the need to address the curriculum policy stipulation for environmental issues in an effective manner was considered.

Environmental issues in South Africa and the world at large are a cause for concern. The United Nations Secretary General Ban Ki-moon (2011, p.2), remarked at the Conference of the Parties (COP 17), “without exaggeration we can say: the future of our planet is at stake; people’s lives, the health of global economy, the very survival of some nations.” He went on to say that “the World Meteorological Organisation has reported that carbon emissions are at their highest in history and rising”. From the foregoing, climate change is one of the greatest environmental challenges of our time. The effects have been catastrophic with irregular weather patterns in different parts of the world, flooding and warm winters to mention a few. Environmental degradation, wetland depletion, deforestation, land pollution, litter and waste management, land degradation, poor conservation of flora and fauna in biodiversity are other challenges. Dalerum (2014) argues that the natural world could break down with the way it is being modified through human activities. These actions, the author adds, are responsible for climate change and loss of biodiversity.

The other reason for doing this study stems from my professional experience. I served as a science teacher for many years, teaching in different South African schools in the senior and Further Education and Training (FET) phases. I have observed that learners do not have adequate knowledge and practice of EE. Many learners litter the school premises and community with papers and wrappers from packaged food. They waste water and food by throwing leftovers carelessly. This garbage eventually finds its way into the storm drains, blocking them, and some enter the rivers through run off from rainfall thereby polluting water bodies and affecting aquatic life. The accumulation of these discarded items, when not recycled or removed, could lead to diseases affecting humans. In addition, the learners possess a superficial knowledge in the ‘Life and Living’ and ‘Planet Earth and Beyond’ strands of the curriculum when engaging with topics such as interactions in the environment, biodiversity, pollution, and the role of human beings in the environment. The Curriculum and Assessment Policy Statement, CAPS (DBE, 2011, p. 5) states as one of its principles: “Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South

Africa". I argue that learners need to become more environmentally conscious in order to understand environmental justice.

In addition, I am of the view that many teachers in the intermediate and senior phases do not have a good grasp of the EE content of the science curriculum. My experience of watching my colleagues teach and having to share written resource materials related to EE which were compiled by them influences this view. I therefore argue that an appropriate starting point to address EE in schools is to explore how pre-service science teachers learn to teach topics related to environmental study. With the advent of CAPS, I believe the pre-service science teachers need to be aware of the content and pedagogical knowledge requirements of EE as it relates to the sustainable development of our society through effective teaching and learning processes. The role of education in supporting sustainable development is central and indispensable. These are the reasons which motivate me to explore the views of pre-service science teachers about how they learn to teach EE.

1.4 Significance of the study

This study will promote the Values and Principles of Education Training Policy, stated in the White Paper on Education and Training as follows:

> Environmental Education, involving inter-disciplinary, integrated and active approach to learning, must be a vital element at all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources (South Africa, 1995, p.18).

The need to have citizens who are environmentally conscious is paramount in order to preserve the natural resources and mitigate the various contemporary environmental challenges we face. In the education field, this research exposes the gaps in the conceptual understanding and pedagogical content knowledge (PCK) of the pre-service science teachers. "Some people knew what they knew deeply, thoroughly, richly. Others knew what they knew much more superficially, more tentatively. And it became an even more interesting question to ask, how does how well you know something relate to how you teach it to someone else?" (Shulman,

2004, p. 403). Knowing content does not automatically imply knowing how to teach that content; this study will contribute to the discourse on PCK as it relates to EE. The outcomes of this study will influence in-service and pre-service teacher education programmes, where EE is concerned. It could have far reaching implications for education policy, given the government's commitment to making the citizenry environmentally conscious and literate.

Exploring the views of pre-service science teachers about how they learn to teach EE will stimulate further research in this area of study. This will have an impact on the shape of intervention strategies to be considered in the future. The findings of this study may help curriculum designers and teacher training institutions to design improved EE curricula.

1.5 Research aims

1. To determine pre-service science teachers' views about teaching Environmental Education in the Natural Sciences classroom.
2. To explore the challenges pre-service science teachers experience when they learn to teach Environmental Education.
3. To explore how pre-service science teachers address these challenges and what enables them teach EE.

1.6 Research questions

1. What are pre-service science teachers' views about teaching Environmental Education in the Natural Sciences classroom?
2. What are the challenges which pre-service science teachers experience when they learn to teach Environmental Education?
3. How do pre-service science teachers address these challenges and what enables them teach EE?

1.7 Research design

A case study design was used in this research to explore 25 pre-service science teachers' views about how they learn to teach EE in Natural Sciences. This group of participants, in their 3rd year in the university, was training to teach in the intermediate and senior phases of the South African schooling system upon

graduation. This qualitative study adopted the interpretive paradigm in order to develop a deep understanding of how the participants give meaning to their learning to teach EE.

Three methods of data collection were used namely focus group interviews, individual interviews and reflective diaries to allow for triangulation of data. Triangulation enhanced the validity, trustworthiness and reliability of the data generated. The data obtained was inductively analysed and the findings that emerged provided answers to the three research questions of this study.

1.8 Findings

The findings that emerged from this study were generated from analysing the views of pre-service science teachers about learning to teach EE using multiple methods of data collection. Focus group interviews, individual interviews and reflective diaries were used to generate the data. Findings provided answers to the three research questions. Three themes emerged from Research Question One, four themes emerged from Research Question Two and five themes emerged from Research Question Three.

The findings showed that pre-service science teachers that participated in this study opined that EE is important due to human dependence on the environment. The need to care for and conserve the environment in order to mitigate the effects of environmental crises by human beings was highlighted. The participants felt that the attitude of learners could positively be transformed towards the environment because numerous environmental crises plague the global society. The findings also revealed the challenges the participants experienced ranging from integrating Indigenous Knowledge Systems (IKS) in learning to teach EE to designing practical work and the lack of foundational knowledge in EE. The unavailability of resources and inability to experience learning to teach EE during the Teaching Practice (TP) period were also revealed.

It also emerged that the pre-service science teachers addressed these challenges through collaborative learning, independent research using digital technology (internet), and tapping into human and material resources. The findings further revealed that improvisation, creativity, and effective implementation of the CAPS

contributed to alleviating the challenges. The study revealed that the different strategies used by the pre-service science teacher participants in addressing their challenges enabled them to learn to teach EE. The participants sought assistance from more knowledgeable persons to do the task of learning to teach EE, and this was analysed using Vygotsky's (1978) ZPD.

1.9 Overview of chapters

Chapter One gives the background to this study. The purpose, focus, rationale and significance of the study to the South African educational system were discussed. The research aims, research questions, research design, overview of this chapter and findings were outlined.

Chapter Two reviews literature that relates to the focus of this study. Both local and international literature was reviewed with regards to EE and teacher education. The chapter is presented in five sections. First, it deals with the definitions and issues around EE. Second, it outlines the South African policy and education curriculum as it concerns EE. Third, it deals with professional development of teachers and fourth, EE and higher education. Finally, the theoretical framework for this research which centres on Lev Vygotsky's Zone of proximal development is explained.

Chapter Three discusses the research methodology adopted in this study. A qualitative approach within an interpretative paradigm was used to explore the views of pre-service science teachers about learning to teach EE in Natural Sciences. The design is a case study and multiple methods of data collection were used namely focus group interviews, individual interviews and reflective diaries. Research rigour, ethical considerations and limitations are highlighted in detail in this chapter.

Chapter Four focuses on data analysis and the presentation of findings. Content analysis was used to make sense of the data generated from the participants. Several themes emerged from the data and were linked to the research questions.

Finally, Chapter Five summarises the key research findings of this study. Recommendations were made based on the findings that emerged from exploring the views of pre-service science teachers about learning to teach EE.

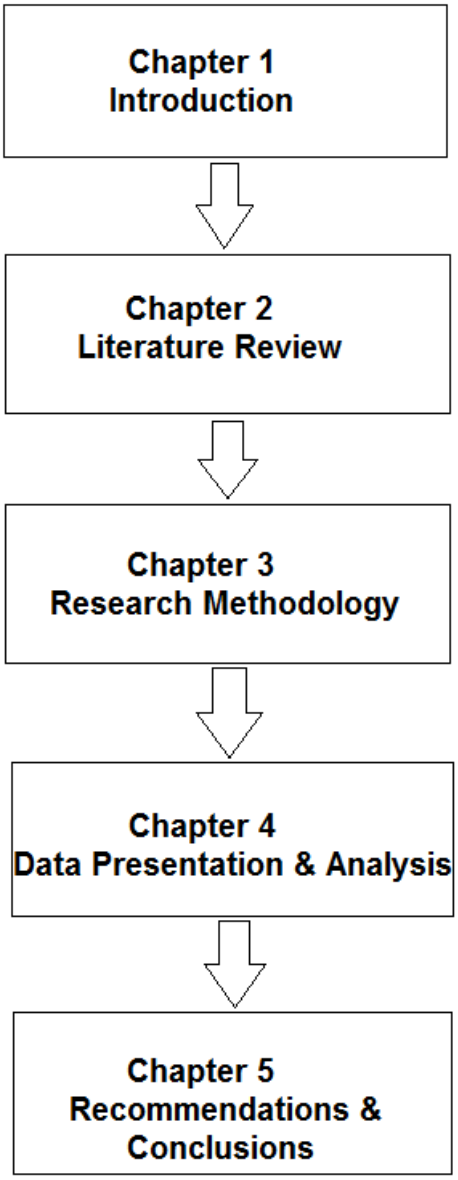

Figure 1: Order of Chapters

1.10 Conclusion

This chapter explained the introduction and background of this study. It also outlined the purpose and focus of the research, rationale and its significance. The research aims, questions and methodology adopted were highlighted with an overview of the chapters in this dissertation. The following chapter will discuss the literature reviewed in relation to the focus of the study.

CHAPTER 2

Literature Review

2.1 Introduction

The literature review is aimed at exploring work conducted in relation to EE. It examines the contributions made in the fields of EE and teacher education in South Africa and worldwide, thereby creating a foundation and context for this study. This chapter is prepared in main sections. First, definitions and issues around EE, second, South African policy and education curriculum as it concerns EE, third, professional development of teachers, fourth, EE and higher education and finally, the theoretical framework for this research are discussed.

2.2 Defining Environmental Education

2.2.1 Environment

Rudd (2006, p. 8) states that “the environment is everything around us, both physical and organic, that creates the conditions in the biosphere in which we live in”.

According to Wood (2009) cited by Ullah and Wee (2013, p. 87) the “Environment is the sum total of water, air and land interrelationships among themselves and also with the human being, other living organisms and property”.

The White Paper on Environmental Management Policy for South Africa (South Africa 1998, p. 9) defines environment as the “biosphere in which people and other organisms live”. It consists of natural resources which include those which are renewable and non-renewable, natural ecosystems and spaces which are modified by people”.

These definitions describe the environment as the whole surrounding which includes both living and non-living things and the influences they have on one another. It is noteworthy that humankind is central to and part of the environment.

The term environment, according to O'Donoghue (2001, p. 3), means "a living world made up of many environments that we experience as the surroundings in which we live. In these environments, communities of humans and other living things interact to shape our surroundings in different ways".

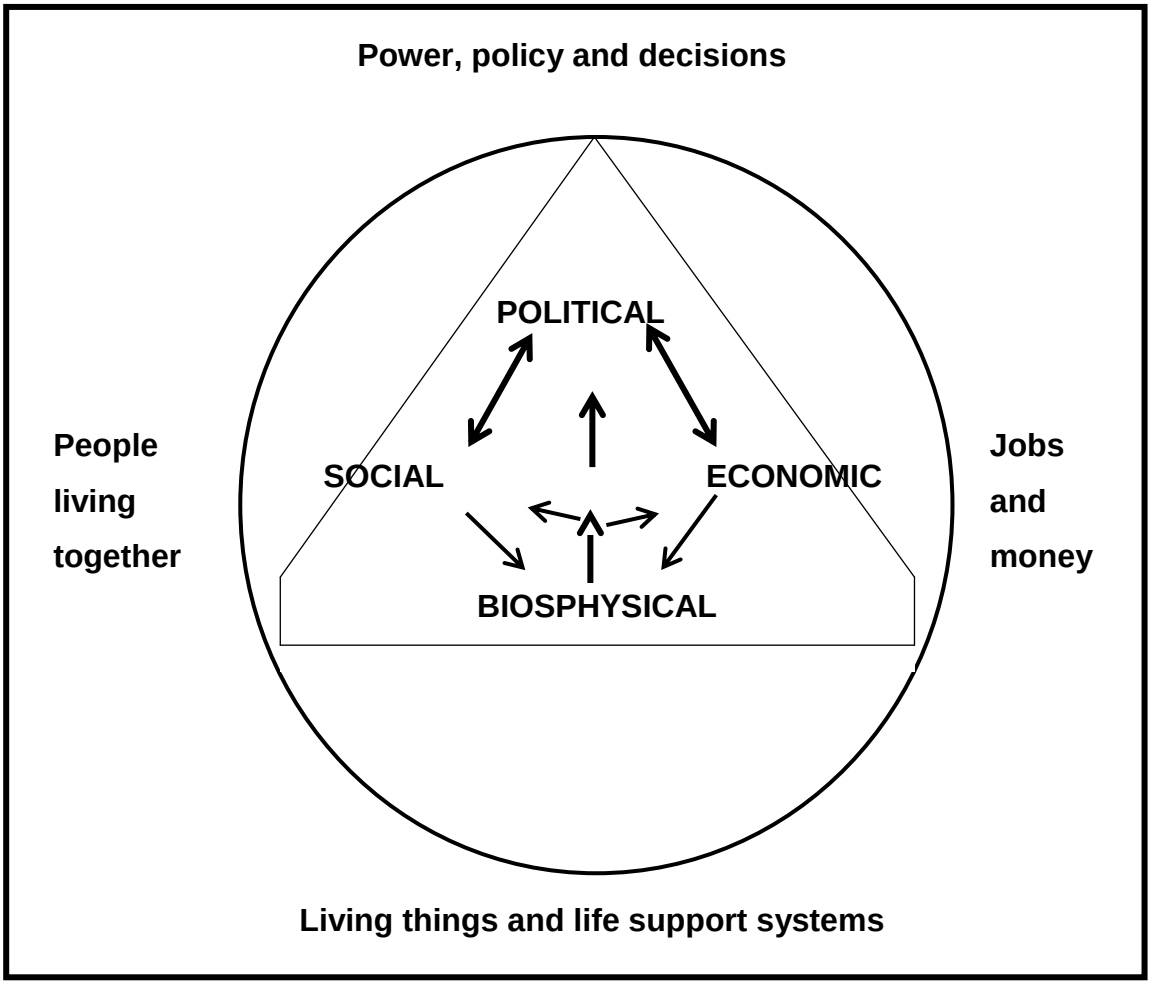

Figure 2: Interaction dimensions of the environment
O'Donoghue (1993) cited by O'Donoghue & Russo, 2004, p. 337)

Figure 2 shows the inter-relationships between various elements, including human beings that constitute the environment. The political aspect dictates the legislation, governance and rule of law and the social shows the interactions in families, communities, and among people in general. The economy depicts the way people earn their living to support themselves and loved ones. The last dimension is the biophysical which comprises the biotic and abiotic factors which are naturally endowed. These four dimensions interact to form a holistic environment.

2.2.2 Environmental Education

The (International Union for the Conservation of Nature and Natural Resources [IUCN] in 1971 defined EE as “the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture and his bio-physical surroundings” (Loubser, 2005, p. 36).

The EE policy options for formal education in South Africa defines EE as the process of “developing the necessary knowledge, understanding, values, skills, and commitment to allow people to be pro-active in securing a healthy and properly functioning environment that is sustainable” (Environmental Education Policy Initiative, [EEPI], 1995, p. ii).

Enabling Environmental Education in the Outcome Based Curriculum Framework, (EECI, 1996, p. 4) defines EE as “a process through which we might enable ourselves and future generations to respond to environmental issues in ways that might foster change towards sustainable community life in a healthy environment”.

Fundamental assertions can be derived from these definitions which makes the knowledge about the environs crucial to the existence of human beings. Firstly, EE enables us to have empathy for the natural world and secondly, it makes us to be pre-emptive in keeping the earth healthy. Thirdly, it gives us the impetus to preserve the ecosystem for the people yet unborn.

Peters and National Council for the Social Studies (1976, p. 2) define EE as the “process whereby students are directly and vicariously exposed to and interact with natural and social life-space phenomena”. These “phenomena directly affect and influence their daily lives as members of an ecological community” (*ibid*).

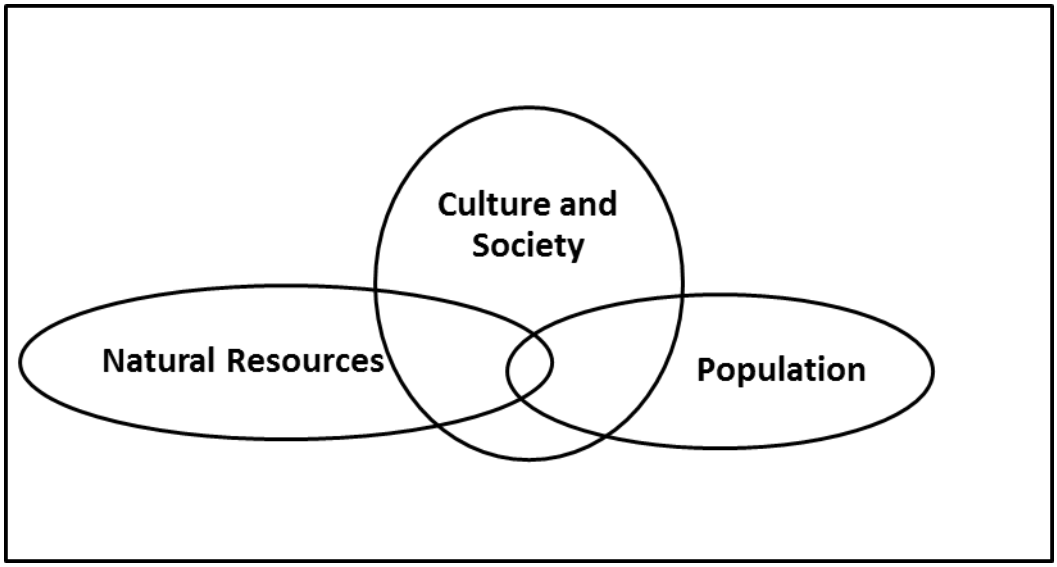

Figure 3: Environmental education concepts
Adapted from Peters *et al.* (1976, p. 2)

Figure 3 buttresses the definition provided by Peters *et al.* (1972). It shows interlinking among the components that define EE. According to Peters *et al.* (1976), Culture and Society represent the ways of life of humans in communities, their norms and how these influence the utilization of the ecosystem. The natural resources are mostly not renewable and must be well utilized. There is a constant growth in the population of humans indicating that humankind should be aware of how to conserve the environment for sustainability and existence.

“Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve the problems, and motivated to work toward their solution” (Stapp, 1969, p. 31).

The definitions encompass key elements which are knowledge, people and the maintenance of a high quality environment. It is important to focus on the world environmental crises in order to strengthen the argument for exploring teachers’ views about EE.

2.3 World Environmental Crises

Angus and Butler (2011, p. 1) assert that “we face an environmental crisis of unprecedented scale and scope”. The Environmental Education Curriculum Initiative (EECI, 1996) indicates that environmental concerns centre on those behaviours and

practices which make the environment unfit for living. An unhealthy milieu makes humans and other organisms prone to dangers and diseases which can ultimately lead to untimely deaths. The following are some of the many environmental crises facing humanity in recent times.

2.3.1 Climate Change

According to Maila and Seroto (2013) the burden on the environment is huge. Countries around the world are competing for the declining natural resources of the earth in order to remain relevant. (2012) agrees that environmental crisis could mean a looming calamity.

According to the 'Climate Reality Project' (2014), the greatest threat confronting the world is the release of carbon into the air. Greenhouse gases are released into the atmosphere through the activities of industries and burning of fossil fuels which result in greenhouse effect that is increasing the temperature of the earth (Dincer, 2000). The negative impact of this, according to Caldeira (2012), is bizzarre weather; we are experiencing life-threatening rainfall, more heat in winter and melting of ice and snow at the north pole. These changes can result in ill health and natural disasters of unimaginable magnitude causing displacements of millions of people.

The National Climate Change Response White paper of South Africa (South Africa, 2011, p. 9) corroborates the views with regards to climate change. It states that "climate change is a global problem requiring a global solution through the concerted and cooperative efforts of all countries. Should multi-lateral international action not effectively limit the average global temperature increase to below 2°C above pre-industrial levels, the potential impacts on South Africa in the medium to long-term are significant and potentially catastrophic" *(ibid).* This comment reiterates the need for awareness and education of the citizens about the scourge that is being created by world climate change and no nation is immune to its negative effect.

2.3.2 Loss of Biodiversity

The distortion in species and ecosystems due to the reliance on and increasing demand for energy by humans was highlighted in the United Nations Environment Programme (UNEP, 2007)'s Global Environment Outlook (GEO_4,) – environment for development. The UNEP (2007, p.6) states that "accelerating species extinction

rates are threatening the loss of unique genetic pools". There is a loss of biodiversity and we need to prevent this (Egoh *et al*., 2010). This resonates with the view of Butchart *et al*. (2010) who confirm that the rate at which the world's biodiversity is lost has increased between 2002 and 2010, with deterioration in species population movements, interactions and interdependence within the environment. Biodiversity makes available livelihood security and enables the use of genetic resources to harness the other ecosystem services (UNEP, 2007).

Invasion of alien plants and poor forest maintenance have also contributed to the loss of biodiversity (Butchart *et al*., 2010). Invasive alien plants cause loss of productive agricultural land and a lot of resources are spent controlling them. They compete with indigenous plants for space, water and sunlight. Indigenous species of plants maintain a vibrant biodiversity and humans will not get quality air to breath, nourishment and water to drink if biodiversity is continually lost (Colorado Natural Heritage Program, 2013).

2.3.3 Water shortage

The world is experiencing water shortage due to increasing population, climate change, environmental degradation, poor investment and management to meet the needs of the people due to lack of infrastructure (Kumar, 2013). The author indicates that 1.2 billion people live in places of physical water scarcity because of environmental degradation while another 1.6 billion experience economic water shortage as a result of nonexistence of infrastructure *(ibid)*. Bogardi, *et al.* (2012, p. 36) describe water as "a climate regulator, a carrier of energy, and cooling and heating agent". The scholars concluded that for the world to have sustainable water supply, creative commitments are required by all stakeholders. The UNEP (2012) - Global Environment Outlook (GEO_5,) notes that only one out of the thirty environmental goals that related to water had made considerable improvement. In spite of this progress, the body states that "water quality remains the largest cause of human health problems worldwide" (UNEP, 2012, p.5).

2.3.4 Land degradation

Land degradation is described by Food and Agriculture Organization of the United Nations (FAO, 2008) as the reduction in the ecosystem function and productivity.

The body notes that this problem is escalating in numerous parts of the globe with more than 20 percent of all cultivated lands, 30 percent of forests and 10 percent of grasslands experiencing degradation. Some of the human activities that cause land degradation are overgrazing, deforestation, poor soil and water management, improper agricultural practices and recurrent use of farm machineries (UNEP, 2003). Flooding and drought, which are natural disasters, can also result in land degradation (*ibid*). Nkonya, Gerber, von Braun, and De Pinto (2011) argue that 42 percent of the world's poor people rely on degraded lands for food and income.

Given these environmental crises, I am of the opinion that exploring the views of pre-service science teachers about learning to teach EE will contribute to the promotion of contemporary environmental knowledge. Their views, challenges, ways of addressing these challenges and what enables them to teach can make a useful input into science teacher education. The opinions of pre-service science teachers can contribute to a more practical way, when the trainees become teachers, of teaching the learners. The knowledge about the environment imparted on the learners can be taken to their communities. In this way, environmental consciousness will be nurtured and the goals enshrined in EEPI in South Africa can be realised.

2.4 Environmental Education in South Africa

2.4.1 Need for Environmental Education

Lotz-Sisitka (2004, p. 10) agrees that "environmental education processes" can influence "social change" as these relate to "issues of development, survival, livelihoods, improved quality of education and improved quality of life, and more sustainable living practices". The author's statement stresses the relevance of EE to the societal transformation and well-being. The need for EE is underscored in the following sub-sections.

2.4.1.1 Creating awareness

The United Nations Conference on the Human Environment, held in 1972, cited by Venkataraman (2008, p. 8), released a pronouncement in Stockholm stating:

> Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well-being depend. Conversely,

> through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes.

This assertion makes EE vital to the sustenance of the earth for the future generations ensuring their survival and well-being.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) (1978) reiterated the need for instant attention to be given to environmental crises as stressed in its Stockholm Conference in 1972. The actions of humankind create permanent harmful effects (UNESCO, 1978). The organization also indicates that environmental problems peculiar to certain continents affect the whole world and some are transferred across nations by way of business interactions. After many years of these declarations, humanity has not reacted to these challenges because the problems are becoming complicated which require everyone to be involved in EE and to be inventive (Venkataraman, 2008).

According to the IUCN (1980, p. VI), “hundreds of millions of rural people in developing countries, including 500 million malnourished and 800 million destitute, are compelled to destroy the resources necessary to free them from starvation and poverty”. The IUCN (1980) has established that this is as a result of poor knowledge. The body explains that the inability of the people to understand the appropriate use of natural resources has resulted in repercussive effects. The Millennium Ecosystem Assessment highlights that about 60% of the ecosystem services were being degraded or used without effort to sustain them by humans (UNEP, 2005). IUCN (2010) also indicates that since the year 2000, 6 million hectares of primary forest have been lost every year and 35% of mangroves had similarly been lost within the period of 20 years prior to the year 2010.

Reddy (2011) remarks that the survival of human beings is at a critical point and that we should take EE seriously.

2.4.1.2 Sustainability of the earth’s resources

EE is essential in order to sustain the natural resources of the earth. Conservation efforts can ensure that the natural endowment of the earth is well-maintained and utilized. The IUCN (1980, p. 2) projects that land degradation will result in the

destruction of 30% of cultivated land, represented as “the stalk of grain” in Figure 4, by the year 2020.

Figure 4: Why a world conservation strategy is needed
IUCN (1980, p. 2)

Figure 4 shows that the estimated population of human beings will increase from 4 000 million in the year 1980 to 6 000 million in the year 2020. However, the human population exceeded the predicted growth rate because in 2013, the population was in excess of 7 000 million (Rosenberg, undated). This indicates an inverse proportion between human population and resources available if land degradation remains unchecked (IUCN, 1980). Land degradation, according to the IUCN, is caused by the increasing use and production of goods and services in developed countries arising from deforestation, pollution and depletion of wetlands *(ibid)*.

The environmental crises expressed by the IUCN resonate with those outlined by the South African Department of Environmental Affairs (DEA, 1995). It argues that underscoring of EE is critical due to the high rate of population growth, cities and the reckless ways in which the natural resources are being used. It stresses the need for preservation of the surroundings. Omofonmwan and Osa-Edoh (2008) concede that the deterioration of the natural resources is as a result of increases in metropolitan areas, land clearing, pollution, and desertification. The authors add that hardship and illiteracy contribute to degrading of the land.

2.4.1.3 Mitigation of Environmental crises and taking action

Le Grange (2012, p. 336) asserts that “a moral education guided by ‘Ubuntu’ should not be restricted to facilitating learners’ capacity to cherish only human communities

but non-human nature as well". 'Ubuntu' is a Southern African philosophy which underscores the importance of valuing community interest above one's own interest (Chaplin, undated). Le Grange (2012) adds that there is a connection between human beings and other biotic factors in the environment which necessitate the need to act in order to save the biophysical setting. He advocates that EE is synonymous to being kind to one another and that youth should be part of the initiative to mitigate the challenges of the environment so as to save other species. According to UNESCO (2002), we need to prevent or unravel the challenges of the environment, created by modern society, by being proactive and environmentally enlightened. Our actions will go a long way in lessening the impact of the EE crises *(ibid)*.

Demuzere *et al*. (2014, p. 108) highlight ways of mitigating the harmful effects of climate change on humankind through the process of "Green Urban Infrastructure, (GUI)". They assert that integrating natural green areas with human-made constructed structures will lead to carbon dioxide sequestration as well as mental and emotional gains. They concur that GUI is better than having an environment without the touch of nature. Tsilini, Papantoniou, Kolokotsa and Maria (2014) corroborate the need for reducing the consequences of climate change through establishing gardens in cities. This act, they contend, lessens the heat in the environment by 5ºC as compared to a city centre without any greenery *(ibid)*. Through studying the views of pre-service science teachers about learning to teach EE, the methods of teaching how to ease the challenges of the environment can be understood. This requires a focus on teacher education and the school system.

2.4.1.4 Invigoration of public school system

The benefits of and need for EE is overwhelming as alluded to by the United States of America's National Environmental Education Foundation (NEEF, 2013). These include making learners develop thought provoking abilities, gaining knowledge on mitigating environmental issues and possessing ingenuity thereby leading to overall societal progress. In South Africa, the DEA (Department of Environmental Affairs, 2013) concludes that highlighting EE in schools and communities cannot be negotiated. According to the DEA, the public schooling system must be actively involved in the issues of the environment through teaching and outdoor activities *(ibid).*

Mabudafhasi (2014, p. 5) remarks that “the foundations of environmental learning start in our schools”. She concludes that through transformation of teacher education and support from government and NGOs, South Africans can have an environment that is not detrimental to their health. According to Parkin, Shackleton and Schudel (2006, p. 177), learners became aware of the significance of trees and their advantages to the environment during “Arbor week activities”. The teachers teach learners who ultimately spread the knowledge to their parents which enhanced the awareness in their communities.

EE is crucial, especially because the public education system is lagging behind (Dreyer & Loubser, 2012). These scholars state that public educational institutions are short of well-groomed teachers as well as teaching aids to facilitate EE learning and that EE is not explicit in the syllabus *(ibid)*. This underscores the need to have competent teachers for the schooling system in South Africa. The insights of the pre-service science teachers have the potential of contributing to the teacher education curriculum which can lead to the invigoration of the schooling system.

2.4.2 History of Environmental Education

EE has developed over many centuries from primitive to the more organised form we have in this contemporary time. A brief history of the development of EE is necessary in order to underscore its value in present-day society. Irwin and Lotz-Sisitka (2005, p. 35) argue that “the history of environmental education is inextricably bound up with social, economic, and political, as well as ecological consideration”.

2.4.2.1 International History

According to Irwin and Lotz-Sisitka (2005), it was documented before the 20th century that EE originated from Egypt, Greece, India and China. During the reign of Pharaoh Ikhnaton in Egypt, the farmers were taught to cultivate their produce farther from the shoreline of the river Nile. Flora growing naturally along the coast prevents soil erosion compared to when crops are grown and harvested which exposes the land to degradation. In China there was general environmental enlightenment some 3000 years ago regarding reforestation while Theophrastus, a scholar of Aristotle, campaigned against the abuse of forest utilization in Athens, Greece (Lotz-Sisitka, 2005).

Lupele (2002) cited by Irwin and Lotz-Sisitka (2005, p. 38) contends that Africans believe “conservation was often realized in a pattern of shared beliefs, cultural taboos, folklore and myths, which frequently embodied a common interest amongst communities to conserve their natural resources”

Wheeler (1975) cited by Irwin and Lotz-Sisitka (2005) believes that the industrial revolution of the 19th century has affected humanity negatively. It brought about massive production of consumer items, indiscriminate use of natural resources and societal issues in Britain, the United States of America, Europe and Asia. This led to the underscoring of EE as a mitigation strategy to address environmental problems *(ibid)*. Many academicians lent their voices to the environmental challenges including Patrick Geddes, a Scottish professor who was renowned as the “founding father of our present day understanding of Environmental education” (Irwin & Lotz-Sisitka, 2005, p. 38).

The first two international organizations for the environment were formed in the 20th century. The International Union for the Conservation of Nature and Natural Resources (IUCN) and World Wildlife Fund (WWF) were established in 1948 and 1961 respectively (Irwin & Lotz-Sisitka, 2005). These bodies collaborated with NGOs and countries across the world including South Africa. They proclaim “conservation awareness”, “environmental awareness” and “environmental education” (Irwin & Lotz-Sisitka, 2005, p. 39). The United Nations Environment Programme (UNEP) was founded in 1972 at the Stockholm UN conference promoted global campaign of EE *(ibid)*.

Many UN conferences were held in different parts of the globe during the 20th century. The first Intergovernmental Conference on EE was in held in Tbilisi, USSR (presently in country of Georgia) in 1977. Twelve principles of EE were approved at the meeting. Prominent among these principles are that EE must a lifelong practice, learners should be aware of environmental issues in all segments of the society and learners should train to take action towards solving environmental issues (Irwin & Lotz-Sisitka, 2005).

The second international conference on EE (ICEE) was held in Moscow (USSR) and termed ‘UNESCO-UNEP International Congress on Environmental Education and Training’ in August 1987 (UNESCO-UNEP, 1987). According to this conference

document, some progress and challenges that arose from the program of action of the first intergovernmental conference on EE held at Tbilisi were addressed. There had been improved awareness on the need for EE, increased computerized information system in the field of EE and a series of trainings for pre-service and in-service teachers, with regards to EE, were conducted by various countries to mention a few. The conference called for more commitment to EE awareness, promotion of more training for pre-service and in-service teachers and improved curricular and teaching materials related to EE (*ibid*).

The role of education and public awareness for achieving sustainability was top on the agenda at the third ICEE was held at Thessaloniki, Greece in 1997 (UNESCO-UNEP, 2007). The forth ICEE which took place in Ahmedabad, India in 2007, emerged with the Ahmedabad declaration that states “Education for life: life through education” (UNESCO-UNEP, 2007, p.1). The declaration stressed the importance of education as a tool for sustaining the ecological integrity of the earth. Through enlightenment, humans can live peacefully, understand their cultural diversities and develop a caring environment *(ibid*).

2.4.2.2 South African History of Environmental Education

- **Pre-1994 emergence of Environmental Education in South Africa**

Irwin and Lotz-Sisitka (2005, p. 47) attest that modern-day EE started in South Africa in the 1970s after motivation from the Belgrade Charter of 1975 and the 1977 Tbilisi Principles. “Conservation education” with emphasis on “soil erosion” was stressed before this time which excluded the socio-political considerations of the society *(ibid)*. However, EE encompasses the social, economic, cultural including the kind of narrow “ecology” considered in the past (Irwin & Lotz-Sisitka, 2005, p. 47).

The White paper on EE was presented in parliament in 1989 even though the then Departments of Education had not been supportive of the EE movement due to their suspicion of EE (Irwin & Lotz-Sisitka, 2005). The prominence of EE grew and higher education began offering courses *(ibid)*. The forerunner was the University of Bophuthatswana (now North-West University) which started EE in 1985 (Irwin & Lotz-Sisitka 2005). Rhodes University, University of South Africa (UNISA) and University of Stellenbosch also set up EE in the faculties of Education at

undergraduate and postgraduate levels in the late 1980s and early 1990s (Irwin & Lotz-Sisitka, 2005). These institutions were very vibrant and gained a lot of support from government, NGOs and the business communities (Irwin & Lotz-Sisitka, 2005).

- **Post-1994 Environmental Education policy and curriculum formation in South Africa**

In 1994, the African National Congress (ANC) Policy Framework for Education and Training proclaim, through the 1995 White Paper on Education and Training formulated the clause that gives the framework for EE inclusion in the South Africa's Basic Education curriculum called Curriculum 2005 (Irwin & Lotz-Sisitka, 2005, p. 52). Prior to May 11, 2009, the Department of Education of South Africa (DoE) was a single body governing both the Basic Education for schooling and the Higher Education and Training for higher institutions (Khumalo, 2009). The DoE (1995) cited by Irwin and Lotz-Sisitka (2005, p. 52) states:

> … environmental education, involving an interdisciplinary, integrated and active approach to learning, must be a vital element of all levels and programs of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources

The Environmental Education Policy Initiative (EEPI) was later transformed into Environmental Education Curriculum Initiative (EECI) that drafted the outcome-based education referred to as Curriculum 2005. EECI comprises various stakeholders including environmental teachers (DoE, 1997 cited by Irwin & Lotz-Sisitka, 2005). The Curriculum 2005 was improved upon in 2002 to become revised "National Curriculum Statement" (DoE, 2002 cited by Irwin & Lotz-Sisitka, 2005, p. 52).

Rosenberg, Nsubuga, and Burt (2009) argue that teachers are not effective enough in EE despite a substantial amount of content and aims allocated to EE in the National Curriculum Statements. It is also noted that many subject advisers do not know enough about EE (Rosenberg, Ramsarup, Burt, Ellery, & Raven, 2009).

2.4.3 Environmental Education policy in South Africa

South Africa has different policy documents that contextualize EE. Some of them are described in this section.

The White paper on Values and Principles of Education and Training states that:

> Environmental education, involving an inter-disciplinary, integrated and active approach to learning, must be a vital element of all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources (South Africa, 1995, p. 18).

This policy underlines the significance of teaching EE at every level of education in South Africa. It connotes that EE should be incorporated into all subjects and must feature in every teacher education courses to ensure healthy living and optimal use of the natural resources.

The South African Constitution (South Africa, 1996, p. 6) guarantees the right to an environment that is "not harmful to human health and well-being" and "to have the environment protected for the benefit of present and future generations, against pollution and ecological degradation, to promote conservation and to secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development". As a result of democracy in South Africa the Constitution recognizes the relevance of the environment for the well-being of its citizens.

According to the National Climate Change Response White paper (South Africa, 2011, p. 5), the world's climate change problem is real and efforts are needed to reduce carbon emission in the country. Its goals are twofold: first, to control the effects of climate change, through strategic measures, on South Africa and second, to support the global reduction of greenhouse gases (GHG) concentrations in the atmosphere. This can be achieved by averting the "anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner" *(ibid).* These policies attest to the value EE is to South Africa. Therefore the research into how pre-service science teachers learn to teach EE is relevant and necessary.

2.4.5 Environmental Education and the Curriculum and Assessment Policy Statements (CAPS)

It is essential to review EE as it appears in the current CAPS, because pre-service science teachers are trained to enable them to teach this curriculum.

According to the DBE (2011) Natural Sciences and Technology are combined as one subject at the Intermediate phase (Grades 4-7) while Natural Sciences stand alone at the senior phase (Grades 8-9). The CAPS includes the following: "… Human rights, inclusivity, environmental … infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa" (DBE, 2011, p. 5). The statement declares that environmental knowledge is to be prioritized in order to achieve a state of fairness for every citizen of the country *(ibid)*. According to the CAPS document, the teaching and learning of Natural Sciences should harness first-hand ideas relating to the environment we live in (DBE, 2011).

There are three "Specific Aims" for Natural Sciences, as outlined in CAPS, which serve as foci for learners to gain in-depth understanding of the subject (DBE, 2011, p.10). Specific Aim 3 states that learners apply Natural Sciences to the "society and environment". It cites, as examples, the enabling of learners to apply knowledge to cultivation of food without land degradation and water conservation awareness (DBE, 2011, p.10). Lotz-Sisitka (2012, p. 27) contends that CAPS was implemented in order to resolve the issues experienced in the previous two post-apartheid curriculums. CAPS, in terms of environment and sustainability topics, is a "strongly content referenced curriculum, inter-disciplinary, contemporary and complex" .The success of teachers to teach EE within this "complex" curriculum is influenced by in-service and pre-service teacher training programmes. Lotz-Sisitka (2012, p. 27) explains that being "complex" means that the whole concept of the environment is not known absolutely and that the debate continues.

2.5 Environmental Education, in-service and pre-service teachers in South Africa

Learners' underperformance in science education has been associated with the quality of the teachers in South Africa. Literature indicates that much work needs to

be done to support the in-service programs for science teachers and to prepare the pre-service science teachers to be more effective.

2.5.1 Environmental Education and in-service teachers in South Africa

Modisaotsile (2012) is of the view that the deficiency of school materials, insufficient teachers' education and low teacher enthusiasm, in spite of huge government funding, are among the troubles being experienced by South African Basic Education Department. Mokhele and Jita (2008) contend that South African teachers do not have the capacity and understanding to impart EE to learners because they were not exposed to it while in basic and higher educational institutions. They further attest that provincial governments and departments of education are not creating adequate support to enable the teaching and learning of EE in the schools through in-service teacher training programmes.

Teachers in South Africa do not have the capacity to make EE part of their instruction due to their inadequate background knowledge (Lotz-Sisitka, 2012). One in-service teacher training programme which was designed to ameliorate in-service teachers' capacity to teach EE is the Fundisa for Change (FFC) programme. The main objective of FFC is "Transformative environment through teacher education" (Lotz-Sisitka & Songqwaru, 2014, p. 6). The initiative is revamping the in-service teachers' environmental competence through enriching their content knowledge, teaching pedagogies and assessment practices using the CAPS curriculum *(ibid)*.

Shallcross, Loubser, Le Roux, O'Donoghue and Lupele, (2006, p. 285) contend that "the prioritising of the education of teachers to reorient their teaching towards sustainable development gels with the preferred strategy of the United Nations Scientific Educational and Cultural Organization (UNESCO)'s Teacher Advisory Group on Education for Sustainable Development". This group supports the work for the United Nations' Decade of Education for Sustainable Development (2005–2014) (*ibid*). Robertson and Krugly-Smolska (1997) assert that efforts must be made to address the urgent and practical issues of in-service teachers for them to be competent in EE pedagogy.

There must be collaboration amongst universities, government and Non-Governmental Organisations (NGOs) to enhance in-service teachers' proficiency in

delivering quality EE to learners (DEA, 1995). Mokhele and Jita (2008) argue that NGOs and government organisations need to work together with basic educational institutions and teachers in providing relevant EE to the learners. These scholars' opinions signal the challenges with in-service teacher training in South Africa with regards to EE. My study focused on how pre-service science teachers learn to teach EE because I contend that this will yield important insights into how teachers can be trained to be effective.

2.5.2 Environmental Education and pre-service teachers in South Africa

Hudson (2001) explains that research into EE, as well as how teachers and other EE experts are prepared to instruct members of society, is required. Pre-service teachers should be proactive when it comes to infusing EE into their professional activities because they are expected to instruct learners on how to manage the environment (Esa, 2010). Put simply, "There should be better teacher training" (Modisaotsile, 2012, p. 6).

Songqwaru (2012) contends that the curriculum requirements for environmental and sustainability education differ from one learning area to another inferring that approach to delivering will not be the same. Thus teachers need to develop a reasonable amount of 'content knowledge' for EE which is required in each subject *(ibid)*. Songqwaru (2012) proposes that educational institutions offering teacher education should groom pre-service science teachers to be proficient in the pedagogical content knowledge in their fields. The previous teacher preparation did not meet the standard necessary for teachers to acquire adequate knowledge of environment and sustainability education didactics (*ibid*).

Mosothwane and Ndwapi (2012) confirm that teachers did not see themselves as being capable of teaching EE but they do appreciate the relevance of the content to learners' knowledge. The DEA (1995) recommends that every teacher training institution should integrate EE as part their pre-service teachers' program.

Teachers' views about learning to teach EE are important because these may determine the extent to which teachers may choose to engage with EE.

2.5.3 Environmental Education teaching and learning in higher education

Emphasis on teachers' proficiency is crucial in EE practice (Robottom & Kyburz-Graber, 2000). Knowledge and learning in universities are significant to the improvement of the well being of a nation (Cloete, Bailey, Pillay, Bunting, & Maassen, 2011). The Department of Higher Education and Training, (DHET, 2011, p. 47) recommends a knowledge mix in teacher education which must incude "disciplinary learning, pedagogical learning, practical learning, fundamental learning and integrated knowledge" all summed up as "integrated and applied knowledge". These are critical to delivery in teacher education. The views highlight the need for quality knowledge by teachers in EE that is paramount to any country's welfare. EE must also be situational and practical (DHET, 2011) which makes the knowledge more relevant to the environmental issues in the society. According to Payne (2006, p. 31), "EE is now situated and practical in the nature of the educative (environmental) experience".

Madikizela-Madiya (2012) reveals that postgraduate EE research in the past focused more on the schooling system (basic education) at the expense of higher education. I contend that research on exploring the views of pre-service science teachers about learning to teach EE will fill in some of the gaps created in previous EE studies. Odeke (2012, p. 7) highlights the goals of UNEP-led Global Universities Partnership for Environment and Sustainability (GUPES)

> … to promote the integration of environment and sustainability concerns into teaching, research, community engagement, the management of universities, greening of university infrastructure/facilities/operations. Also to enhance student engagement and participation in sustainability activities both within and beyond universities.

This view indicates that by encouraging EE in higher institutions of learning, awareness will develop among the citizens in the society.

2.5.4 Microteaching

In this study, the views of pre-service science teachers about learning to teach EE were sought by reflecting on the microteaching experiences of the participants. The

microteaching was presented to the participants' peers. Therefore, a brief discussion about learning to teach in a microteaching setting is required.

Microteaching started at Stanford University, California, United States of America in 1963 (Yule, Steyn, Soobiah, & Keri Davies, 1991). Microteaching is defined "as a teaching situation which is scaled down in terms of time and numbers of learners" (Cooper & Allen, 1970, p. 1). The scholars add that the presentation in a micro-teaching setting is for about twenty minutes for three to ten learners and only emphasises certain features of pedagogy. This definition is similar to that of Remesh (2013, p. 158) who states that microteaching is a "teacher education technique for learning teaching skills. It employs real teaching situations for developing skills and helps to get deeper knowledge regarding the art of teaching".

Dutta (2014, online) defines microteaching as "a procedure in which a student teacher practices teaching with a reduced number of pupils in a reduced period of time with emphasis on a narrow and specific teaching skill". She mentions some of the purposes of microteaching to include supporting pre-service teachers in acquiring pedagogical abilities and developing the confidence to teach. Naim (2012) attests that using microteaching methods in pre-service teachers' training in EE lessens fears and increases their interest and self-confidence in the subject.

The microteaching cycle has the following sequence "Plan-Teach-Observe (Critique) – Replan-Reteach-Reobserve" (Brown 1975, p. 15).

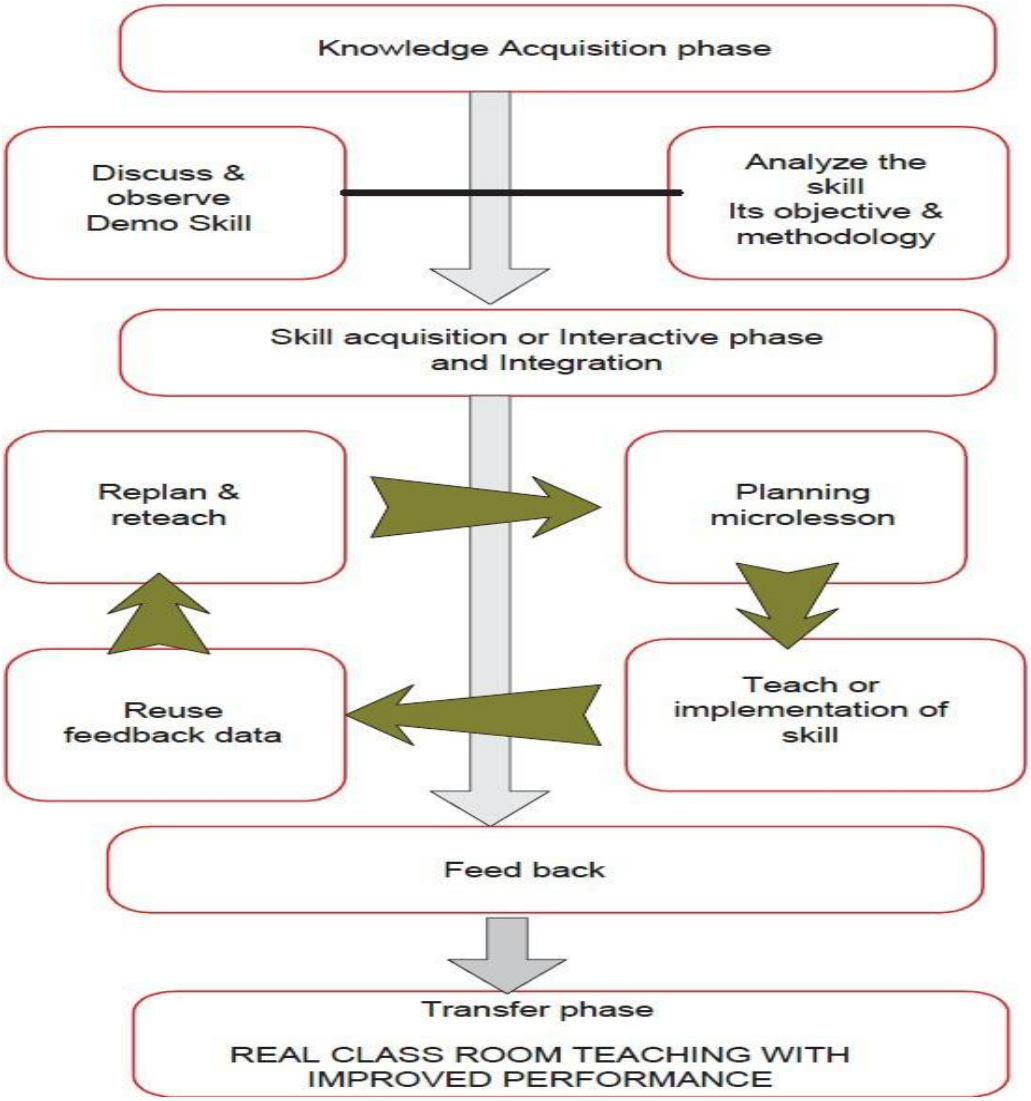

Figure 5: Various phases involved in a microteaching activity
Remesh (2013 p. 160)

Remesh (2013, p 160) presents a model which is illustrated in Figure 5. It summarises different steps in the microteaching exercise. She propounds that pre-service teachers begin with “knowledge acquisition phase” where they learn about the content of the module from lecturers through different methods. “Skill acquisition” is the microteaching proper where the trainee plans a lesson, teach it to a small group, get critiqued and reteach to reinforce the teaching skills. During this stage, according to Remesh (2013), other trainees can appraise their colleagues to enhance the skills under focus. The experience from microteaching is finally taken into “real classroom with improved performance” (Remesh, 2013, p.160).

Diana (2013, p. 151) explains that microteaching involves three steps which are "Planning, teaching and reflection". The author establishes that reflection gives the pre-service teachers the room to review the strengths and weaknesses of their teaching practice by reflecting in order to perform better in the future. Zhang and Lin (2014) attest that as starters, pre-service teachers require thoughtfulness to develop themselves during microteaching. The authors argue that the pre-service teachers require adequate preparation for the microteaching process and can reflect on their performance using their peers' critique. Ananthakrishnan (1993) observes that microteaching enables the pre-service teacher to develop learning constantly and allows for useful criticism essential for professional development. The experience gained through practicing to teach will increase the teaching abilities of the pre-service teachers before getting into the real classroom (Ananthakrishnan, 1993).

Fernandez (2010, p. 361) reveals that pre-service teachers only concentrated on the "content" of the curriculum before experiencing microteaching, neglecting the "processes" of imparting knowledge. The ways in which knowledge is acquired by learners such as experiential learning, critical thinking, etc., will be advanced by pre-service teachers through microteaching process according to Fernandez (2010). Gunning and Mensah (2011) contend that providing opportunities for pre-service teachers to be critiqued during microteaching has a meaningful effect on their performance as future teachers. The use of microteaching in pre-service teacher program can enhance the trainees' "self-efficacy" (Gunning & Mensah, 2011, p. 184).

2.6 Silence/gap in literature that was reviewed

The preceding literature review comprises insights and works of researchers, policy makers, experts and other stakeholders in the field of EE. Based on the literature which was reviewed, the views of pre-service science teachers about learning to teach EE in the Intermediate and Senior phases of South African schooling system is scarce. Voices of pre-service teachers about how they learn to teach appear to be marginalised. With the advent of the newly introduced CAPS curriculum, and the emphasis on EE, research into how pre-service teachers learn to teach EE becomes crucial. My study addresses this research lacuna by bringing to the centre views of pre-service teachers about how they learn to teach EE.

2.7. Theoretical framework

Exploring the views of pre-service science teachers about how they learn to teach EE is about learning in the field of science education. To understand the views of the participants about how they learn to teach EE, constructs from Vygotsky's Zone of Proximal Development (ZPD) and the constructivist learning theory were used.

Green and Gredler (2002, p. 54) attest that the theory of constructivism applies when "learners actively construct their own knowledge rather than receive performed information transmitted by others". Tuckman and Monetti, (2011) assert that constructivism involves active learning and learners must acquire knowledge through collaboration processes rather than just being told what to do. Donald, Lazarus and Lolwana (2002) agree that constructivism occurs when a person or cluster of people gains knowledge through activities instead of passively receiving information.

Gauvain (2001) cited by Tuckman and Monetti (2011, p. 311) argue that Vygotsky's perspective of constructivism illustrates that learners learn better when they work in groups than when working alone; the element of "social interaction" cannot be overemphasised. Woolfolk (2010) contends that collaboration is the key to pedagogy in Vygotsky's approach. "Human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (Vygotsky, 1997, p. 34).

Vygotsky (1978) developed the concept of the Zone of Proximal Development (ZPD) to enable the understanding of the process of learning. According to Vygotsky, the ZPD is "the distance between the actual developmental 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, p. 86). Chaiklin (2003) agrees that the ZPD is the point where a less skilled individual is able to carry out an undertaking alone after cooperatively networking with a more knowledgeable person.

Coffey (2009) describes the ZPD as the region between what a learner can accomplish when given necessary instructional assistance and what he or she previously knows. Coffey (2009, p. 1) contends that "social interaction is the basis for cognitive growth" in Vygotsky's ZPD. "There is a communication that transpires in a

social setting with more knowledgeable or proficient people (parents, teachers, peers, others) that assists children in building an understanding of the concept" *(ibid)*. Donald, Lazarus, & Lolwana (2002, p. 71) argue that there is a "cognitive mediation" which assists the learner to acquire more knowledge through the "proximal interaction".

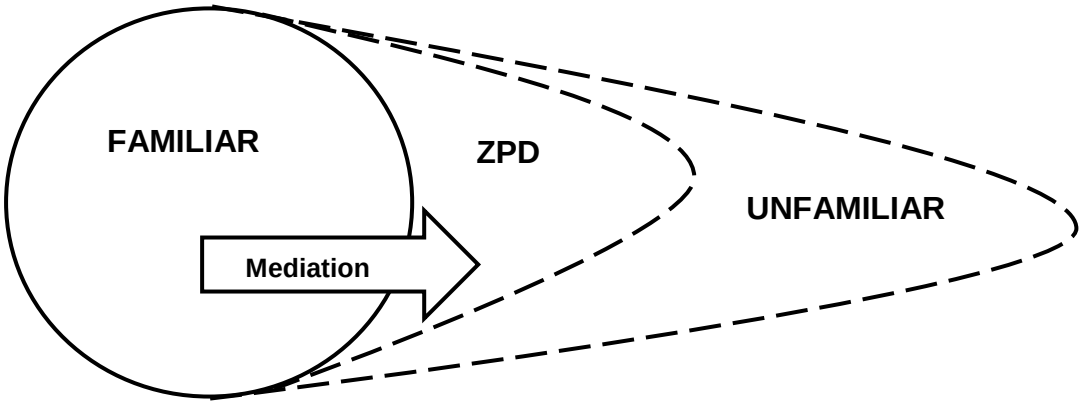

Figure 6: Zone of Proximal Development (ZPD)
Donald, Lazarus, & Lolwana (2002, p. 71)

Figure 6 illustrates the state of the learner as "familiar" in which he or she has obtained previous knowledge. The "unfamiliar" depicts the region where knowledge is too difficult for the learner to acquire while ZPD represents region in which the learner can comprehend with the guidance of a more knowledgeable person. "Mediation" is the interaction that takes place between the more competent individual and the learner that results in the improvement of the cognitive level of the learner.

Zinkiewicz, Hammond and Trapp (2003) concur that Vygotsky's ZPD is the point at which a task can be done independently by a learner after receiving assistance from a more capable person. Zinkiewicz *et al.* (2003, p. 16) refer to the "direction, guidance, support" the learner receives from a more skilful person as "scaffolding". This resonates with the views of Snowman and McCown (2012) that in the classroom setting, the support given to the learner to gain new understanding and abilities is called scaffolding.

Doolittle (1995) states that "three aspects of ZPD namely; whole and authentic activities, social mediation and change influence functional pedagogy". He also stresses that the ZPD provides a framework for cooperative learning as a teaching method. Cooperative learning is described by Woolfolk (2010) as a state where

peers work together in a group and learn from one another during a task. Doolittle (1995, p. 8) identifies “positive interdependence, face-to-face interaction, individual accountability, small group and interpersonal skills, and group self-evaluation” as requirements for cooperative learning. Zinkiewicz *et al.* (2003) submit that Vygotsky’s view with regard to learning is that personal traits of a person must be groomed through his or her innovative abilities.

2.8 Link between theoretical framework and study

My study drew on theoretical constructs from constructivist learning theory and Vygotsky’s ZPD. I adapted the constructs because the pre-service learner was positioned as the learner who learned from more knowledgeable others. I explored the views of pre-service science teachers about how they learn to teach EE and the way they construct knowledge and meaning from their interpretation of what is happening around them, based on their experiences and understandings, through the processes of assimilation and accommodation. My study also explored how intrinsically social activities, through cooperative work, influence their thinking.

2.9 Conclusion

This review of the literature indicates that humanity is experiencing environmental crises of various types and these issues are not localized to particular areas or communities, but are global. Challenges such as global warming, loss of biodiversity, land degradation, to mention a few, are threatening the existence of human beings. Concerted efforts are needed by governments, stakeholders, basic and higher education, and teachers to mitigate these issues, as revealed in the literature. Scholars underscore the need for EE in terms of creating awareness, conservation of natural resources and mitigation.

According to the literature, EE has been practiced centuries ago in primitive ways and a more contemporary form of EE started in the 20th century due to the impact of globalization on the world. The industrial revolution, population growth and misuse of the earth’s natural resources made EE necessary for EE. Several international conferences have been held since the mid-20th century by the United Nations bodies, NGOs and governments of various countries, including South Africa, to prioritize EE in formal schooling and higher education. South Africa has been making

efforts in the implementation of EE since 1994, and has infused EE into its entire schooling curriculum.

South Africa has enshrined EE in the Constitution, and policy documents such as white papers on education, Department of Environmental Affairs documents and others government statements validate the need for EE in the country. South Africa has reviewed its school curriculum three times since 1994 and the greatest amount of EE content is in the present curriculum called CAPS. CAPS has been enriched with up-to-date environmental issues and is all-encompassing in scope.

Many researchers have studied in-service teachers and their competence to teach EE topics in the South African schooling system. According to the literature, in-service science teachers did not receive adequate EE during their schooling and teacher training. This made them unfamiliar and inexperienced in the EE pedagogy. They are not familiar with the content and the teaching approaches of EE which results in the learners being disadvantaged. Many subject advisers and Department of Education officials are also not competent in supporting the teachers, according to research revealed in this literature review.

The literature points to findings from research studies which indicate the need for more training for in-service teachers to help them gain the capacity to teach EE. One of the recent initiatives in the country is the ‘Fundisa for Change’ programme which has identified this vacuum and is providing training events and developing teaching and learning materials in partnership with the government, universities, NGOs and other stakeholders for the in-service teachers.

Pre-service science teachers have been marginalised in the EE discourse. This is based on the scarcity of documented research works in this regard. Research studies which focus on pre-service science teacher education on EE appear to be minimal, and this makes me argue that for the future teachers to be well equipped for the classrooms, a high standard of pre-service teacher training is crucial. Exploring the views of pre-service science teachers about learning to teach EE will contribute to the debate of pedagogical content knowledge (PCK) of pre-service teachers.

The literature review and the theoretical framework provided insight into the study and have enhanced the research design, analysis, findings and recommendations.

The following chapter looks at the research design and methodology adopted for this study.

CHAPTER 3

Research Methodology

3.1 Introduction

Salkind (2012, p. 47) states that “research methods consist of a group of tools and techniques used to answer questions in a scientific manner”. This chapter explains the research methodology engaged in answering the research questions for this study. A qualitative approach was employed and the research was positioned within the interpretive paradigm. A case study design allowed for an in-depth study of pre-service science teachers’ views about how they learned to teach EE in a Natural Sciences classroom. The justification for selection of the methods of data collection and the research instruments used, and issues of validity and reliability, are elucidated. Ethical considerations and the limitations of the study conclude the chapter.

3.2 Context of the study

The study was undertaken at Rudacoast University (Rudacoast is a pseudonym). The university has four colleges and nineteen schools. The study was carried out in the School of Education within the College of Humanities. The School of Education offers the Bachelor of Education (BEd) degree programs and other postgraduate courses in different fields of Education. For this research the sample was drawn from 3rd year undergraduate students who were studying the Natural Science Method 2 (NSM 2) module from the cluster of Science and Technology in the school of Education.

NSM 2 is a first semester module and according to the university’s template for the module, the aim is “to prepare students to teach Natural Sciences at the intermediate and senior phases” of the South African schooling system. The content of the module includes “Learning Theories, Practical Work and Investigations, Demonstrations, Improvisations, Laboratory Safety, Problem Solving, Concept Mapping and Indigenous Knowledge Systems” as they relate to Natural Sciences.

Participants were organized into groups to prepare and present lessons in microteaching sessions on EE topics in Natural Sciences, according to CAPS. CAPS is the newly launched curriculum in South Africa for Basic Education. “The National Curriculum Statement Grades R-12 represents a policy statement for learning and teaching in South African schools” (Motshekga, 2011, p. 0). Multiple data generation methods were used to obtain insights into pre-service teacher participants’ views about learning to teach EE.

NSM 2 was used for this study because the goal of this research was to explore the views of pre-service science teachers about learning to teach EE. The NSM 2 module is not a ‘content’ module but a ‘teaching methods’ module. ‘Content’ modules only stress the ‘subject matter’ of the curriculum while the ‘method’ modules place emphasis on the approaches to teaching and ‘how to teach’.

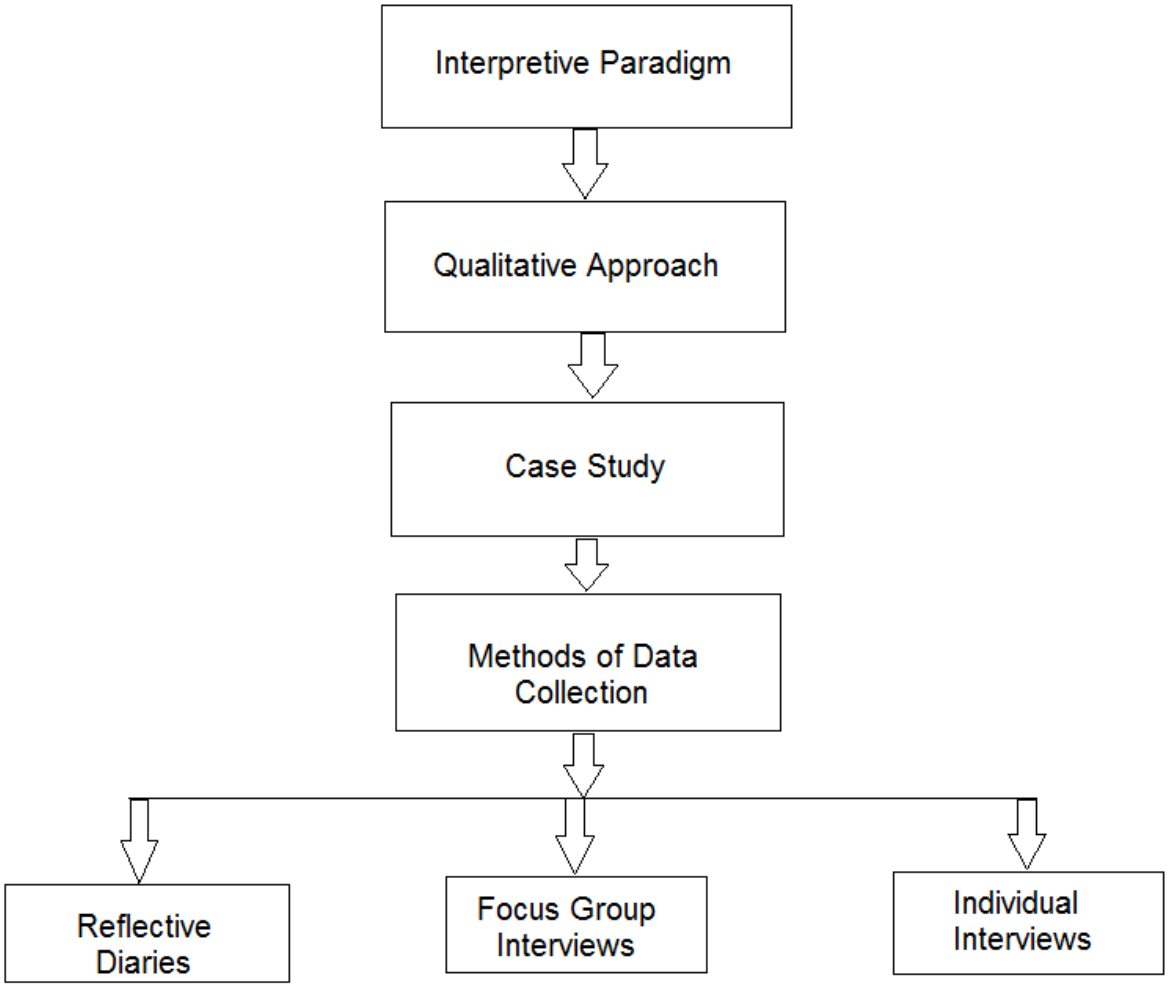

Figure 7: Diagrammatic representation of research methods/approach to study

Figure 7 provides a schematic representation of the research methods and approach to this study. The details are explained in the following sections.

3.3 Paradigm

Sikes (2004, p. 18) defines paradigm as “a basic set of beliefs that guides action”. Paradigm means “worldview” according to Creswell (2009, p. 6). It is the way by which people perceive the world. ‘Paradigm’ embraces four terms namely; “ethics, epistemology, ontology and methodology” (Denzin & Lincoln, 2008, p. 245). These terms, according to the scholars, explain how humans relate to and gain understanding about the “world” around them. During this study I examined the pre-service science teachers’ understanding of what they perceived as valid, in order to generate the data. The way the participants engaged with answering the research questions based on their interpretation of reality, during the data collection, was central to this study. My role was that of an observer.

This study was framed within an interpretive paradigm which, according to Cohen, Manion and Morrison (2011), examines the individual’s personal judgement in relation to reality. The authors add that an interpretive paradigm is based on the activities of human beings and the interpretations of their experiences. Check & Schutt (2012, p. 15) describe interpretivism “as the belief that reality is socially constructed and that the goal of social scientists is to understand what meanings people give to that reality”.

Based on these assertions, the views of the participants, as constructed by their social interactions, are peculiar to them and my goal was to understand the values they attached to them. These individuals came from different backgrounds and possessed varied assumptions which informed their construction of views. I used the interpretive paradigm in order to comprehend the experiences of how the pre-service science teachers learned to teach EE. The interpretive paradigm is apposite for this study because the experiences of the participants were socially created based on the world around them.

3.4 Approach

The research approach adopted for this investigation was qualitative. Salkind (2012, p. 11) defines qualitative research as research that “examines individuals, and

phenomena within the context in which they occur". He further explains that a qualitative researcher's goal is "gaining an in-depth understanding of behaviour and the reasons for that behaviour" *(ibid)*. This resonates with Creswell's (2009) description of qualitative research as a procedure for interpreting a person or groups' perception of a societal or human issue. Drew, Hardman and Hosp (2008, p. 185) establish that it is "so-called thick descriptions that render a clear and accurate picture of the nature of each culture that form the basis of anthropological studies". In this study, pre-service science teachers' views were sought while training to become professional teachers. The university represented the setting where the research took place. The research aimed at generating thick descriptions about how pre-service science teachers learned to teach EE in the intermediate and senior phases of the South African schooling system.

In the opinion of McMillan and Schumacher (2010, p. 324), "qualitative researchers cite two major purposes of a study: to describe and explore and to describe and explain". Check and Schutt (2012) attest that qualitative research methods draw on the genuineness of the participants' knowledge and not on the researcher's pre-set views. It is an "emerging process" whereby the investigator does not enforce his or her opinions but rather seeks to understand the participants' insight and expressions (Creswell, 2012, p. 130). Data from this research includes descriptions from participants' of their introspections with regard to the phenomenon being studied. The outcomes were based on what came forth from the participants' assertions and not my perception of what they said: I was careful not to impose my views on them. I ensured that the atmosphere in which the research was conducted was conducive to enable the participants to share their opinions freely without any inhibitions.

The quantitative research approach was not selected because the views generated from the study were not as a result of "experimentation, manipulation of study conditions and use of numeric data" (Drew, Hardman and Hosp 2008, p. 138-139). A quantitative approach has the following goals according to Bogdan and Biklen (2007, p. 45): "theory testing, statistical description, showing relationships between variables and predictions". These strategies were not employed in this study.

Bogdan and Biklen (2007, p. 4-6) highlight that a qualitative study has features which are "naturalistic", "descriptive", "concerned with process", and "inductive". Drew,

Hardman and Hosp (2008) agree that qualitative methods require a normal and regular place for participants to express their thoughts at will. The researcher should carry out the research at the same setting where the opinions of the participants are generated *(ibid)*. The study was conducted in the natural setting of the participants where their views were obtained as they were generated. The setting was the university which represented the natural environment for the pre-service science teachers to learn how to teach while undergoing EE training.

3.5 Design

The design I adopted for this research was a case study. This design allowed me to study, in greater detail, the main focus of the research which was exploring the views of how pre-service science teachers learned to teach EE. Yin (2009, p. 18) states that "a case study is an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context". In the view of Opie (2004), case study centres on actuality and people in a place known to the researcher. Creswell (2007) cited by Creswell (2012, p. 465) writes that "a case study is an in-depth exploration of a bounded system (e.g., activity, event, process, or individuals) based on extensive data collection". "Being bounded", according to McMillan and Schumacher (2010, p. 344) means that the study is distinctive in terms of period, location and the features of the individuals participating in the research.

Hitchcock and Hughes (1995) cited by Cohen *et.al.* (2011) assert that in case study design the activities and conduct of the participants are not to be influenced by the investigator, which makes the research worth the while. They contend that case study deals with a comprehensive and clear expression of happenings in a storyline order. A rich data set was obtained from the insight of the participants based on their experiences. The venue was the university, during the first semester of the 2014 academic session. All the participants were 3rd year pre-service science teachers taking the NSM 2 module and studying towards attaining a BEd degree. Twenty five pre-service science teachers formed the case to be studied.

3.6. Sample

A sample is a part of a group that is used as a data source during an investigation and whose understanding can be adopted to describe the whole cluster (Cohen *et al.*

(2011). According to Neuman (2006, p. 219) “the primary purpose of qualitative sampling is to collect specific cases, events, or actions that can clarify and deepen understanding”. This resonates with Check and Schutt’s (2012) assertion that decisions about sampling in qualitative research are informed by the necessity to thoroughly consider in detail the participants, locations and the situations under investigation. In this study some pre-service science teachers were engaged to be part of the research.

Convenience and purposive sampling techniques were used for this study. Convenience sampling entails selecting people as participants because of their proximity (Cohen *et al*, 2011). The pre-service science teachers that participated in the research were easily accessible to me and I was able to reach them with minimal effort. This strategy was also used because gaining access to the participants was not prohibitively expensive. Purposive sampling “is common in exploratory studies and much of qualitative research and it depends on the judgement of the researcher based on what unit will facilitate an investigation” (Adler & Clark, 2008, p. 121). Researchers use their discretion to choose participants and places for the research in order to explore the central issue of the study (Creswell, 2012). I purposely selected the 3rd year students of Rudacoast University who were registered for the NSM 2 module and who had volunteered to be part of the study. The volunteers were approached through the lecturer lecturing the module (NSM2) during the period and the number of the total number of the whole class was 79.

The module was used by me to explore the views of how pre-service science teachers learn to teach EE in Natural Sciences. The module is ‘method’ in nature and the content comprises different approaches to teaching Natural Sciences in the intermediate and senior phases of South African curriculum. The participants provided “information about the topic of interest” (McMillan & Schumacher, 2010, p. 138) which represented the core of the study from their experiences of learning to teach EE.

Twenty five students who volunteered for the study were organized into five groups with five participants in each group. Each participant was given a reflective diary to document his or her views and insights during the research process. Each group participated in a microteaching session. They researched, prepared and presented

lessons which were based on topics related to EE from the CAPS curriculum, intended for the intermediate and senior phases of South African curriculum. After the presentations, focus group interviews were conducted with the five groups in order to capture their opinions and experiences about learning to teach EE.

Eight individuals were selected to participate in individual face-to-face interviews as a follow up to the focus group interviews. I purposively selected one participant from groups two and three respectively. Two pre-service science teachers were also purposively selected from each of group one, four and five. These individuals were chosen because they displayed particular insight during the focus group interviews. I selected eight respondents to participate in the individual interviews because I wanted to enrich the data which had been generated during focus group interviews. The following table reveals the topics which were allocated to the groups, as well as selected biographical details of the participants.

Table 1: Details of participants and topics selected for teaching during microteaching

Group	Race group of Participants		Gender		Year of Study	Topics	Grade
	African	Indian	M	F			
1	5	-	2	3	3rd	Medicinal Plants	9
2	5	-	1	4	3rd	Sustainable use of resources (Plants and animals)	8
3	5	-	2	3	3rd	Effects of human development in an environment: Acid rain	6
4	5	-	1	4	3rd	Biodiversity: Importance of conserving biodiversity	5
5	-	5	2	3	3rd	Human impact on the composition of the atmosphere: Global warming and Climate	9

Table 1 describes details of the pre-service science teachers that participated in the study. The 25 participants comprised 20 Africans from South Africa and five South African Indians. South Africa has a ‘race- based history’ (Mudaly, 2012, p.39) and comprises African, Indian, Coloured and White races. A total of eight men and 17 women were involved in the study. EE topics which were used for the research were from the CAPS curriculum, specifically from the “Life and Living strand” in Natural Sciences and Technology (DBE, 2011, p. 14) and Natural Sciences respectively

(DBE, 2011, p. 13). Natural Sciences and Technology is prescribed as a subject in the intermediate phase while Natural Sciences is studied at senior phase level (DBE_s, 2011) and is also a compulsory subject. The topics were intended for learners in grades five, six, eight and nine.

3.7 Pilot study

Boudah (2011) describes a pilot study as a process that provides the researcher with the opportunity to learn about the research questions, methods and procedure with a smaller sample of participants. He adds that this is done to strengthen the research questions and the methodology of the study. When using an interview procedure for data collection, Opie (2004, p. 115) recommends that the researcher carry out a pilot study. This is to "eliminate any ambiguous, confusing and insensitive questions and check the length of time appropriate for the interviews". I decided to conduct a pilot study in order to check the level of clarity of the questions in the research instruments and to enhance the validity and reliability of other research procedures.

Ten pre-service science teachers who had similar characteristics to the participants of the study, and who volunteered to participate, were selected for the pilot study. These participants were 3rd year students and were registered for NSM 2 module in Rudacoast University during the first semester of the 2014 academic year. They were divided into two groups of five participants and each was given a reflective diary to record for reflections during the pilot study. Each group prepared and presented a microteaching lesson of 30 minutes duration on EE topics. The first group presented a lesson on "Ecosystem" while the second group did its presentation on "The concept of the biosphere; the requirements for sustaining life" in line with CAPS requirements (DBE, 2011). The topic for the first group was in the intermediate phase and that for the second was for the senior phase of the South African schooling system.

Focus group interviews were conducted with the two groups at separate times. One individual, that had the most insight in each group, was selected to participate in the individual interview. All interviews were between 20-25 minutes and were audio-recorded. During the interviews, I noticed that I was speaking quickly and the participants had to request that I slowed down the pace of my speech. Also, some participants could not sit for more than 20 minutes due to other academic

commitments. One of the questions in the focus group interview was ambiguous and created confusion. The question was initially framed as *What logistic challenges did you encounter while learning to teach EE?* I then simplified the question into two parts for the main study which read; *How did your group design the lesson? What were some of the challenges/opportunities in designing the lesson as a group?*

The experience I had during the pilot study caused me to improve the research instruments and the arrangements ahead of the main study. This effort enabled me to obtain rich in-depth information and improve the validity of the study. “Validity refers to the degree to which a method actually measures what it is supposed to measure” (Wellington 2000 cited by Scaife, 2004, p. 68).

3.8. Data generation

“Most qualitative sources use a variety of methods” to collect data (Bogdan & Biklen 2007, p. 117). According to Yin (2009) cited by Cohen *et al*. (2011, p. 299-300), “documents (diaries) and interviews form part of the six sources of evidence in case studies”. He continues to say that “diverse data provide a chain of evidence that gives credibility, reliability and validity to the case study”. In this study, three methods of data collection were used, namely: reflective diaries, focus group interviews and individual face-to-face interviews. The methods provided in-depth information that facilitated the answering of the research questions of this study.

3.8.1 Data generation methods and instruments

Table 2: Outline of the research questions and instruments used for data generation

Questions to be answered	Participant(s)	Instrument/method
What are pre-service science teachers' views about teaching Environmental Education in the Natural Sciences classroom? What are the challenges which pre-service science teachers experience when they learn to teach Environmental Education? How do pre-service science teachers address these challenges and what enables them to teach Environmental Education?	25 volunteers were purposively selected because they were pre-service science teachers who were registered for Natural Science Method 2 (NSM 2) module.	Reflective diaries
	25 participants were organized into 5 groups with 5 participants per group.	Focus group interviews
	Eight individuals purposively selected (based on their insight and views about learning to teach EE and to enrich the data generated)	Individual face-to-face semi-structured interviews

Table 2 shows the three research questions for the study and how the participants were engaged with the process of answering them. The 25 students that volunteered maintained reflective diaries for the period of the study. Focus group interviews were conducted with the five groups with five participants in each group. Individual face-to-face interviews were conducted with eight purposively selected members from the five groups, who displayed a deeper understanding of the phenomenon under investigation.

The data were generated using focus group interviews, individual interviews and reflective diaries. The interviews were audio-recorded and the reflections documented in the reflective diaries.

3.8.1.1 Focus group interview

According to Check and Schutt (2012, p. 188), focus groups are "a qualitative method that involves unstructured group interviews in which the focus group leader actively encourages discussion among participants on the topic of interest". Creswell (2012) states that focus group interviews can be used to obtain common views from many people and usually involves four to six persons per group. In the opinion of Krueger and Casey (2009, p. 2), this "creates a permissive environment in the focus

group that encourages participants to share perceptions and points of view without pressuring participants to vote or reach consensus". This resonates with the assertion of Kvale and Brinkmann (2009) that the goal of the focus group interview is to articulate diverse points of view, and not to arrive at a unanimous decision.

The focus group interview allowed the participants to engage freely with the interview process and to give their insights as they related to the phenomenon which was explored by the study. Some of them were prompted to speak while listening to their peers' contributions. This corroborates Patton's (2002) view that in focus group interviews, participants can provide more perceptiveness as they pay attention to their peers' opinions.

Cohen *et al*. (2011, p. 436) are of the view that "it is from the interaction of the group that the data emerge". Check and Schutt (2012, p. 205) affirm that "focus groups generate qualitative data using open-ended questions posed by the researcher or group leader". Krueger and Casey (2009, p. 7) agree that "the data in the focus group are solicited through open-ended questions". The focus group interview had a schedule of questions which were semi-structured and open-ended to allow the participants to provide details of their experiences in order to reveal the way they perceive their reality. The interview questions were designed to provide answers to my research questions. The interview questions related to the views of pre-service teachers about teaching EE in Natural Sciences classroom, their challenges of learning how to teach EE and the way these challenges were addressed.

Three benefits of focus group interviews are highlighted by Adler and Clark (2008): firstly, the interviewees' ideas are given prominence with the researcher's influence reduced to minimum; secondly, an enormous amount of feedback to inquiries is yielded and thirdly, it enhances other methods of data collection. Kvale and Brinkmann (2009) affirm that audio recording of interviews allows the researcher to focus on the issue and obtain adequate feedback from the interviewees without being distracted by note-taking. Thus the use of an audio recording device made the focus group interview easier, because I could probe responses more deeply. I was also able to listen to the audio records repeatedly while transcribing the interviews to get the actual words, tone, meaning and pronunciations articulated by the participants. Appendix 3 outlines the focus group interview schedule.

3.8.1.2 Individual interview

The individual interview is a one-on-one interview where the "physical and social circumstances of the interview can be monitored, and respondents' interpretations of questions can be probed and clarified" (Check & Schutt, 2012, p. 174). These scholars underscore the value of individual interviews by stating that the researcher is able to clearly comprehend what the participants actually say. Neuman (2006, p. 301) asserts that individual interviews provide the greatest amount of information when compared to other methods of data collection because of its potential for "extensive probes". McMillan and Schumacher (2010) explain that individual interviews are good for respondents who can easily contribute information and are confident enough to express themselves coherently.

Eight members from the five groups that showed deeper insights were individually interviewed. These participants were bolder in their responses than the others in their groups and displayed more knowledge of the subject matter which was study. The interviews proceeded on the basis of semi-structured and open-ended questions. Through face-to-face individual interviews, the participants were able to give in-depth information, clarify ambiguous responses and gave a clearer picture of their insights into learning to teach EE as pre-service science teachers. The interviews were audio-recorded then transcribed individually (see Appendix 4 for the individual interview schedule). Participants' responses gave insight into answering the Research Questions Two and Three of the study. These questions delved into the challenges the pre-service science teachers highlighted in their individual groups and how they had planned to surmount them.

Further probing using the individual interview guide provided information into what enabled the participants to learn to teach EE while training to become professional teachers which was related to Research Question Three.

3.8.1.3 Reflective diaries

Progoff (1975 cited by Hiemstra, 2001, p. 21) asserts that "diary writing usually involves the unstructured, chronological recording of the events of a person's life" as the happenings are observed. Woolfolk (2010, p. 8) defines reflective as "thoughtful and inventive". The reflective diary schedule was designed to allow pre-service

science teachers to provide their reflections and in the process provide data for answering the three research questions. The participants expressed their thoughts and feelings in their respective reflective diaries about teaching EE, challenges, overcoming the challenges and what enabled them to learn to teach EE (see Appendix 5). Thus the process of keeping reflective diaries enabled me to determine, through data analysis, the depth of thought and creativity of the pre-service science teachers in relation to the topic of this study.

3.9. Triangulation

"Triangulation is the process of corroborating evidence from different individuals, types of data or methods of data collection in description and themes in qualitative research" (Creswell, 2012, p. 259). Similar patterns are derived from data obtained from various methods which brings precision and trustworthiness *(ibid)*. Drew Hardman and Hosp (2008) agree that by finding evidence from "multiple sources, accuracy" can be achieved. Neuman (2006) describes triangulation as a technique of ensuring genuineness by considering something from different perspectives.

McMillan and Schumacher (2010, p. 379) maintain that triangulation is a "theme of collaboration" which relates information emerging from various sources such as "interviews and documents".

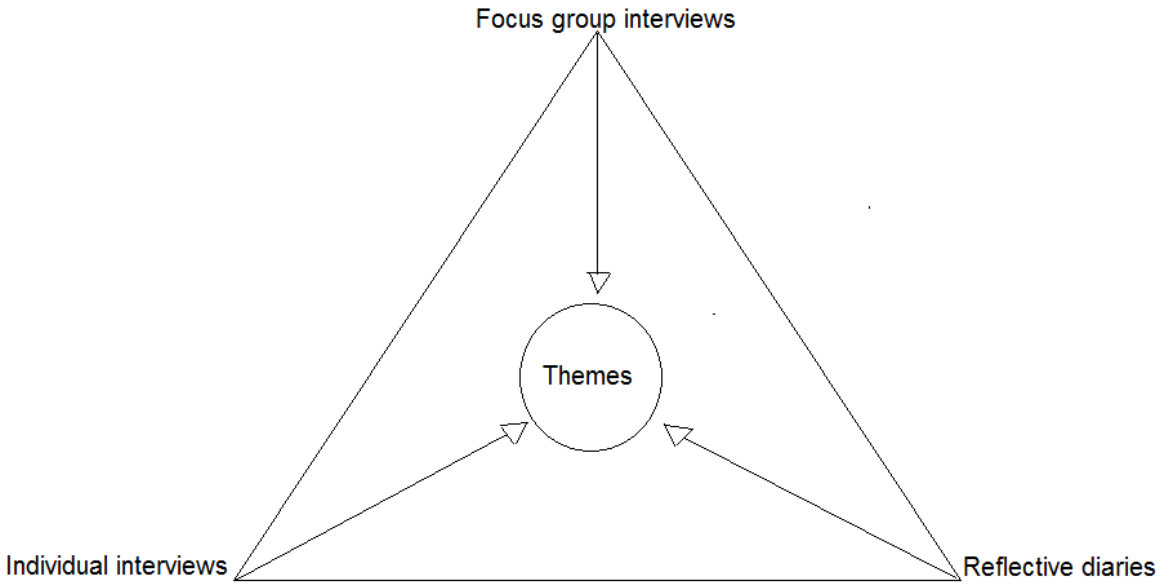

Figure 8: Diagrammatic representation of "triangulation"
Adapted from Waters-Adams (2006 cited by Check & Schutt, 2012, p. 267)

Figure 8 illustrates triangulation as adapted for this study. Data from the reflective diaries, focus group interviews and individual interviews were critically examined to develop patterns, categories and themes that emerged from them. Triangulation helps to ensure validity of the research. The information that emerged from the multiple methods of data collection was as a result of the pre-service science

teachers' construction of knowledge. "Active involvement through thought-provoking experiences and peer collaboration" (Tuckman & Monetti, 2011, p. 312) gave rise to the themes that provided answers to the research questions. Through collaboration and interactions knowledge was constructed.

3.10 Data analysis

"Qualitative data analysis involves organizing, accounting for and explaining the data; in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities" (Cohen *et al*. 2011, p. 537). Bogdan and Biklen (2007) describe data analysis as the process of arranging data, writing in codes and themes to develop some outcomes. Drew, Hardman and Hosp (2008) agree that qualitative data analysis uses "words to isolate themes and identify trends". The data from this study was analysed by carefully obtaining, organizing, coding and establishing themes and patterns that emerged from the multiple methods of data collection.

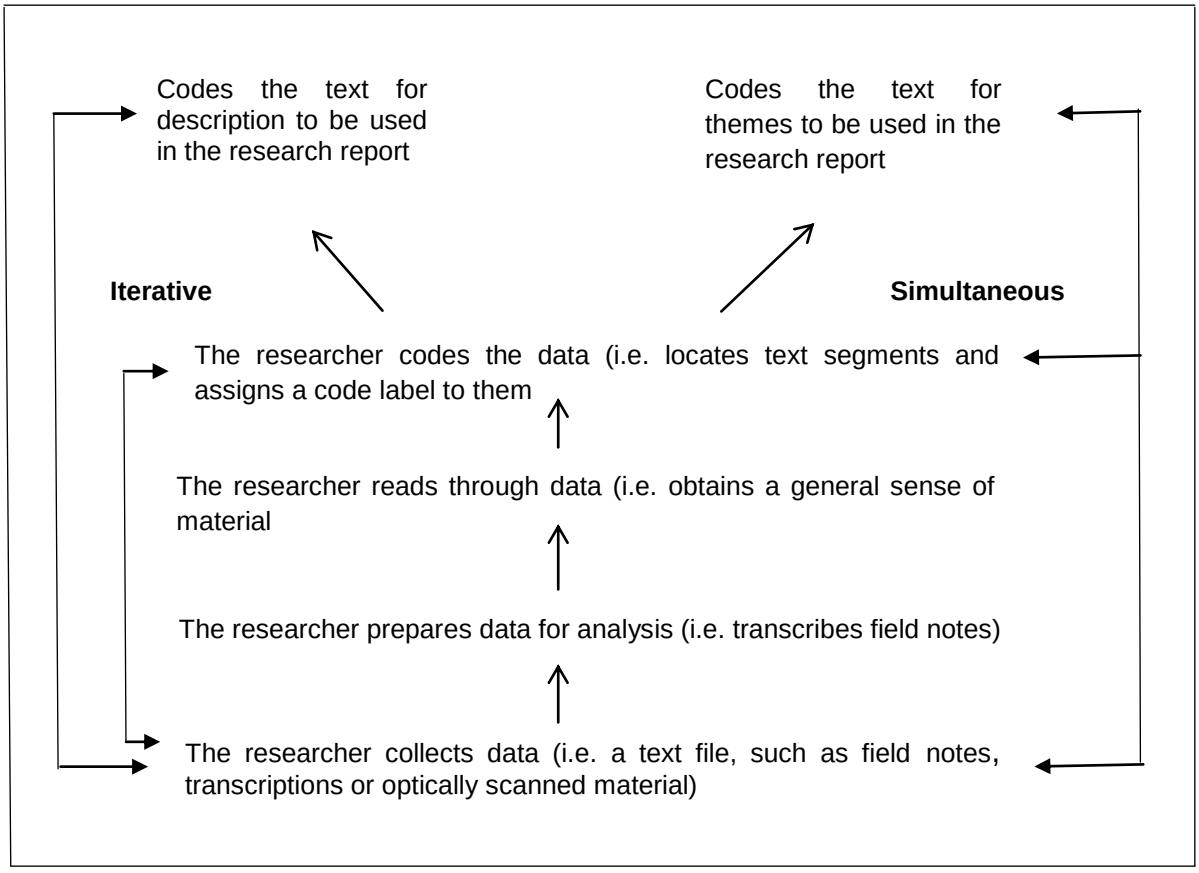

Figure 9: Diagrammatic representation of data analysis

Adapted from Creswell (2012, p. 237)

Figure 9 shows that data analysis is not a one-way process; it goes back and forth in order to conceptualize the eventual outcome that is trustworthy. Creswell (2012, p. 238) presents the procedure as “inductive”, “iterative”, “eclectic” and “interpretive”. Data analysis entails working from specific sets of data to develop general codes and patterns.

Data was obtained from focus group interviews, individual interviews and reflective diaries. All interviews were audio-recorded which “frees the interviewer to concentrate on the topic” and allowed for the “words, tones, pauses” of the participants to be captured and played over and over again as required (Kvale & Brinkmann, 2009, p. 179). The focus interviews were conducted at separate times and I started transcription during the interview phase. I listened and re-listened to the recorded interviews in order to obtain the words and phrases expressed. Data transcription is described by McMillan & Schumacher (2010, p. 371) as a way of translating data into “format that will facilitate analysis”.

The interviews were transcribed word for word and transcripts were prepared for each interview. I read the transcripts repeatedly to understand the participants’ views in relation to answering the research questions of the study. The reflective diaries were read several times to depict the insights expressed in the text data. All the data was “reduced” according to Miles and Huberman (1994, p. 10) to see how they articulated their views and challenges and what enabled them to learn to teach EE.

Coding refers to relating standardized remarks made in transcripts and grouping them together into sections (Adler & Clark, 2008). I adopted the “open-coding” approach where “concepts” are used to convey the information derived from the data collection methods (Flick, 2006, p. 297). Open-coding was accomplished using “line-by-line and phrase by phrase” technique (Cohen *et al.* 2011, p. 561). The participants’ experiences of learning to teach EE in relation to the research questions were categorized and coded. Interview transcripts and the reflective diaries were reviewed to derive this information.

Themes appear when similar segments or codes are merged together (Creswell, 2012). In this process, pointless and repeated codes were also eliminated to generate an accurate summary of the dataset. Roulston (2010, p. 150) describes

thematic analysis in qualitative approach as “sorting and classifying codes into groupings or clusters”.

Miles and Huberman (1994, p. 11) write that “displaying coded data” will enhance the researcher’s findings. After coding the transcripts and reflections of the participants, I displayed and organized the codes into themes according to Research Questions One, Two and Three respectively.

Interpretation of qualitative data is authenticating and then making inferences (Adler & Clark, 2008). After meticulously establishing the themes, I interpreted and made sense of the data based on how the “research questions were answered, personal reflections and literature reviewed” (Creswell, 2012, p. 257).

3.10.1 Content analysis

Content analysis was used to analyse the data. Krippendorff (2013, p. 24) defines content analysis as a “research technique for making replicable and valid inferences from texts to the contexts of their use”. This resonates with the views of Cohen *et al.* (2011, p. 564) that describe content analysis as the process by which scripted data are summed up and reported. The authors add that this involves “coding, categorizing, and comparing text” after which “themes” are put together using substantive expressions from the transcripts before arriving at the findings.

The data generated were obtained through multiple methods of data collection, and transcribed into text form which could be verified by the participants, thereby allowing for re-analysing and replication if necessary. The flexibility allowed by content analysis which makes re-analysis possible, renders this method of analysis apposite in this study.

3.11 Rigor of the research

The quality of the research can be evaluated by two constructs which were validity and reliability.

3.11.1 Validity

Validity refers to the “degree of congruence between the explanations of the phenomenon and the realities of the world” (McMillan & Schumacher, 2010, p. 330).

It is the extent to which the findings of the research reveal shared significances between the participants and the researcher *(ibid).* Validating findings, according to Creswell (2012, p. 259) requires the researcher to decide the "accuracy or credibility" through "triangulation and member checking". Validity is vital to a good research; the whole study will be worthless if a portion of it is unacceptable (Cohen *et al*., 2011).

The study sought to provide answers to the three research questions based on the perceptions of 25 pre-service science teacher participants about their learning to teach EE in Natural Sciences. I systematically and thoroughly analysed the data obtained from the participants in relation to the theoretical framework of the research which was based on the Vygotsky's Zone of Proximal Development. I employed the use of multiple data collection strategies and instruments, namely, reflective diaries, focus group interviews and individual interviews (face-to-face). Themes and patterns emerged from the various sources which ensured triangulation of the datasets. The analysis and report were also verified by the participants to corroborate the study as a true reflection of their insights.

3.11.2 Reliability

Reliability refers to "dependability and consistency" (Neuman, 2006, p. 196). Neuman argues that qualitative researchers involve the use of several methods of collecting data because obtaining information is collaborative between the researcher and participants. The term reliability also refers to trustworthiness, regularity and repetition of study over time, over instruments and over clusters of participants (Cohen, 2011). Kvale and Brinkmann (2009, p. 245) state that reliability "pertains to consistency and trustworthiness of research findings". They explain that if other researchers carry out the same study with the same participants, the findings should be similar. To maintain consistency in research, leading and ambiguous questions must be avoided during interviews *(ibid).*

The study used unambiguous questions in the focus group interview schedule, the individual interview schedule and the reflective diary (see Appendices 3, 4 and 5 respectively). The pilot study facilitated greater clarity of the questions in the instruments. The use of multiple data collection and triangulation contributed to reliability and validity of the findings of this study.

3.12. Ethical issues

Ethics refers to “mutual trust, acceptance, cooperation, promises and well acceptable conventions and expectations between all parties involved in a research project” (Strydom, 2011, p. 113). According to Kvale and Brinkmann (2009), the decency in terms of how human beings live, reason and behave is termed ethics. Neuman (2006) writes that ethical consideration requires researchers not to disturb the lives of people (respondents in a study) at the expense of advancing the body of knowledge. My study took into consideration a number of ethical issues in order to respect the dignity of all concerned.

3.12.1 Permission to conduct study

Wiersma and Jurs (2009, p. 436) explain that it is important to “obtain permission from the site’s gatekeeper” when carrying out research in an educational environment. I applied for the ethical clearance from the Human and Social Sciences Ethics Committee of my university. This ethical clearance application was approved (see Appendix 1). Thereafter, I wrote letters to the gatekeepers of Rudacoast University for permission to conduct my research. The permission was obtained in writing from the Dean and Cluster Leader to carry out the study. They were the gate keepers in the School of Education where the study was conducted.

3.12.2 Informed consent from participants

“Consent involves the procedure by which an individual may choose whether or not to participate in a study” (Drew, Hardman, & Hosp, 2008, p. 57). Participants were informed that their participation was on a voluntary basis, and that they could withdraw from the study at any time without negative consequences. I prepared informed consent letters (see Appendix 2) for all the participants which they read and understood before participating in the study.

3.12.3 Anonymity and confidentiality

The locations and names of individuals that participate in research should not be disclosed in printed publications (McMillan & Schumacher, 2010). The details should be anonymized to maintain the participants trust. Kvale and Brinkmann (2009, p. 72) concur, stating that “participants’ right to privacy” must be guaranteed.

Anonymity was assured in the letters to the gatekeepers and participants. The settings and participants' details were not mentioned in my dissertation, and pseudonyms were used where necessary and appropriate. Codes were employed to protect the identities of my participants when writing the dissertation report. The participants were also not exposed to threat or duress during the study.

3.12.4 Data use and disposal

The research data will be stored for a minimum of five years in a secure location agreed to by my supervisor. This will be in the university at which I was registered during this study. Disposal of all transcripts will be accomplished by shredding using a shredding machine and by incineration of audio tapes after 5 years. This commitment was made in writing to the gatekeeper and the participants.

3.13 Limitations of the study

Maxwell cited by Cohen (2011, p. 236) states that "some participants may feel uncomfortable during interviews and formal verbal communication". A few of the participants were shy during the focus interviews. The use of reflective diaries helped to address this as it deals with their personal introspections. Also, the study was conducted in only one university and the findings would be relevant and limited to that context.

3.14 Conclusion

This chapter focused on the research methodology I used for this study. The interpretive paradigm and case study approach were adopted. Details of the design, sampling and data generation techniques were explained and justified. I provided an account of triangulation, data analysis and the rigour of the research were done. Finally, the ethical considerations and limitations of the study were described. The following chapter will centre on the presentation and analysis of the data that emerged from this research.

Chapter 4

Data Presentation and Analysis

4.1 Introduction

In this chapter, analysis of the qualitative data generated through focus group interviews, individual interviews and reflections is presented. In order to explore the views of pre-service science teacher participants about how they learn to teach EE, responses that were related to the research questions were analysed.

4.2 Data presentation and analysis

Several methods were used to generate data. First, students worked in groups to research, prepare and present lessons on EE in a microteaching setting. Table 3 shows the details of the groups and the lessons' topics which were presented.

Table 3: Microteaching: Participants and Topics

Group Number	Number of members	Topic presented	Grade lesson was intended for
1	5	Medicinal Plants	9
2	5	Sustainable use of resources (Plants and animals)	8
3	5	Effects of human development in an environment: Acid rain	6
4	5	Biodiversity: Importance of conserving biodiversity	5
5	5	Human impact on the composition of the atmosphere: Global warming and Climate change.	9

Although these lesson plans and presentations were not admitted into the data set, participants' reflections on these were captured in focus groups interviews, individual interviews, and reflective diaries which contributed to the data.

Second, focus group interviews were conducted with the groups of students, mentioned in Table 3. Third, individual interviews, based on responses generated

during focus group interviews, were conducted. Finally, reflective diaries which were maintained by the participants were admitted as a data set.

The above research methods and instruments were used to generate data in response to the three critical questions which were central to this research, namely:

Research Question One: *What are pre-service science teachers' views about teaching Environmental Education in the Natural Sciences classroom?*

Research Question Two: *What are the challenges which pre-service science teachers experience when they learn to teach Environmental Education?*

Research Question Three: *How do pre-service science teachers address these challenges and what enables them teach EE?*

Themes emerged from the data through inductive analysis to provide a rich description of the views of participants. The views related to how the trainees learned to teach EE in Natural Sciences in the intermediate and senior phases of the South African education system. Direct quotations from the participants' responses were presented in substantiation of the emerging themes. Finally, the literature review and associated theoretical framework was presented in support of the emerging themes. The classification of the themes was according to the specific research questions.

The following abbreviations will be used to distinguish among data from different sources:

Focus Group Interview – FGI

Individual Interview – II

Reflective Diaries – RD

Group One – G1

Group Two – G2

Group Three – G3

Group Four – G4

Group Five – G5

Participant – P

An example of a code for the participant is:

FGI-1 P2: Focus Group Interview, Group 1, Participant 2.

II-1 G2: Individual interviewee 1, Group 2

A detailed description of the findings related to the research questions follows. The themes were not mutually exclusive and several elements are common.

4.3 Research Question One: What are pre-service science teachers' views about teaching Environmental Education in the Natural Sciences classroom?

Three themes emerged from the data with respect to this question. They are:

Theme One - Views of EE as important due to human dependence on the environment.

Theme Two – Views of EE as important due to the need to transform societies.

Theme Three – Views of global environmental challenges.

4.3.1 Theme One

- Views of EE as important due to human dependence on the environment.

The dependence of human beings on the environment was underscored by most of the participants. The following data from focus group interview transcripts attest to this:

I will also say yes because hmm … the environment itself is very important; as people we entirely depend on the environment, so they (learners) have to know about environment. (FGI-1 P2)

I think it is very essential that EE is taught in our schools (primary and high schools) because learners need to understand that we mainly depend on environment for many things such as food, water, shelter which we are given by the environment … so if they decide to deplete the environment such as you (Mr Oluwakemi) mentioned wetland; wetlands are a source of food to other people so if it is depleted, that means other people will be hungry and that will be the end of this generation. (FGI-2 P2)

I am partly covered (others had spoken his mind) … Oh but hmm … just to add on that, it is important to talk about our environment because we depend on it … and other organisms also depend on it; let's say if we pollute the water, then the fish will have no habitat or habitat will be destroyed for them and it will be important to take note that if we continue to destroy … like say we litter plastics and stuff and things that are not recyclable … if we do that, we actually hmm … destroying our environment. (FGI-2 P4)

Imagine we didn't have plants … if all plants went extinct, what will happen in our planet? We are all dead … we don't have oxygen, we don't have food … some animals which are vital to our ecosystem will go extinct because they do not have food. (FGI-1 P4)

Similar views were offered by participants during the individual interviews to indicate that teaching EE is important because human beings rely on the environment for survival. The following evidence from the individual interview transcripts attests to this:

EE is very important … It is now even more important as I have said last time … the… the … research also revealed that we are facing another major extinction, so imagine if we can't teach our learners about environment, what is going to happen? What is going to happen to our environment? So we are entirely depending on the environment for our survival as well so it is very important that we teach EE. (II-1 G1)

… the importance of maintaining the earth's biodiversity and all that, it can be linked with general cultural issues such as having herds, ducks, sheep and all those animals … pigs which traditional people usually kept and herded for the majority of the day, so they kind of show that the traditional people actually value the diversity of species and plants … because they planted all sorts of things; crops and all that (II-5 G4)

The participants were of the view that human beings, as well as plants and animals rely on the environment for their existence. Pre-service teachers in this study believed that it is essential for learners to be taught EE, because learners have the potential to make a tangible difference by maintaining the earth's biodiversity and

preventing destruction of wetlands as well as species extinction. These views resonate with those of Loubser (2005) who argues that the environment is made up of different creatures and non-living things with human beings at the heart of the system. Rudd (2006) highlights the usefulness of wetlands, for instance, to humanity which include homes and food for aquatic organisms, water quality enhancement, use for activities that renew our strength, training and inquiry. The submissions of the scholars are similar to the participants' position because a disruption in the food chains and food webs in the ecosystem will negatively affect human beings.

4.3.2 Theme Two

- Views of EE as important due to the need to transform societies.

The need to care for and conserve the environment cannot be overemphasized according to the participants, who stressed its relevance in the midst of a myriad of environmental challenges. Participants were of the opinion that mitigating the negative effects of environmental crises cannot come at a better time than now. Data generated from the focus group interviews confirmed this:

Ya like right now we are only being told about things that we are doing that are harming the earth … that you know, that leads to its destruction. So teaching about it, it gives you ways that you can actually implement which is essentially going to lead to the sustenance of the earth. (FGI-5 P1)

We as teachers (future teachers) have to teach them (learners); we have to make sure that they understand and they know about the environment and how to take care of it and the advantages of taking care of the environment … so they have to know. (FGI-1 P2)

Yes it is valuable, I think the most important thing to consider is that hmm … we are experiencing climate change, global warming and it is important for the learners to understand the importance of hmm … the environment and what we human beings can do to save our environment and maybe hmm … deal responsibly with the problem of global warming. (FGI-4 P1)

Let's look specifically to the topic we just did, which is global warming, we looked at how human activities actually contribute to global warming and how our

actions are actually … global warming is actually the result of our actions … so by teaching about EE, you can actually instil an awareness in learners and from there they will be able to take this valuable knowledge and like change their habits which will ultimately improve the environment conditions or counteract the previous effects (negative effects). (FGI-5 P1)

Research reveals that learners develop positive attitudes such as feelings for other organisms, feelings of obligation and appreciation of the natural world when they participate in environmental study activities (Cheng & Monroe, 2012). They assert that learners will have empathy for the environment when they have the knowledge. Yavetz, Goldman and Pe'er (2014) also argue that the ability of learners to comprehend the term 'environment' can add to more effective EE. These views were apparent in the expression of the participants who felt that making learners knowledgeable about the environment will help conserve the environment.

The participants agreed that ways of mitigating natural disasters like global warming can be achieved if learners are made aware of these catastrophes. Mitigating climate change can boost agricultural production and reduce crop failure through reducing the emission of greenhouse gases by carbon dioxide (CO_2) sequestration, and the quality of water and soil resources are maintained (Haris, Chhabra, & Biswas, 2013). According to the International Federation of Red Cross and Red Crescent Societies (IFRC, 2005), between 1995 and 2005, climate change has caused 90% of weather-related natural disasters like flooding and droughts and developing countries are the most affected.

Furthermore, the necessity to preserve the environment also emerged during the individual interviews with most of the participants acceding to that fact, as is evident in the following excerpts:

I think it has been very enlightening, you know … something we just take for granted and we don't think we can fix it ourselves but now that I know that if there is a problem and there is something you can do about it and if you know who to go to on what to do, I think you can actually fix it to save the earth … it's a lifelong process and by doing that, we are … what's this … hmm … principles of the curriculum … of CAPS, that talks about how they want learners to be responsible citizens … I think

this is it… this is how you can be responsible citizens to your country and be faithful to this earth by giving it back what it deserves. (II-2 G1)

… as I said before, you have to act it in your community and then that can help the learners as they grow to know what to do as the citizens of that society or of this country. So I've learnt so much and hmm … there was so much I wasn't aware of … but right now I am aware as I am going to teach next year (2015), I will make the difference. (II-4 G3)

Participants saw the need for EE as a vital pedagogical component in Natural Sciences in order to have environmentally literate citizens in South Africa. Citizenship, they echoed, relates to environmental responsibility, lifelong learning and commitments to the society. UNESCO (1977, p. 19) asserts that "EE is a lifelong process and should not remain confined to the schooling system". The body reiterates that the content of EE must cut across both conventional and non-conventional activities of human endeavours. The City of Cape Town (2011) contends that all social, ethnic and economic groups have lifelong benefits from EE and it is important everyone participate in the campaign of taking care of the earth.

Pre-service science teachers who participated in this research also reflected on the care, conservation of the environment and mitigation of environmental crises. They expressed that learners should be skilled in the issues of the environment in order to be proactive and know about the care, preservation and prevention of challenges facing our natural world. These insights were supported by several entries in the reflective journals. The following diary excerpts attest to this:

EE is valuable in creating awareness in learners which ultimately may lead to them changing their activities to improve and counteract the harmful effects on the environment. (RD G5)

It is valuable in that learners are instilled and equipped with the knowledge and skills to help eradicate environmental problems. (RD G2)

Learners should be allowed to be in close contact with nature. They should be involved in environmental campaigns and nature conservation should be a lifestyle in and out of school. (RD G4)

It is very important so that learners will be able to know how to preserve the earth and not add on the damage that already exists. It will teach learners the importance of how to take care of the environment. (RD G3)

The perspective of the participants concerning care and conservation of the environment coincides with the words of Maathai cited by Kabiru (2011, online): “We owe it to ourselves and to the next generation to conserve the environment so that we can bequeath our children a sustainable world that benefits all". Maathai cited by Kabiru (2011, online) argues that it is a responsibility that everyone participates in this conservation effort. This resonates with the views expressed in the White Paper on Education and Training (South Africa, 1995) which stresses that EE must cut across various fields of study. The White Paper on Education and Training (South Africa, 1995) underscores the value of participatory methods in all spheres of education and training in order to produce South Africans who will delight in a pleasant existence through the sustainable utilization of the earth’s natural endowment.

4.3.3 Theme Three

- Views of global environmental challenges.

Environmental crises related to climate change, carbon footprint, wildlife conservation and environmental degradation are some of the issues confronting the global society, which were alluded to by the participants. The following data from the focus group interviews corroborates this:

We learned along the way that some habitats and ecosystems are being destroyed such as the one in Ukraine … in hmm … American Indian tribe, we learnt that in Natural Sciences 110 (a content module taken in year 1 in the university) and so which shows that EE teaches people to sustain the environment and be eco-friendly and illustrated examples of where people who weren’t eco-friendly and all that didn’t survive because their environment fell apart which is what will eventually happen to the earth if we continue to abuse our environment and neglect teaching EE. (FGI-4 P3)

Ya like right now we are only being told about things that we are doing that are harming the earth … that you know that leads to its destruction. (FGI-5 P3)

Yes, because learners have to know about the purpose of the environment, how to care about it, know about issues related to environment like pollution, acid rain, global warming … so they won't burn hmm … wood for nothing because it produces gases into the air that pollute the air. (FGI-1 P1)

The participants acknowledged that the challenges of the environment were not localized to certain parts of the world but cut across nations. The whole world is experiencing the negative impact of the issues and no country is spared. The Natural Resources Defense Council (NRDC, 2014) concludes that climate change is the greatest environmental and humanitarian issue affecting us currently. Le Grange, Reddy and Beets cited by Reddy (2011) concur that the natural world's crises are so critical that many will agree that the ecological catastrophe, such as climate change, is felt across all nations including local communities.

Some participants indicated that there were environmental crises which informed their emphasis on the importance of instilling in learners the need to be environmentally conscious. The following data from the reflective diaries attest to this:

It (EE) can influence behaviour in a way that the learners will better understand the environmental issues. (RD G3)

It (EE) helps us try and look for solutions to problems that we face globally such as global warming. (RD G2)

The understandings of the participants in this study confirm their concerns about environmental crises which abound at the present time in our world. The pre-service science teacher participants' view that sound teaching and learning process grounded in environmental knowledge will save our planet was also evident. Janse van Rensburg (1994, p. 4), argues that, "environmental education is widely regarded as a key response to the environmental crisis". This assertion relates with the participants' unequivocal position about the importance of teaching EE in the Natural Sciences classroom. However, the pre-service teachers in this study did raise several challenges which were associated with learning to teach EE, as is reflected by responses to the second research question.

4.4 Research Question Two: What are the challenges which pre-service science teachers experience when they learn to teach Environmental Education?

Four themes emerged, namely:

Theme One – Integrating IKS and EE in Natural Sciences

Theme Two – Designing practical work on EE and lack of resources

Theme Three – Lack of adequate foundational EE knowledge due to limited exposure to EE of pre-service science teachers when in primary and secondary schools.

Theme Four – Inadequate opportunity for pre-service science teachers to experience learning to teach EE during Work Integrated Learning, WIL (Teaching Practice)

4.4.1 Theme One

- Integrating IKS and EE in Natural Sciences

The participants were required to integrate IKS in their teaching plans and lesson presentations during the research. This is in keeping with the CAPS policy requirement to teach about environmental knowledge which was constructed by our predecessors (DBE, 2011). The challenge of integrating IKS by pre-service science teacher participants while learning to teach EE in Natural Sciences was overwhelming because all the participants expressed their difficulties in this regard. This was confirmed in the focus group interviews and evidence from the transcripts reveals this:

Usually when we designed the lesson, we stick to the CAPS document, the curriculum document but we as teachers (trainees) are required to also include something about the indigenous knowledge; so stick to CAPS and follow the requirements that are on the CAPS document and also we have to go out of our way to include indigenous knowledge and it is a challenge to include it … we had to come up with strategies that will enable learners to understand the link between science and indigenous knowledge. (FGI-4 P2)

I comment that including indigenous knowledge is often a challenge as we experienced in this lesson. (FGI-4 P3)

Another thing … there was the point whereby they said we must link our lesson with IKS so it was difficult for us on how are we going to link our lesson with the… (FGI-3 P1)

I think one of the challenges was to … actually integrating the IKS … because even though we did do it, like I said our prior knowledge isn't up to date, we haven't really been exposed to much IKS … so to me I think that was a bit too difficult to relate it to our topic. (FGI-5 P3)

One of the general aims of South African curriculum states "Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution…" (DBE, 2011, p. 5). However very few books are available for university scholars and intellectuals on IKS (Kaya, 2013). Ismail (2013) also argued that pre-service science teachers lacked sufficient background and content knowledge of IKS. The difficulty experienced by the participants in this research calls for more attention to be paid to IKS promotion in the university Science Education curriculum before trainees become in-service teachers. This view resonates with that articulated by Ogunniyi and Ogawa (2008, p. 176) who assert that "…programmes in higher education (particularly those training teachers) will have to undergo substantial revision in terms of content and modes of delivery and this implies that teachers being trained in higher education should become: (1) knowledgeable about the Nature of Science and IKS; (2) well aware of the ways and means by which indigenous peoples deal with environmentally related problems; and (3) capable of inculcating in their learners the necessary knowledge, skills and values to manage their immediate environment". Virtually all participants in the individual interviews indicated their difficulty in integrating IKS with EE. The transcriptions corroborated this insight:

Okay... basically if you start off with IKS, we come to campus with a very limited understanding what IKS is, so that … that's our first struggle … cos we don't have a good base, ok. So when come … whatever we learn is new. (II-8 G5)

Hmm … well err … the challenges that we had are, firstly in that presentation, we had to integrate Natural Sciences with IKS. So from our background, as we (members of focus group) are from the rural schools (high schools)… all of us, we had a challenge of integrating that because before we've never had lesson integrating the two (Natural Sciences and IKS). (II-4 G4)

Mudaly and Ismail (2013) contend that IKS demands unrelenting research with regards to school and higher education syllabuses because it is still at an initial phase. These authors argue that many research studies have been conducted pertaining to how in-service teachers react to the changing curriculum in South Africa, but that there is a paucity of research concerning pre-service science teachers' views regarding the integration of IKS with the science curriculum.

Pre-service science teachers are required to be creative when incorporating IKS into the curriculum, and they have few resources to enable adequate accomplishment in this regard. Conceptualizing the inclusion of IKS with environmental science topics in Natural Sciences requires greater attention at higher education level, and the following excerpts attest to this.

Hmm … ya it was hard to integrate it with IKS because we were thinking of biodiversity and IKS so we thought of it to use the case study since they (learners) are still young, we used the case study … that they will read the case study that has the difference between the indigenous people on how they were acting towards biodiversity and the modern society; how are they acting towards biodiversity now…? Err … looking at the challenges and how that affects the biodiversity. (II-4 G2)

Participants also reflected on this challenge. Some expressed their difficulties which were documented in reflective journals as highlighted in the following texts:

Getting the essential resources and making links between the content, real life situation and indigenous knowledge and it requires a lot of preparation. (RD G4)

Finding information on this topic with regard to IKS was very challenging and even deciding on the manner in which to integrate and relate it to the lesson was difficult. (RD G5)

As the indigenous knowledge was included, because in previous years there were little pollutions that cause the environment to be polluted. (RD G3)

Maila and Seroto (2013) attest that educational experts have proposed the incorporation of locally developed knowledge into the curriculum of universities offering education courses in order to alleviate the challenges of environmental crises. They submit that the conventional science has been unable to solve the myriad of issues pertaining to the natural world *(ibid)*. The challenge expressed in this theme by the participants is an indication that university communities and providers of science education, in particular, should prioritize indigenous information as it relates to the environment alongside western science. The purpose of this is twofold: first, it enables teachers to teach to the CAPS curriculum and second, it fulfils the requirements of university curricula. Taylor and Mulhall (2001) contend that for instruction to be good there must be a proper connection among the school, family of learner and society. Each of these three environments produces its own experiences and it is only the integration that makes learning effectual.

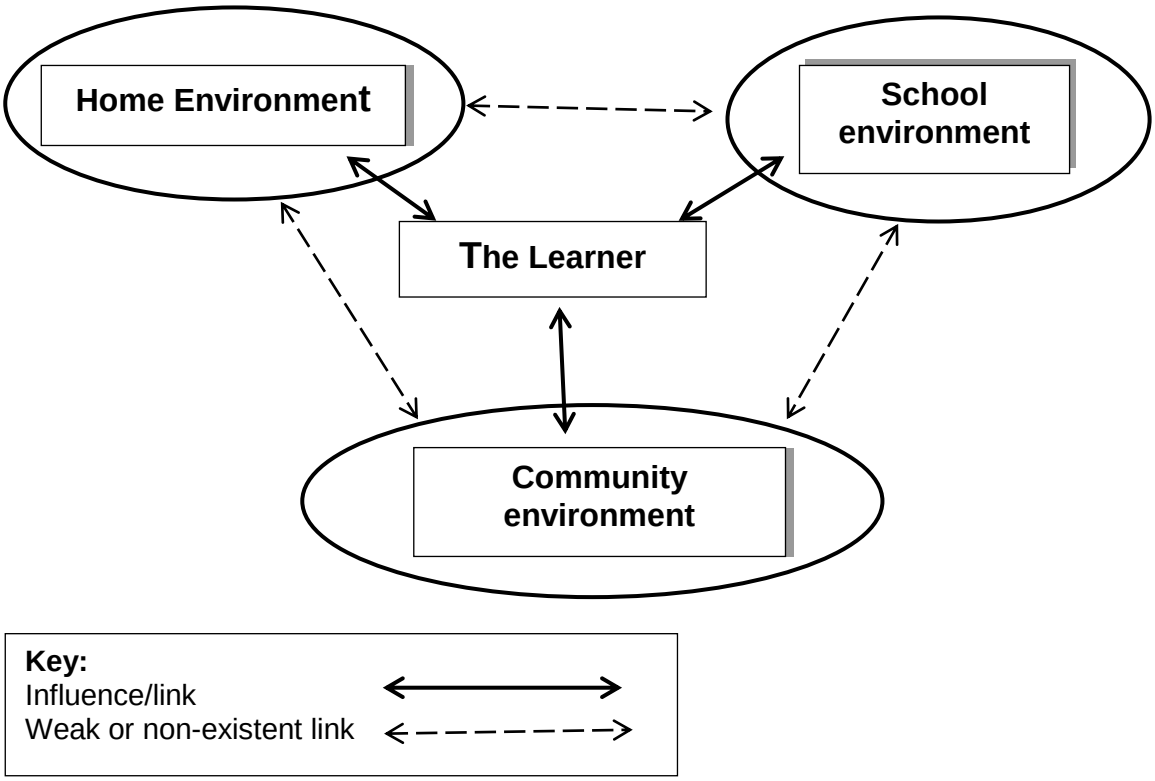

Figure 10: Linkages between school, home and community environments
(Taylor & Mulhall, 2001, p. 138)

Figure 10 shows the weak link between the three environments with the learner at the centre. Taylor and Mulhall (2001) describe the environment in the context of agriculture. I argue that agriculture is related to EE and that the older generations possess indigenous knowledge which is relevant to teaching and learning in the school. I contend that IKS influences the community and therefore the home environment in overt or covert ways. If there is no link, a learner may struggle to comprehend certain concepts in EE. I base this argument on the research conducted by Ogunniyi and Hewson (2008, p.173) which reveals that "teachers should be sensitive to the socio-cultural environment of the learners". The socio-cultural environment comprises culture in the community, the people and institutions like schools. The integration of IKS in science curriculum can enhance the understanding of the ways of mitigating environmental crises (Ogunniyi & Hewson, 2008).

Thus a weak link between the three environments (in figure 10) is likely to produce cognitive conflict when learners from non-western classrooms try to learn western science concepts. This can occur when learning in science classrooms takes place without consideration of learners' prior knowledge, some of which is embedded in IKS.

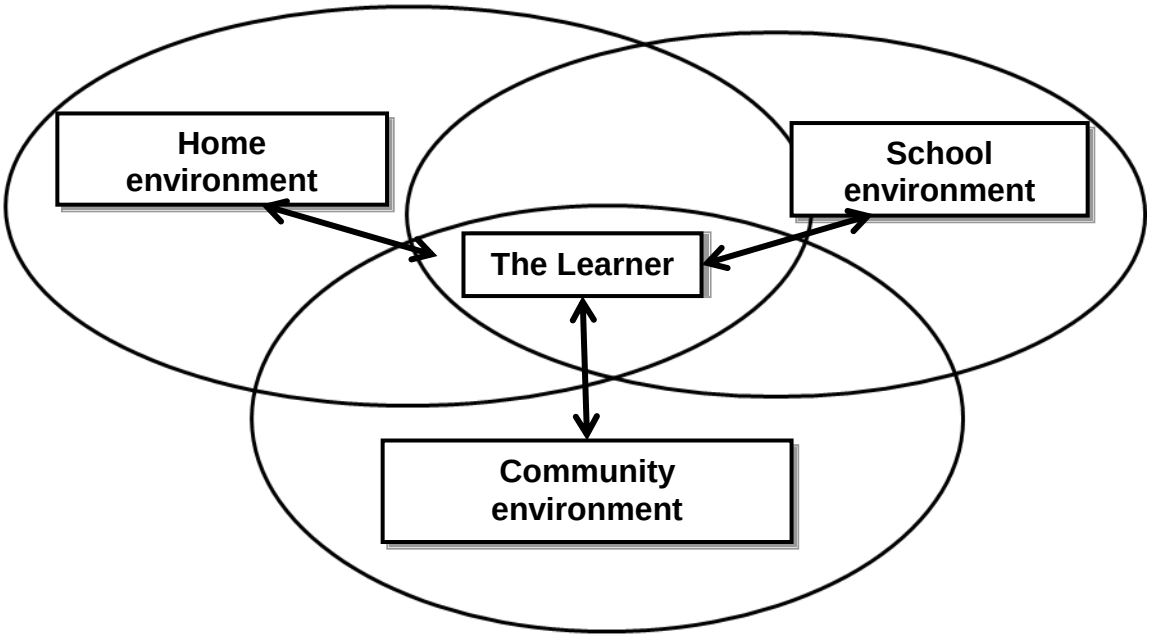

Figure 11: Linking the learning environments
Adapted from Taylor & Mulhall (2001, p. 138)

Figure 11 shows a connection between the three environments. Taylor and Mulhall (2001, p. 145) assert that if the teacher knows the indigenous knowledge possessed by learners, this can lead to the "development of appropriate teaching and learning methods and materials". Thus the lack of knowledge about IKS amongst the participants was a barrier because they found it difficult to articulate the local knowledge with the western science which affected their teaching methods and resourcefulness.

Ismail (2013) argues that the integration of IKS in the school's curriculum will enable the learners to link both local and western science together. This, the author believes, can enhance the performance in the subject. Reyes-García *et al.* (2010, p.305) contend that "contextualized learning and curriculum" according to the "indigenous environmental knowledge" will complement effective schooling for the learners in the community they are living.

4.4.2 Theme Two

- Designing practical work on EE and lack of resources

Pre-service science teachers voiced their concerns regarding designing practical work and obtaining resources while they learned to teach EE in Natural Sciences. Transcripts from the focus group interviews confirmed this:

When we came to planning our practical activity, we had a problem … a bit of problem there; our practical activity was mainly concerned with biodiversity … showcasing the biodiversity of the earth but then the problem is that we couldn't come up with err … an appropriate assessment for Grade 5 learners which made us shift to this practical demonstration. (FGI-4 P3)

In Natural Sciences, integrative approaches are often used in teaching and learning. Theory is linked to practical work and assessment. The participants in this study struggled to link these aspects effectively. Kibirige, Osodo and Mgiba (2014) reveal that in-service teachers are unwilling to do practical work for primary school learners because they are not well trained in both the procedure and assessment of practical work. This assertion resonates with the challenge the participant *(FGI-4 P3)* experienced which highlights the lack of preparation for practical activities.

It took us about 2-3 weeks to incorporate practical … practical aspect together with our lesson, the one that we have just presented. We had to think about the plants and we didn't obtain it here. (FGI-1 P4)

And the challenges that we faced, err … we faced a challenge maybe on designing a lesson; a practical lesson, that was a very difficult part because maybe it takes us a very long time to come up with this (acid rain) topic because we didn't know … because we looked at the main topic 'Effects of human developments on the environment', ok the topic was very easy but now we have problem when it comes to how are we going to construct a practical lesson for this topic (acid rain) but we ended up trying and we got this acid rain. (FGI-3 P2)

The problem could be the case of incorporating practical in this thing (microteaching), we don't know how to design the practical related to environmental

issues; it is not an easy thing to do … we don't know which one directly to use. (FGI-1 P3)

The Curriculum and Assessment Statements (CAPS) for Natural Sciences highlights in Specific Aim 1: "doing science" where "learners should be able to complete investigations, analyse problems and use practical processes and skills in evaluating solutions" (DBE 2011, p. 10). According to van Kerkhoff and Lebel (cited by Brundiers, Wiek & Redman, 2010, p. 310), practical knowledge competencies involve "linking knowledge and action for sustainable development" to bridge the "knowledge-action gap". This resonates with Brundiers, Wiek & Redman, and (2010) who state that teachers must have a sound knowledge in practical work because it is a requirement in planning and carrying out productive environmental programs at any level. However the pre-service teachers in this study, who will be future teachers, revealed that designing and incorporating practical activities in their EE lessons was a challenge. They struggled with conceptualizing and formulating practical activities that relate to EE and sourcing the necessary materials.

In addition, some participants shed more light on the challenges of designing practical and getting resources in the individual interviews, as is evidenced in the following excerpts:

So we mentioned that we had a difficulty in trying to put the practical together with our lesson just because we didn't have a resource which was an "Aloe" (Aloe Vera). One thing that we did was that one of our group members went to his home near the Nongoma area (about 303km away from campus) to get that Aloe because here in this campus we don't have that species. (II-1 G1)

… and then the other problem was that it has to be practical … hmm … when doing a practical we need resources, we don't have resources. (II-4 G4)

Designing gives teachers (trainees) a bit of a problem due to that you just don't know where to start … for example if you have to design a practical for the global warming, it is not an easy thing to do because you look at the resources first … ok, before you know the resources to use and you have to have an idea of what you want to use those resources for like the global warming when you speak of the heat, when you speak of the changes in the temperature of the earth on its own and

then take that and put in the lesson of the environment it is not an easy thing to just narrow it like that so I think it requires the teacher (trainee) to be a researcher … you know; a serious researcher in terms of what practical are available for such topics. (II-3 G2)

This challenge underscores the need for pre-service science teachers to be researchers. The participants were motivated to overcome challenges such as designing practical work and sourcing for teaching aids. Llewellyn and van Zee (2010) describe the "teacher researcher" alluded to in the previous excerpt, as a teacher who inquires, gathers information, interprets the data and collaborates with colleagues in order to facilitate instruction and learners' achievement. Pekarek, Krockover and Shepardson (cited by Loughran, 2007) argue that training teachers as researchers should be integrated in pre-service science teachers' curriculum.

In the reflective diaries, many participants revealed that designing practical work coupled with a lack of resources were issues they experienced while learning to teach EE. The following data attests to this:

Most topics do not have practical that can fit primary school teachers, they are broad and complicated for younger learners. (RD G2)

The CAPS curriculum for the intermediate phase (DBE) states that effective teaching and learning of Natural science must be embedded in "investigative and logical processes" based on hands-on activities. Practical work in science, according to Randler and Hulde (2007), increases the learners' knowledge and retentive capability. This method of teaching also sparks more enthusiasm amongst the learners who participate actively during science activities *(ibid)*. The reflection of participant (*RD G2)* showed that more attention is required in the area of practical work.

For the practical, it wasn't easy to do the practical for the learners. Here also we had to do more research on how to do practical on acid rain. (RD G3)

One of the challenges we experience as a group is that some medicinal plants are very difficult to obtain. To get them, you have to travel a lot before you can even obtain an access permit to obtain that plant. One of the major reasons why we

experienced this is because of human impact on the environment. Some plants have been destroyed. (RD G1)

Shortage of resources; Aloe, the plant we used is not available in some places … cutting Aloe to use it as medicinal plant damage the environment. (RD G1)

The inferences being made by these participants, who were 3rd year students, suggested that previous modules taken by them in the university had possibly neglected EE. The neglect, according to the participants had compromised their abilities to design follow through practical work, thus forcing them to become researchers. This brings in the concern of content and pedagogy in EE that needs to be addressed by the university community. According to Mellado, Blanco and Ruiz (1999, p. 274), pre-service science teachers must be proficient in "science practical work and methodological change". The authors affirmed that teacher trainees develop this skill as part of the competences required for a professional teaching career.

In the public schools however, in-service teachers find it difficult to handle practical work due to large and poorly equipped science classes. This is alluded to by Onwu and Stoffels (2005, p. 89) who state that in-service teachers "resort to lecturing and teaching" due to overcrowded classrooms and lack of science resources which is a setback to effective teaching. Thus the revelation of this problem calls for university teacher education to pay more attention to this challenge to prepare pre-service science teachers to go into the classrooms.

4.4.3 Theme Three

- Lack of adequate foundational EE knowledge due to limited exposure to EE of pre-service science teachers when in primary and secondary schools.

Some participants underscored their own lack of foundational knowledge due to limited exposure to EE while in primary and secondary school. The following data from focus group interviews attests to this:

Also I think when we were matriculated, there wasn't much focus on the environment itself, like the IKS and stuff, we haven't really been exposed to it as of now. (FGI-5 P3)

Sheya (2014) expounds that in-service teachers and subject advisers do not have adequate comprehension of EE together with IKS content. This was justified in this study by pre-service science teachers' claim about not being exposed to EE and IKS during their primary and secondary school days. The participants were not taught by their teachers and it has reflected in their experience as they learned to teach EE topics with IKS in Natural Sciences.

'It only took me learning about such issues (environmental issues) from Natural Sciences (at university) … to understand these issues. In the past, I would have rid (got rid of) the leaf of a tree without any problems but now I think before I do that which is why I think most learners in schools (primary and secondary) coming from background (rural) such as mine would discriminate the environment because they aren't aware … we weren't given the opportunity to learn about EE a lot in schools so if it is possible, EE could be focus (a focus) in our school teaching from now on giving everyone the opportunity to be aware. (FGI-4 P3)

I will regard to lack of knowledge. To be able to enjoy something that you teach, you have to know what you are talking about … like you have no knowledge of it, there is no way that you can understand … you gonna enjoy teaching that particular aspect. (FGI-5 P1)

The participants had inadequate disciplinary knowledge and they struggled to keep pace with the requirements of learning to teach. According to Cooper, Kenny and Fraser (2012, p. 1891) "the science background of pre-service teachers is a key factor because it may have an effect on their beliefs, attitudes and self-efficacy to teach science". This resonates with the views of the participants who felt that they cannot enjoy teaching what they were not well grounded in. Maila (2003) contended that teachers are incapable and not resourceful in EE due to lack of knowledge. Teachers in primary and secondary schools exclude some EE topics they do not find appealing in Natural Sciences (Mbokazi, 2009). This type of action puts the learners, who became pre-service teachers, at a disadvantage as expressed in this study.

Furthermore, the lack of foundational knowledge was also expressed in the individual interviews by some participants as evidenced in the following excerpts:

Hmm … with regards to lack of knowledge, I think on a broad scale, for me that was because of … we weren't really taught about it in school (high school), well overcoming that will be a big change in terms of the school curriculum; to incorporate it more into the school curriculum as was previously. (II-7 G5)

Ok … firstly at school (high school), we were generally exposed to the "banking" method, which is what we … where teacher stands there, you are empty vessel and they just give you all the information … so when we came to the university we were told that that is not what we are supposed to do, we are supposed to be more 'learner-centred' and we've learned the benefits of it being 'learner-centred' and I've witnessed the benefits of having a "learner-centred" lesson in which students (learners) were more enthusiastic and they pay more attention and they understand more and when you give then like a quick quiz at end, they are able to answer you because they were actually, actively involved in it and students (learners) are made aware that you know … it's not … they aren't empty, they actually know what you are talking about. (II-8 G5)

The preceding excerpt points to the nature of process of learning. Teacher centred plus subject centred pedagogy were the dominant experiences of some participants and this negatively affected their ability to learn to teach EE.

The issue of pedagogy and active knowledge construction was noted from the views of the participants. They expressed that their school teachers were simply transmitting knowledge and the teachers used a teacher-centred approach rather than a learner-centred method of teaching and learning process. Freire (1968) cited by (Maylor, 2012, p. 24) expounds that "education… becomes an act of depositing, in which the students (learners) are depositories and the teacher is the depositor. Instead of communicating, the teacher issues communiqués and makes deposits which the students (learners) patiently receive, memorize and repeat...." He contends that learners are not imparted with useful knowledge thereby becoming uninspired in a "misguided system". Participants' views that teaching should be more learner oriented was echoed as this will inform the teaching and learning methods that will be suitable for the learners. This reinforces the essence of participatory learning as crucial in laying a solid EE foundation in Natural Sciences.

Learner-centred pedagogy is an intrinsic feature of constructivism, as a learning theory. Consideration of learners' prior knowledge, and building new concepts on existing knowledge, is important in constructivist learning environments. The use of multiple strategies and diverse learning aids to enable learners to actively construct knowledge is advocated. This study reveals the shift in thinking about how to teach. Participants realised that they should not teach in the same way that they were taught at school. Instead, they viewed active engagement in knowledge as critical to the learning process.

The issue of misconceptions and lack of knowledge with regards to environmental topics raises many concerns. According to Khalid (2003) pre-service science teachers who will be teaching in the future are often not fully prepared to teach abstract environmental concepts in the classrooms. This is due to lack of full understanding of certain science-related matters. Khalid (2003) argues that science teachers should deliberate about this state of affairs and ways of rectifying it. Esa, (2010) asserts that pre-service science teachers lack proficient knowledge to teach skilfully. The author affirms that many learners and teachers do not possess adequate EE disciplinary knowledge. This view resonates with that of Yavetz Goldman and Pe'er (2014) that while in-service teachers, notwithstanding their major, recognize the value of EE, they cannot display enough knowledge of the concept 'environment'. The challenge of poor foundational knowledge is a contributory factor to the level of competence of teachers, and this was revealed by the pre-service science teachers who participated in this study.

4.4.4 Theme Four

- Inadequate opportunity for pre-service science teachers to experience learning to teach EE during Work Integrated Learning, WIL (Teaching Practice)

Participants' challenges were also exacerbated by the lack of experience in workplace integrated learning settings. The lack of opportunities for most participants to experience learning to teach EE during Teaching Practice (TP) was highlighted and the following data from the focus group interviews showed this:

I have never got a chance to teach about EE (during TP) but I enjoy learning to teach it. It is something that the learners know … something that happens in our local communities … they (learners) are exposed to the plants. (FGI-1 P1)

One of the problems confronting the teaching and learning process in South Africa is the "lack of access to quality Teacher Education Development (TED) for prospective and practising teachers" according to DHET (2011, p. 1). One of the ways of improving this is by "strengthening the teaching practice/school experience component of teacher education programmes…" (DHET, 2011, p. 32). The purpose of workplace integrated learning is to avail pre-service teachers with the opportunity to apply knowledge gained from the university into praxis and also become skilled while working with experienced in-service teachers (Nelson Mandela Metropolitan University [NMMU], 2013). In some instances, participants were completely denied the opportunity to teach EE, as is evidenced in the following excerpt:

In fact, during our teaching practice, we don't … I don't think we get an opportunity to teach these things like EE in Natural Sciences … so I haven't yet experienced how to teach EE in NS…. (FGI-1 P4)

At Rudacoast University, pre-service teachers go to schools to engage in Teaching Practice between July and August. This period is the Term Three of the South African school calendar and according to the CAPS curriculum, learners in Grade 8 are scheduled to study the 'Energy and Change' strand (DBE, 2011, p. 14) during this time. This prescription by the policy document does not afford pre-service science teachers the opportunity to practice teaching EE topics in Natural Sciences (DBE, 2011, p. 14) which compounds the challenge of receiving the opportunity of learning to teach EE. The topics and times when these are expected to be taught, as prescribed in the curriculum document, are presented in Table 4.

Table 4: Summary of syllabus and year plan for Natural Sciences, Grade 8
DBE, (2011, p. 14)

GRADE	TERM 1: LIFE & LIVING		TERM 2: MATTER & MATERIALS		TERM 3: ENERGY & CHANGE		TERM 4: PLANET EARTH & BEYOND		TOTAL
	TOPIC	WKS	TOPIC	WKS	TOPIC	WKS	TOPIC	WKS	
8	• **Photosynthesis and respiration** - Photosynthesis - Respiration • **Interactions and interdependence within the environment** - Introduction to ecology - Ecosystems - Feeding relationships - Energy flow: Food chains and food webs - Balance in an ecosystem - Adaptations - Conservation of the ecosystem • **Micro-organisms** - Types of micro-organisms - Harmful micro-organisms - Useful micro-organisms	2 5 2	• **Atoms** - Atoms – building blocks of matter - Sub atomic particles - Pure substances - Elements - Compounds - Mixtures of elements and compounds • **Particle model of matter** - The concept of the particle model of matter - Change of state - Density, mass and volume - Density and states of matter - Density of different materials - Expansion and contraction of materials - Pressure • **Chemical reactions** - Reactants and products	2 5 1	• **Static electricity** - Friction and static electricity • **Energy transfer in electrical systems** - Circuits and current electricity - Components of a circuit - Effects of an electric current • **Series and parallel circuits** - Series circuits - Parallel circuits - Other output devices • **Visible light** - Radiation of light - Spectrum of visible light - Opaque and transparent substances - Absorption of light - Reflection of light - Seeing light - Refraction of light	1 3 2 3	• **The Solar System** - The Sun - Objects around the Sun - Earth's position in the Solar System • **Beyond the Solar System** - The Milky Way Galaxy - Our nearest star - Light years, light hours and light minutes - Beyond the Milky Way Galaxy • **Looking into space** - Early viewing of space - Telescopes	3 3 2	34 weeks

The inopportune time to teach EE is evident in the following response:

EE hmm … is a bit difficult to apply in real schools (primary and secondary) rather than when you practice it here (in the university) … when you are doing your degree, from my experiences during my teaching practices. You actually found out it was really hard to incorporate it because the time frame you are working with and all that … and sometimes the resources … although it could be the teacher's responsibility to get the resources; in the real world, it is not really many things that most teachers (in-service teachers) in many schools focus on because it is very difficult to teach in schools … it's very difficult to teach. (FGI-4 P3)

Similar views were offered by participants who were part of the individual interviews and the following evidence from the transcripts attest to this:

… Ok, before studying Method 2 (NSM2), hmm … practical work was just ok … I'll do practical at the of university and then am done … so that's just what I was just thinking about because in my teaching practice; I did 2 teaching practices and I never did practical work … I was just teaching theory but now I have an idea that when you are doing the practical, you just make things clearer for your learners; they will explore what you were teaching them as theory and then they know ok this goes this way and then this goes this way … that's all you should do … not just theory, theory … it just confuses them and then they put their knowledge just for examining purpose. (II-4 G4)

I think before NSM 2, I was focusing on theory … it was just the theory part, maybe if I could show the something I could (learning how to teach EE/teaching practice), if I could make them (learners) do something I will. I really didn't see the importance of learners actually meeting especially 'Specific Aim 1' which is investigating phenomenon in Natural Sciences. Now I have learnt to incorporate it at all times just to accommodate the multiple intelligence in the class. (II-2 G1)

In the senior phase it is not easy to put learners in groups because they tend to play and forget about the focus of the whole lesson but I have used the grouping method (EE teaching approach) in the FET phase taking Biology (Life Sciences); the learners were supposed to design a chart and present it and then it worked because those are matured … No, I haven't (used the method in the senior phase) and usually the classroom (class size) is large; about 50 learners … It might not because they are too many … at one of my teaching practice; I had 60 learners in Grade 8 in a township school around here [university]. (II-3 G3)

The Council on Higher Education of South Africa (CHE, 2011) explains that Workplace Integrated Learning (WIL) allows for the incorporation of the content knowledge of a discipline and practice. The practice is undertaken at the workplace where students in the higher institutions acquire real life experience while applying their disciplinary knowledge and skills thereby building self-efficacy (ibid). Okanlawon (2014, p.107) reveals that pre-service science teachers "demonstrated proficiency in reinforcing learning, managing of classroom and understood learners' development"

after undergoing Teaching Practice (TP) at schools. The importance of TP is crucial to learning to teach EE, as expressed by the participants. They discovered that EE comprises practical work and other pedagogical skills which could be acquired when situated in the schools.

The preceding excerpts provide valuable insight into pre-service teachers' understanding of the value of creating opportunities for practical work for their learners within school settings. These pre-service teacher participants exhibited many strategies which they designed to address challenges related to learning to teach EE; this was revealed in their responses to Research Question Three.

4.5 Research Question Three: How do pre-service science teachers address these challenges and what enables them to teach Environmental Education?

Five themes related to Research Question Three emerged:

Theme One – Collaborative learning with peers

Theme Two – Independent research; the use of digital technology (internet), and different human and material resources.

Theme Three – Improvisation, resourcefulness and creativity

Theme four – Going on field trips and engaging in outdoor activities related to EE

Theme five - The use of CAPS curriculum and its implementation as it relates to EE in Natural Sciences.

4.5.1 Theme One

- Collaborative learning with peers

Collaborative learning was overwhelmingly expressed by all the pre-service teachers who took part in this study. This was corroborated by the transcriptions from the focus group interviews shown below:

Don't feel scared to ask anyone, collaborative learning … all the way, share ideas. (FGI-5 P2)

And then again you've got to go and choose the most suitable one among ourselves (group), we generated different types of practical so we then say 'this one, then we can't use it ok, then we can use this one (another one)' why? … pros and cons of each one (type of practical) and then decide on one. (FGI-5 P1)

The participant's remark that working together and sharing ideas as a problem solving technique led to generative thinking of varieties of ideas and provides evidence of the benefit of working in a group. Van Laren, Mudaly, Pithouse-Morgan and Singh (2013) assert that the practice of productive judgment involves engagement with others, zeal and insightfulness. This praxis was exhibited by these participants who felt that synergy was important in learning to teach EE and through networking they could perform better. Slavin (2012, p. 42) describe peers working together in a group to work out a problem as "operating within each other's' ZPD". He explains the less knowledgeable amongst the group learn from the more versed member(s) to gain more understanding. The participants were able to learn from one another in this manner.

And another thing … hmm… these group presentations that happened were the topics we were focusing and things like that … so they helped us maybe in a way that ok; I am doing 4th year right now (participant just took NSM2 3rd year module), next year I will go to teach (full time) so there were things that the groups were creating. They were very creative maybe if they were going to do experiment and these things we can apply, they helped us … they helped us … maybe we can apply them in schools like the experiment they did today on global warming, I see it very helpful and I think can apply it … So err … the creativeness (creativity) of different groups help us … helped us maybe we can use their strategies that they did, that they were using, to apply them in schools (place of work). (FGI-3 P2)

'We consult … finished students (graduates). (FGI-1 P1)

In order to overcome their challenges, as experienced in this study, participants relied on the inventiveness of their peers and graduates to learn how to teach EE in Natural Sciences.

The need for collaboration and cooperative learning were also stressed during the individual interviews by the participants. Evidence presented below confirms this:

For example the presentation we had, that presentation involved different people … we were working as a team to make our lesson … so it was quite wonderful because we helped each other (one another); some group members came with wonderful ideas which were very beneficial to our group presentation. (II-1 G1)

I like the fact that we got to work in groups to do this assignment. Because we got to … again work with lots of people … so we could exchange ideas, compare ideas, see which one is better … (More knowledgeable others- ZPD) you know I run to each other's ideas … so that helped. And hmm … in terms of knowledge, I mean there are some people who because they don't do Natural Sciences, don't know what IKS is. (II-8 G5)

According to Dillenbourg (1999 p. 1), "collaborative learning is a situation in which two or more people learn or attempt to learn something together". This confirms Vygotsky's construct about learning (1978, p. 86), the zone of proximal development (ZPD), which is the area between the child's current development level "as determined by independent problem solving" and the level of development that the child could achieve "through adult guidance or in collaboration with more capable peers". The participants' level of knowledge was enhanced through the help of their more knowledgeable equals and graduates; they were able to progress from known to unknown (ZDP).

I saw the other group, they were presenting on the effects of global warming and then they (group) showed us, because we learn from each other, how to design hmm … they used easily accessible materials which were; they had 2 thermometers and plastics and then they were testing the temperature outside, in just the normal environment and then put the thermometer in the plastic and then they blew into the plastic and then tied it. (II-3 G2)

Through this study pre-service science teacher participants were able to discover ways of overcoming the challenge related to the lack of resources through collaborating and learning from one another's ingenuity.

A few participants reflected on the benefits of collaborative learning in the reflective journals as is evidenced below:

My group and I had the opportunity of liaising with other knowledgeable people and also sharing the workload amongst peers. (RD G1)

It is most valuable, because we as the group; we had to come up with the exact causes (of acid rain) or lesson topic that will explain and would be effective to the learners. (RD G3)

We sought assistance from other students. (RD G4)

Evidence from the views of the participants reveals that working together and sharing ideas can develop pedagogical skills of the trainee teachers. The process of interacting with peers and other more knowledgeable persons is a "psychological tool" called "mediation" according to Vygotsky (1978) cited by Bakhurst (2007, p. 53). He argues that through "mediation, a human being becomes a master of their own mental functions" *(ibid)*. This was demonstrated by the participants as illustrated by the comment from the participant *(RD G3)* regarding presenting microteaching on acid rain.

4.5.2 Theme Two

- Independent research; the use of digital technology (internet), and different human and material resources.

All the participants acknowledged the fact that the use of internet, human and material resources helped them in addressing the challenges which they experienced when they learned to teach EE. Some of the challenges highlighted in research Question 2 included integrating IKS in EE, and designing practical work. The data from the focus group interviews reflect participants' proposals of ways of addressing some of these issues.

We struggled to come up with the practical activities; if it wasn't for Google (internet search engine) I think we were going to struggle to come up with something nice. (FGI-3 P1)

Songer (2007, p. 475) defines "a digital resource as any computer-available information source containing facts, perspectives, or information on a topic of interest … It has "valuable information presented in the form of text, pictures, simulations,

video, or other interactive formats". The participants in this study valued the contribution of digital resources to their lesson designs.

We consult various … various sources like library, get the textbooks, we mostly use the internet for hmm … the pictures … even though we use the original pictures for hmm … the background of the presentation but then, we usually consult the internet … it's rich in information. (FGI-1 P3)

Ask people, ask other teachers with experience who have been in the field. (FGI-2 P1)

Even with regards to IKS, if you look for information, fair enough there is a certain amount of information that is available but it's not like theoretical information that is readily available for you, we have to go and ask older people (More knowledgeable others - ZPD) like my grandmother and mam, they … because (our) knowledge of indigenous knowledge is not that vast … it's there but not so great and specific to our topic, it is much difficult like participant 3 said, it is much difficult to relate it. I'll give you looking IKS with regards to medicinal plants, it is much easier there but with our topic it was a lot more difficult. (FGI-5 P1)

… even the Dr (lecturers) who have done research. (FGI-1 P3)

Ya and speaking to other people in our circle like maybe older generations because … well in terms of IKS … and then you have to consult with your lecture notes as well. (FGI-5 P1)

… the videos. (FGI-1 P1)

The effort to consult with lecturers, library books, older generations proved that the participants can navigate to the ZPD by using human resources as intermediaries as resonated in Donald, Lazarus and Lolwana (2002). A mediator, the authors argue, interacts with the learner to accomplish a task by providing expert knowledge or guidance.

Table 5: The Zone of Proximal Development as a Range of Competence
(O'Donnell, Reeve & Smith, 2009, p. 93)

Predevelopment	Zone of Proximal Development (ZPD)	Zone of Actual Development
Students lack the competencies to learn from the task, even with guidance.	Students can learn from the task if they receive another's expert guidance and support.	Students have the competencies to learn from the task on their own

Table 5 explains three levels of development with regards to acquiring competence and abilities when attempting to accomplish a task. The "predevelopment" depicts the stage at which a student (in this case pre-service science teacher) does not have the knowledge and skills to teach. ZPD is the level at which he or she can acquire competence by interacting with more capable and knowledgeable person(s) to become proficient. "Zone of actual development" is when the student has the ability to do things on their own.

For the participants to get to ZPD, it was evident from this research that they relied on human resources (experts) which they had expressed by consulting with their lecturers, older generations, and professional teachers already in the schools. They would not have been able to overcome these challenges without the assistance of more knowledgeable people.

Similar views were offered by participants who were part of the individual interviews and the following evidence from the transcripts proves this:

With the design, I think it is best to consult other people have been in the field … somebody I could rely on like Dr A (lecturer in charge of NSM 2 module), my peers; somebody I can ask … I know that they can give me good advice or what not … maybe research, Google (internet search engine) and ask what other alternatives I could do in … instead of what I can't do. (II-2 G1)

Hmm … I think NSM2 has turned me or us to be initiator of everything you know … don't just rely on the things that are in the book and all that but you can start your own thing from the scratch and delivers it to the class like the ones I've told you … formulating you own case study like this issue on pollution, err … the global warming thing and these days we were taught to design a lesson plan and then present it front of everybody else … and that lesson plan was just our baby; we could

only consult the coordinator or the lecturer when we are having some problems. (II-3 G2)

It was evident, from the foregoing, that a creative spark had been ignited. This pre-service science teacher had been awakened to new possibilities related to being responsible for one's own learning.

Hmm …, with regards to IKS, the only way I think that we could overcome that was or is to probably speak to senior citizens, like in our case with global warming and climate change and how we could use IKS to overcome climate change. So there maybe you will be looking at more farming methods or things like that there because crops are basically affected, like there if we could go on a research trips speaking to senior farmers (More knowledgeable others – ZPD) who may have indigenous knowledge and then from there you can work from there. (II-7 G5)

Ok, in terms of that it … it … is completely on individual ok. In terms of accessing practical, you go on research practical, you got your internet, you got your literature … you-tube, you go and watch them, you see which one is best for you, which one is best for your learner, their abilities, the resources … it's time consuming but it can be done. (II-8 G5)

Findings emerging from this research have established that the use of digital technology, as well as tapping into human and material resources, enabled the participants to learn how to teach EE and develop pedagogical skills.

All the participants reflected on the use of internet, and engaging with human and material resources as ways of addressing the challenges that faced them while learning to teach EE in the reflective journals which is corroborated by the following transcripts:

We did seek assistance from the traditional old people who were long born; we interviewed them about the way things were before involving the environmental factor (crises) (RD FG3)

… Lecturers, elders in community, books and internet. (RD G1)

I consulted the library books and the internet. (RD G1)

I searched it in Google [internet search engine]. (RD G5)

We sought assistance from other students, resources such as internet and books. (RD G4)

Many respondents in this study leveraged the availability of digital information as a strategy towards overcoming challenges which they encountered when they learned to teach EE.

The pre-service science teachers in this study engaged a lot with the use of digital technology as manifested in the excerpts. The use and access to internet via computers and smart phones enabled the participants to overcome some of the challenges encountered during the period of learning to teach EE. This emerged from the participants' use of 'Google' (internet search engine) to source EE information when preparing for the microteaching. Lotz-Sisitka (2012) indicated that provision of teaching and learning support like textbooks and charts related to EE have not been adequate. Participants relied on the internet as a 'scaffolding' measure to navigate to ZPD. The use of internet search engine; 'Google' was overwhelming. Pre-service teachers' creativity is extended in the next theme.

4.5.3 Theme Three

- Improvisation, resourcefulness and creativity

A majority of the pre-service science teachers that participated in the study highlighted improvisation, being resourceful and being creative as coping measures to address the challenges they encountered while learning to teach EE. Data from focus group interviews confirm this:

And then you can use the media (audio and audio-visual media) also … the groups are the listeners; you can use the media to play the lesson because we know that they (learners) know about this. (FGI-2 P2)

Then you can ask them (learners) to watch a certain program, maybe the one that DStv (Digital Satellite Television station) such as 'National Geographic'. (FGI-2 P4)

… or '50/50', if they don't have 'National Geographic' on SABC 3 [South African Broadcasting Corporation 3]. (FGI-2 P1)

You can be creative when you're given a topic related to EE, you can be creative as a teacher, there are so many things you can do like the posters, pictures, hmm … ya. (FGI-4 P4)

Participants revealed an enthusiasm and enormous capacity for innovating in the science classroom. The availability of digital media was preferred by many participants. The use of multimedia devices has enormous positive effect on cognitive acquisition of learners and can also augment teachers' capacity to deliver (Oshinaike & Adekunmisi, 2012), and this was alluded to by the pre-service science teachers' perceptions and real life experiences in this research. In addition, participants looked towards the physical environment as a crucial resource in teaching EE, and this is evident in the following excerpts:

But apart … apart from this like … like formal teaching of it (EE), it needs to be informal also … like start an environmental club in your school (high or primary school) or something; have something once a week; take them (learners) on a field trip or something. (FGI-5 P1)

… and do something that is available not something that is impossible. (FGI-4 P2)

You can use the 5 Es … explain, explore, when you go the wetland (if teaching wetland), evaluate them … what is the fifth E? I've forgotten the 5th E but with the use of those Es' you can actually achieve most of…. (FGI-2 P4)

As (pre-service) teachers, we should hmm … we should take the initiative, create hmm … campaign against pollution … err during "Arbour week", we should take our learners out learners to plant trees … basically we should be practical about EE; we should let our learners experience it, do it, so that when they are out in their communities they will be practising what they are doing in school … it should be a lifestyle. (FGI-4 P4)

The importance of "doing science" in Specific Aim 1 (DBE, 2011, p. 10) as a way to learning science was underscored by these participants. Cronin-Jones (2000)

asserts there is substantial acquisition of knowledge by primary school learners when they learn Natural Sciences in the school grounds than in the classrooms. She continues that the learners develop psychomotor skills and positive attitude towards the environment.

Furthermore, all the participants expressed similar views about improvisation, resourcefulness and creativity in the individual interviews and the following evidence attests to this:

…The thing was … I think it was just their own creation (creativity) … so in NSM 2, it has trained us to be the initiator of everything … don't just rely on other people's work, try to be critical thinkers … so we get ideas from such presentations. (II-3 G2)

I would say that there is a huge difference … for … let me start by saying this, Dr A always says … "We must forget about this song; I don't have the resources, that song that we usually sing" … she said we must make our own resources. I think that statement is … usually changed my mind … it was not the first time she mentioned that. During this period, I also learnt that I don't have to rely on the school (school participant will be working in future) to get the resources for me, I also have to take an initiative too as a teacher … because at the end of the day, I have to make a difference to those learners' lives so crying about the resources … it is … it is not a solution … it is not a solution. (II-1 G1)

The influence of the lecturer and the module, Natural Science Methods 2 (NSM 2) used for this research, on the participants' views with regards to lack of resources had sparked off the ingenuity in them. Kind and Kind (2007) point out that when student teachers are groomed to be inventive their capabilities to deal with modifications in professional activities are enhanced with a high level of adjustability and power to think is the starting point.

Yes … you know I thought that I had to have the right equipment … I didn't think that I could actually use anything … you know; I just didn't know … I just didn't know what to do. Now I know what to do … I can just figure out something, ask somebody, Google it … you know, if you think about it and you have an idea of what to do. (II-2 G1)

Yes. Also I thought practical was only in the lab and hands-on thing but only to find out that you are not always required to be practical, you can even have the video showing what you want the children to see … so in terms of practical, some of the solution could be that uploading the video about the particular topic and the children (learners) see that. (II-3 G2)

… we tried to use available resources … for example, as we were doing 'Biodiversity' (EE topic for group presentation), we had to think of the things that will represent the animals and some things that will represent the plants and those things will make sense to learners, something that is familiar to them. So that doesn't stop us from doing the practical because you can't just bring animals around the class, you have to bring something that they are familiar to it and they will interpret what you are going to do … Hmm … for example a snake. We used whole snake … you can't just bring a snake in the class for Grade 5 learners, they won't sleep at night t… you know they will have that problem. Hmm … ya, as a teacher, to do a practical, you just use something that is available and use your mind totally needed. (II-4 G4)

Ok, let me start with the resources issue, hmm … for a lack of resources, what we've learnt in our NS module (NSM2) is that anything can be a resource; you must be innovative and creative when thinking about the resources … for example, lacking a beaker, a beaker could be replaced with a glass … an open glass and all that stuff if it is not necessarily going to carry hot water. If you are just looking for a beaker to demonstrate something, 2 litre bottles (of cold drinks), bins, all these stuff could be resources when teaching about EE because most of the things we use in everyday life involve aspects that can be linked to EE. (II-5 G4)

Creativity and resourcefulness were demonstrated by the participants based on the realization that EE must be hands-on and ensuring that they provided alternative resources through improvisation. The use of videos, posters and cheap plastic bottles, as resources to present their lessons, gave impetus to their learning to teach EE. Lotz-Sisitka (2006, p. 22) highlighted the value of "creativity and critical thinking" in environmental and sustainability education practice. According to her, the use of approaches such as open-ended questions, case studies, experiments, research based role plays and dramas can stimulate thinking of learners. She also contends that engaging learners in hands-on activities will develop critical thinking skills in EE.

A few participants reflected on improvisation, resourcefulness and creativity in the reflective diaries, as is evidenced below:

Through the use of various available resources, chart, case studies and pictures and different objects available. (RD G4)

We looked at the things that we use almost in our everyday life which could be the cause of environmental effects. (RD G3)

The opportunity that arose was that of being aware of different strategies and methods we can use as teacher to teach EE and I think it is valuable to teach EE because learners will be aware of different aspects of the environment that they need to take care of for having a good environment to live in. (RD G5)

An opportunity to explore different practical activities which can be used to enhance learning using recyclable materials. (RD G4)

Participants, through this experience, were able to synthesise innovative ideas and resources on how to help their learners in the future while learning to teach EE. This is in line with the objectives states in the template of the NSM 2 module which included “improvisation, practical work and investigation, problem solving and demonstration”.

4.5.4 Theme Four

- Going on field trips and engaging in outdoor activities related to EE

Most of the participants stressed the importance of field trips and outdoor activities in alleviating the challenges they faced and this is shown in the focus group interview transcripts below:

… or visit the wetland; field trip where you teach such topics like wetland depletion. (FGI-2 P3)

What I discovered when you are learning to teach about biodiversity or any topic related to EE, it is always best that you do something out of the class and allow learners to be in close contact with the nature. (FGI-4 P4)

Maybe it should be more practical than theory, maybe they (learners) should actually go out there in the garden and then water; go clean up the river, they (trainees and teachers) should actually do those … encourage the learners to do those things. (FGI-2 P2)

Rosenberg, O'Donoghue and Olvitt (2013) describe outdoor activities as going to places of instructional values in order to expand pupils' horizons, appreciate various phenomena, interact communally and develop self-assurance in them about environmental concepts they had learned theoretically.

A field trip is an outdoor environmental activity which the participants attest to as one way of enhancing the teaching of EE in Natural Sciences.

I will enjoy teaching EE if the school (university) itself will be able to assist us for example funding us to go on trips like going to Mtunzini (a nature reserve) which we had in BIO 220 module. (FGI-1 P4)

Similar views were offered by participants who were part of the individual interviews, and the following evidence from transcripts attest to this:

I only see the importance of field trips … yes. Field trips are very important because you'll get a chance to explore things … it … it involves "experiential learning" (is the process of making meaning from direct experience) rather than the 'content based learning'. You see when you are being taken to a place to see those things happening; it's not like you read about it in the book … then you have to write an exam on it. It is very important to have more field trips. (II-1 G1)

The importance of experiential learning was highlighted by the *(II-1 G1)* participant who saw the need for attaining knowledge from personal experience rather than only through the textbooks. Kolb and Boyatzis (2000) describe experiential learning as the process of acquiring knowledge and skill through an individual's direct action and experience. Tarter (2002) argues that exposing learners to activities outside the classroom can correct some misunderstandings learners might have about certain concepts in science. They will also appreciate that "science exists in the real world outside the textbooks" (Tarter 2002, p 95). These views corroborate the pre-service science teachers' thoughts, in this study, that field trips and experiential learning can augment learning to teach EE in Natural Sciences.

… I think they (EE) should be everywhere (in university modules) or I think there should be modules about environmental studies, about being in the lab …ok going outside, taking field trips … maybe a module like that could really help (II-2 G1).

Hmm … ya they are … some of the things … for example if you look at hmm … other module like Biology … the major, they (students) learn about the plants and then go out (outdoor activities and field trips), do the practical work there, and then when we look on Natural Sciences, we just do it, but although which is a practical, but we do it in the lab only … we don't go outside exploring the environment … I think that is needed too on Natural Sciences. (II-4 G4)

The participants stressed the need for field trips as a way of enhancing their learning to teach EE. The pre-service science teacher participant *(II-4 G4)* requested that the university should include field trips and outdoor programs in the studying of Natural Sciences modules. Biology modules offered in the university enjoy field trips according to this participant. Field trips are educational activities, which are undergone outside the classroom environment, such as "visiting a pond or observing wildlife" (Garrity, Pastore, & Roche, 2010, p.9). A substantial amount of learning occurs when learners go on field trips *(ibid)* and knowledge gained cannot be easily forgotten after returning from the trip (Hofstein & Rosenfeld, 1996 cited by Garrity, Pastore, & Roche, 2010)

4.5.5 Theme Five

- The use of CAPS curriculum and its implementation as it relates to EE in Natural Sciences

Pre-service science teachers are required to refer to the CAPS curriculum in order to learn to teach Natural Sciences. They had diverse views about referring to the CAPS curriculum, as is evident in the following excerpts:

You look at the Specific Aims in the curriculum to help you because it guides you on what you gonna achieve for the lesson. You specifically look at the curriculum, the Specific Aims … under different Aims, what outcome do you want to achieve after the lesson obviously to educate them (learners) and make them aware

of what's happening around them so that they can practice good deeds rather than continue hmm … depleting the earth. (FGI-2 P4)

I think before NSM 2, I was focusing on theory … it was just the theory part, maybe if I could show the something I could (learning how to teach EE/teaching practice), if I could make them (learners) do something I will. I really didn't see the importance of learners actually meeting especially 'Specific Aim 2' (in CAPS) which is investigating phenomenon in Natural Sciences. Now I have learnt to incorporate it at all times just to accommodate the multiple intelligence in the class. (II-2 G1)

I think it has been very enlightening, you know … something we just take for granted and we don't think we can fix it ourselves but now that I know that if there is a problem and there is something you can do about it and if you know who to go to on what to do, I think you can actually fix it to save the earth … it's a lifelong process and by doing that, we are … what's this … hmm … principles of the curriculum … of CAPS, that talks about how they want learners to be responsible citizens … I think this is it … this is how you can be responsible citizens to your country and be faithful to this earth by giving it back what it deserves. (II-2 G1)

Hmm … the first step we took when designing our lesson plan; we looked at CAPS, what are the 'Specific Aims', 'Objectives', all those things that are needed by CAPS and then think the topic; what does it need?, and what err … Grade 5 learners do, thereafter we then decided on what apparatus we would use as we were doing the practical. (II-4 G4)

Conde and Sanchez (2010) argue that teachers should be conversant with the syllabus and how to use it so as to facilitate the attainment of the purposes of EE and sustainability education. The authors contend that effective teaching and learning in EE can be achieved if teachers are familiar with the curriculum. Stables (2004) concedes that teachers must regularly elucidate the curriculum to avoid misconception of the content in science. In this study, the use of the CAPS curriculum enabled the pre-service science teachers to learn how to teach EE accordingly.

4.6 CONCLUSION

In this chapter, the analysis of the findings was achieved inductively. The views of the pre-service science teacher participants about learning to teach EE were coded and analysed into themes which provided answers to the three research questions of this study. The methods of collecting data included focus group interviews, individual interviews and reflective diaries. The summary of the themes that emerged from the answers to the critical questions are explained in three points.

First, three themes emerged from the first research question which was, *What are pre-service science teachers' views about teaching EE in Natural Sciences classroom?* The participants' experience of learning to teach EE through microteaching suggested that EE was valuable in the classroom. They agreed that we need the environment for our survival and that learners need to know about the world environmental crisis and mitigations.

Second, they expressed the difficulties they encountered during the process of learning to teach EE in response to research question two which was, *What are the challenges which pre-service science teachers experience when they learn to teach EE?.* The participants' challenges ranged from integrating IKS into EE, designing practical work, to the lack of foundational knowledge and the inability to gain work experience to teach EE during Teaching Practice.

Third, the participants, while learning to teach EE came up with different ways of overcoming their challenges and this was in response to research question three which was, *How do pre-service teachers address these challenges and what enables them to teach EE?* Through insights and determination to surmount these challenges, the participants engaged in collaborative learning, independent research, and improvisation of resources in order to gain knowledge. They also suggested the effective use of the CAPS document.

Finally, the role of ZPD, which is the theoretical construct of this study, was established. The participants at the beginning of the investigation did not have much knowledge about teaching EE. In the process of learning to teach, they collaborated and interacted with their peers and with more knowledgeable persons which ultimately advanced them to the ZPD. Through scaffolding, and by interacting with

their lecturers, professional teachers, older generations and graduate students, they were enabled to perform the task of teaching EE better and gained self-confidence.

The next chapter will provide details of the findings and recommendations of this study.

Chapter 5

Summary, Recommendations and Conclusions

5.1 Introduction

This chapter provides a review of the findings, suggestions and conclusion of this qualitative study. The analysis of the findings, which were produced using diverse data generation strategies are discussed along with recommendations and conclusions. This study, which aimed to explore the views of pre-service science teachers about learning to teach EE, sought to answer three research questions: first, 'What are pre-service science teachers' views about teaching EE in Natural Sciences classroom'?, second, 'What are the challenges which pre-service science teachers experience when they learn to teach EE'?, and third, 'How do pre-service science teachers address these challenges and what enables them teach EE'?

5.2 Summary of key research findings

Table 6: Summary of findings from Research Question One

Research Question One	Overall finding	Themes
What are pre-service science teachers' views about teaching EE in Natural Sciences classroom?	Pre-service science teachers view the teaching of EE as critical in Natural Sciences	1. Views of EE as important due to human dependence on the environment 2. Views of EE as important due to the need to transform societies 3. Views of global environmental challenges

Table 6 shows a summary of the themes that emerged from the data generated from the participants which answered Research Question One of this study.

Findings revealed that the pre-service science teacher participants believe that EE is important due to human dependence on the environment. They stressed the need for teaching EE in the classroom to create awareness in learners about interactions in the environment and how a disruption in the relationships can affect humanity. The issues of imbalance in the ecosystem were highlighted. According to the participants,

humans depend on the environment for food, oxygen, water and shelter which form the basic necessities of life.

Theme Two expressed the participants' views of EE as important due to the need to transform societies. Findings showed that in order for the earth to be conserved, the participants expressed the views that learners should be taught about how to show concern for the environment. The pre-service science teachers in this study revealed that conservation should be a 'lifestyle' with learners having positive attitudes towards the environment. Enabling learners to develop positive, environmentally-conscious lifestyle decisions and choices, was regarded as critical by the participants. The teaching of learners in the classroom about the ways of alleviating the problems confronting the environment formed part of the findings.

Theme Three focused on the numerous global environmental crises that humanity at large is facing presently. The crises in the environment are not localized in certain parts of the world but are worldwide. The participants alluded to the challenges of global warming, deforestation and loss of biodiversity which affect every country. The participants believed that learners must be taught to understand these phenomena in the Natural Sciences classroom.

Table 7: Summary of findings from Research Question Two

Research Question Two	Overall finding	Themes
What are the challenges which pre-service science teachers experience when they learn to teach EE?	A lack of pedagogical content knowledge and inadequate experiences during work integrated learning were impediments.	1. Integrating IKS and EE in Natural Sciences. 2. Designing practical work on EE and lack of resources 3. Lack of adequate foundational EE knowledge due to limited exposure to EE of pre-service science teachers when in primary and secondary schools. 4. Inadequate opportunity for pre-service science teachers to experience learning to teach EE during Work Integrated Learning, WIL (Teaching Practice)

Table 7 outlines the four themes that emerged from the challenges pre-service science teachers experienced while learning to teach EE in Natural Sciences.

Integrating indigenous knowledge systems (IKS) into the EE lessons during the microteaching was difficult for the participants. Due to poor knowledge and background in IKS, it was a struggle for the participants to incorporate IKS into EE topics.

The study also revealed that the 3rd year participants were faced with the challenge of designing practical work for EE. This was associated with what they perceived to be the pedagogical content knowledge (PCK) gap in the previous modules they had taken in the university. Their views were that they were not adequately prepared to teach practical work in the PCK modules. Finding resources to carry out these practical activities made learning to teach EE difficult for the pre-service science teachers participating in this research. Some of the resources the participants required, which included some protected plant species, were not readily available for use.

Several pre-service science teachers in this study indicated that they were not taught EE effectively in their primary and secondary schools and thus entered university with significant knowledge gaps. Despite the fact that some of the participants came from the rural areas, where natural resources and unspoilt landscapes are abundant, their knowledge about EE was not developed by their teachers. The participants were mainly exposed to rote learning when in the primary and high schools which suggested that their teachers had poor EE competence and pedagogy. The lack of adequate background knowledge resulted in the participants' struggle while preparing EE lessons for microteaching sessions in this study.

Work Integrated Learning (WIL) gives pre-service science teachers the chance to develop teaching skills and school experience which is part of teacher education (DHET, 2011). Findings revealed that several 3rd year pre-service science teachers who participated in this case study had not received the opportunity to teach EE in schools during 'Teaching Practice' (TP). TP takes place between July and August every year in this university. Pre-service teachers are placed in schools for a period of 4 weeks to practice teaching in the work place. The months of July and August fall in Term Three of the South African schooling calendar. According to the CAPS curriculum (DBE, 2011, p. 14), the strand taught in the intermediate and senior phases in this term is "Energy and Change" which has no EE topics. This deprived

the participants from the opportunity of experiencing EE in the process of teaching and learning with the learners in a typical classroom, which would have been a useful experience.

Table 8: Summary of findings from Research Question Three

Research Question Three	Overall finding	Themes
How do pre-service teachers address these challenges and what enables them teach EE?	Human and material resources which were linked to enhancing pedagogical content knowledge were utilized.	1. Collaborative learning with peers 2. Independent research; the use of digital technology (internet), and different human and material resources. 3.Improvisation, resourcefulness and creativity 4. Going on field trips and engaging in outdoor activities related to EE 5. The use of CAPS curriculum and its implementation as it relates to EE in Natural Sciences

Table 8 presents the findings that emerged from Research Question Three which explains the various ways pre-service science teachers addressed the challenges they experienced while learning to teach EE. It also describes what enabled the participants to teach EE.

First, collaborative learning with peers was revealed as a way of addressing the challenges the pre-service science teachers experienced while learning to teach EE in Natural Sciences. The participants worked with their peers, learned from one another during preparations and the presentation of the different microteachings. They felt excited that designing practical work was achievable through the collaborative effort. This act of collaboration is central to the theoretical construct employed in this qualitative study which was the Zone of Proximal Development (ZPD). The ZPD is the area between the student's current development level "as determined by independent problem solving" and the level of development that the child (student) could achieve "through adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p: 86). Collaborating with more knowledgeable peers, experts and elders enabled the pre-service science teachers in this study to learn how to teach EE as demonstrated in this research process.

Second, findings revealed that independent research on the part of the participants enabled them to overcome their challenges and also improved their ability to learn to

teach EE. Kincheloe (2012, p. 24) asserts that practicing teachers and pre-service teachers must be involved in educational research in order to create knowledge. He argues that “these individuals must understand that such an endeavour is both important and possible”. It emerged that the use of the internet to search for information, and sourcing knowledge from lecturers, older generations, professional teachers, graduates and libraries, assisted the participants. The use of human resources resulted in “scaffolding” as explained by Slavin (2012, p. 222), based on Vygotsky’s concept of “assisted learning”. The author contends that when learners (pre-service science teachers) are supported to acquire knowledge by more capable persons, they move from “mediated learning” to “self-mediated learning” *(ibid)*. This is the ZPD as described by Vygotsky (1978).

Third, the study also revealed that being able to create and use available resources helped in surmounting the challenges of learning to teach EE. The pre-service science teacher participants became creative in response to their challenges. It emerged that using, for an example, an empty plastic bottle with a two litre capacity, could replace an apparatus in a science experiment where resources are not available. This ability to improvise in practical science lesson settings was revealed by several participants. It was also revealed that the use of constructivism as a learning theory was applied when learning to teach. Emphasis was placed on the 5 ‘E’s’ which Enhancing Education (2002, online) describes as “the phases of learning; Engage, Explore, Explain, Elaborate, and Evaluate”. These are to be used for building and expanding on previous knowledge. The participants noted that these ‘E’s’ simplified learning to teach EE. They had learned about the 5 E’s and constructivist learning theory as part of the requirements for the Natural Science Method 2 module. The use of posters, pictures, documentaries and simulations to replace real life activities or dangerous animals for presentation of lessons were highlighted. This revealed the pre-service teachers’ skills related to utilizing audio-visual resources which were developed when they learned to teach EE.

Fourth, it emerged from the research that field trips and outdoor activities enabled the participants to learn to teach EE. A recollection of a field trip in their 2nd year in the university motivated their learning experience which was used to support the learning to teach EE during the microteaching session.

Finally, findings revealed that the study of the newly designed CAPS curriculum by the Department of Basic Education, especially, the “Specific Aims” (DBE, 2011, p. 10) enabled the participants to focus on the teaching process and methods. This made them realize that the ‘content’ should not only be stressed in the practice of teaching but that the PCK was equally significant.

In summary, the insights from the findings can be captured as follows:

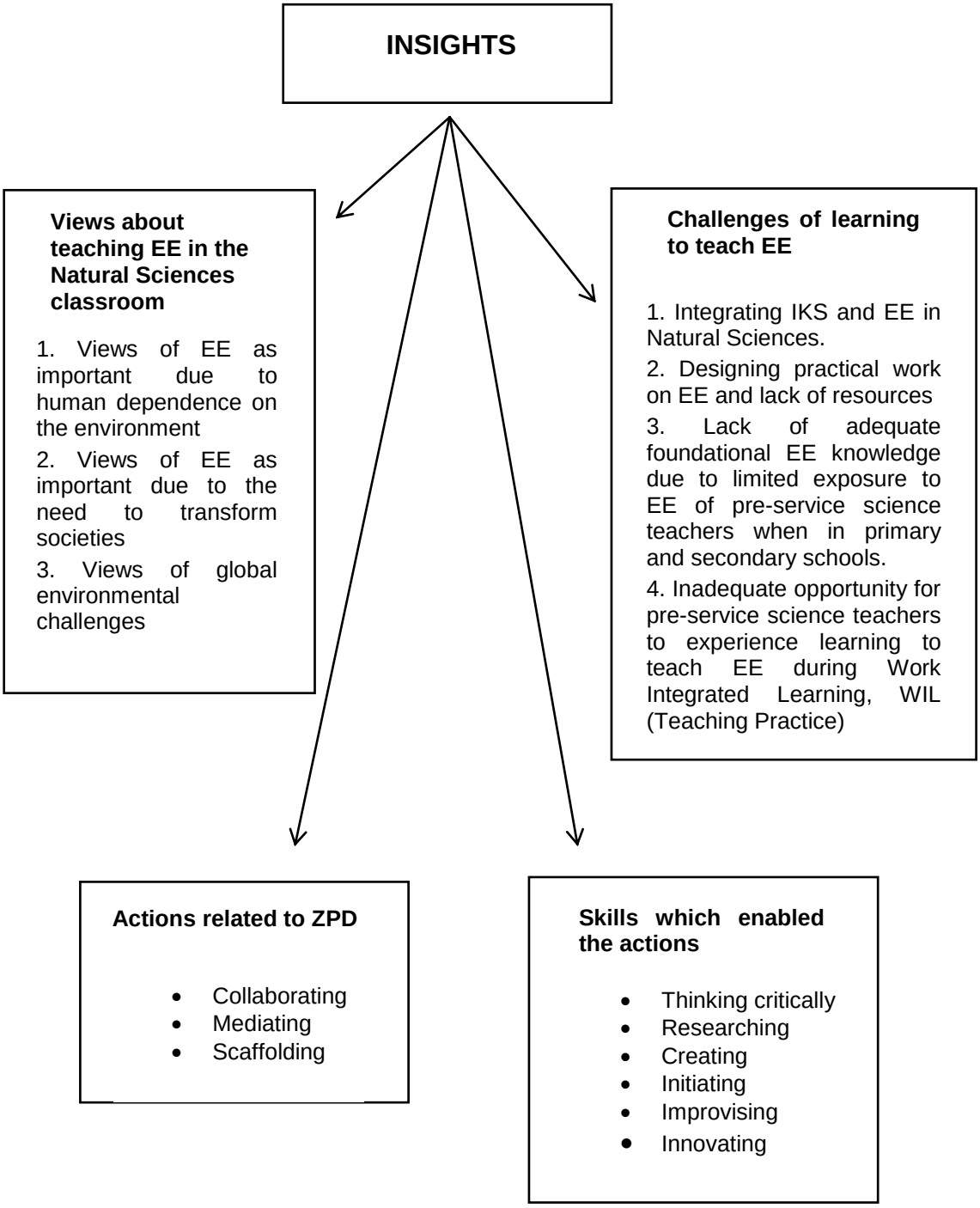

Figure 12: Diagrammatic representation of insights from the findings of study

Figure 12 summarises the insights that emerged from this study. The pre-service science teacher participants engaged with collaborating, mediating and scaffolding, as propounded in the ZPD by Vygotsky (1978). These participants developed skills

ranging from critical thinking, researching, creating, initiating to improvising and innovating while learning to teach EE in Natural Sciences. These skills enabled them to do tasks on their own at the ZPD.

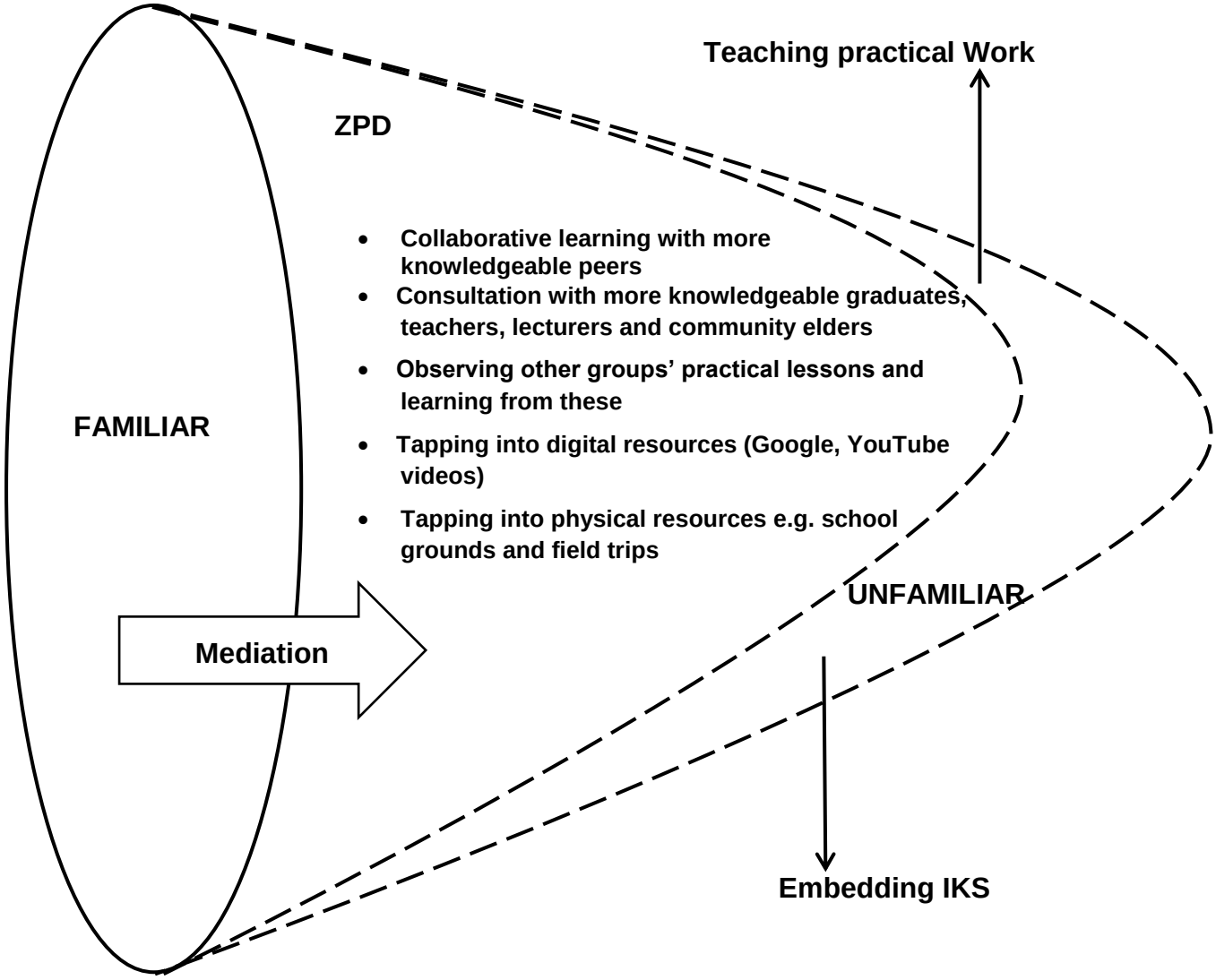

Figure 13: Zone of Proximal Development (ZPD)
Adapted from Donald, Lazarus, & Lolwana (2002, p. 71)

The ZPD of the pre-service science teacher participants are shown in the figure 13. Through collaborative learning with more knowledgeable peers, and consultations with more knowledgeable human resources, these 3rd year pre-service science teacher participants were able to move from 'familiar zone' to the ZPD and address that which was unfamiliar. Other ways employed to get to their ZPD were through

observing other groups' practical lessons and learning from them, exploring digital resources and utilizing physical resources such as school grounds and field trips. The participants were empowered to overcome the challenges such as integrating IKS in EE, designing practical work amongst others which fell into the 'unfamiliar zone'.

5.3 Recommendations

The various findings from this study showed that efforts are needed to support pre-service science teachers to enable them to learn to teach EE. The challenges that emerged can be addressed through the recommendations made in this research in order to prepare the future professional teachers for the South African schooling system. The draft policy on the minimum requirements for teacher education qualifications selected from the Higher Education Qualifications Framework (HEQF) in South Africa recommends "situational learning" for pre-service teachers (DHET, 2010, p. 11). This policy states that "situational learning refers to knowledge of the varied learning situations, contexts and the environments of education (classrooms, schools, communities, districts, regions, countries and the globe)". Thus EE requires a more practical approach to pre-service science teacher education.

5.3.1 Recommendations for teacher education institutions

The universities and all other teacher education institutions should provide an adequate number of modules in the Natural Sciences Method (NSM) from the first year to the fourth year. NSM modules which emphasise PCK related to practical work including investigations, demonstrations and improvisations are crucial in the education of pre-service science teachers. The engagement of pre-service science teachers with these topics will enable them to become more familiar and proficient with utilizing different methods of teaching EE before they enter the profession. The institutions can also invest in more field trips and outdoor programs that will enhance the learning experiences of EE by the pre-service teachers. A minimum of three field trips in the four years duration of (BEd) can expose the pre-service science teachers to different ecological sites which can stimulate their interests and commitment to the learning of EE. This will enhance their capacity for practical learning as advocated in the policy document of the minimum requirements for teacher qualifications in South

Africa (DHET, 2010). Practical learning as it relates to work integrated learning is crucial.

5.3.2 Recommendations for university lecturers

The university lecturers can provide more mentoring and role modelling for pre-service science teachers. From the data that emerged from this study, some the participants came from rural areas and poorly resourced schools. Thus the lecturers should consider the previous knowledge and knowledge gaps of this group and ensure that all the pre-service science teachers are supported while they are learning to teach EE. University lecturers should ensure that adequate practical work is infused into PCK modules while the pre-service science teachers are undergoing the BEd training in the university. The challenge of designing practical work can be addressed in this manner.

5.3.3 Documentation of Indigenous Knowledge and Environmental Education related information

The scarcity of IK and EE related texts and other forms of hard copies of printed materials can be addressed if the government and universities invest in obtaining and documenting indigenous information from the older generations for educational purposes. A lot of indigenous knowledge is still in oral form. “IK is disseminated and preserved through various family histories, taboos, symbols, myths or legends, rituals, sounds or dances, festivals, proverbs and poetry” (Sithole, 2007, p. 118). He argues that IK may be lost if it is not documented *(ibid)*. I believe that the older generations will pass away one day and the knowledge will be lost if the information is not recorded.

5.3.4 Recommendations for increased use of online resources

This study revealed that digital technology, especially the use of the internet played a vital role in learning to teach EE by the participants. Google (internet search engine) was used extensively by the participants in this study to conduct research on their topics. The Department of Higher Education and Training (DHET) and the university community can develop websites specifically for EE, as it relates to the South African context. This platform can be interactive and can serve to enhance pre-service teachers’ PCK about EE. The use of smart phones and computer devices is common

among pre-service science teachers and young people as a whole. If pre-service teachers are trained to leverage the costs and accessibility of digital technology then this can develop their PCK further and support them in their teaching of EE.

5.3.5 Recommendations for participation by Non-Governmental Organizations (NGOs) in pre-service science teachers' education

Educating EE teachers can be promoted if more NGOs partner with teacher education institutions by providing funds and EE educational resources. They can also send experts to do workshops and training with both pre-service science teachers and lecturers at different times. An initiative worthy of mention is Fundisa for Change (FFC) that was recently launched in South Africa. It aims to "transform environmental learning through teacher education" (Lotz-Sisitka and Songqwaru, 2014). The organization, in conjunction with other partners, has been training classroom teachers and developing workbooks for easy teaching of EE and sustainability education.

5.3.6 Recommendations for further studies

The literature review revealed a scarcity of research related to pre-service teachers learning to teach EE. Similar studies can be conducted in different settings in South Africa, and the findings can be synthesised and provide vital insights to higher education institutions which train science teachers. This can result in improved PCK modules especially those which relate to the teaching of EE.

5.4 Limitations

The study was carried out in one university offering a Bachelor of Education (BEd) degree in KwaZulu Natal province in South Africa. Thus the data generated cannot be generalized to other teacher education institutions in the country. Further research into pre-service science teachers about learning to teach EE is suggested. The investigation relied on the views of the participants, whose backgrounds and experiences were diverse, and cannot be generalized to the general pre-service science teacher population.

5.5 Conclusion

This chapter summarized the findings that emerged from this study. It also made recommendations regarding the promotion of pre-service science teacher education and learning to teach EE, and what stakeholders can do to improve this group's competencies. EE is topical and critical; it has received attention locally and globally. Therefore high quality teacher training is vital if schools are to make a difference to how future generations will contribute to mitigation of environmental challenges. If greater consideration is given to pre-service science teachers' education in the intermediate and senior phases of the South African schooling system, it is likely that teachers will become more proficient in the teaching of EE, which is crucial to the well-being of individuals, societies, countries, and the world at large.

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APPENDICES

1. Ethical clearance from the University of KwaZulu-Natal

2. Letter to pre-service teachers (informed consent).

3. Focus group interview schedule.

4. Individual interview schedule.

5. Reflective diary schedule.

6. Focus group interview transcript.

7. Individual interview transcript.

8. Pre-service science teachers' reflective diary.

9. Professional editing approval letter.

APPENDIX 1

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

16 July 2014

Mr Oluwakemi Ayodeji Adebayo (214581977)
School of Education
Edgewood Campus

Protocol reference number: HSS/0405/014M
New project title: Exploring the views of Pre-Service Science Teachers about how they learn to Teach Environmental Education

Dear Mr Adebayo,

Approval - Change of project title

I wish to confirm that your application in connection with the above mentioned project has been approved.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

.....
Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr Ronicka Mudaly
cc Academic Leader Research: Professor P Morojele
cc School Administrator: Mr Thoba Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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APPENDIX 2

Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,
KwaZulu Natal.
02-04-2914

Dear Participant,

INFORMED CONSENT LETTER

My name is **Mr. Adebayo O.A.** I am a Master's student from the Science and Technology Cluster, School of Education, College of Humanities, University of KwaZulu-Natal. I am conducting research titled 'Exploring the views of pre-service science teachers about how they learn to teach environmental education'.

Globally and in South Africa, environmental issues are a cause for concern. Contemporary environmental challenges include global warming, environmental degradation, wetlands depletion, deforestation, land pollution, litter and waste management, land degradation, poor conservation of flora and fauna in biodiversity. My view is that teachers can play a pivotal role in education for the environment and of the environment. I believe that the quality of pre-service teachers' knowledge, and pre-service teachers' abilities to teach 'new' environmental knowledge should be explored in order to enable more relevant education to be offered at teacher training institutions.

You are requested to please participate in the study. To gather the information, I am interested in asking you some questions during one group and one individual interview, each of 20-25 minutes duration. I will also ask you to keep a reflective diary, in which you can record your experiences of learning to teach EE.

Please note that:

- Your participation is voluntary
- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- You will prepare and present a lesson on EE topic in a microteaching setting.
- The focus group and individual interviews (1 of each) will last for about 20-25 minutes and may be split depending on your preference.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at 'Exploring the views pre-service science teachers about how they learn to teach environmental education'
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to have your lesson observed and possibly be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow recording by the following equipment:

	Willing	Not willing
Audio equipment		

Thank you
Yours faithfully

Mr. Adebayo O.A
My contact details are as follows:
Email: 214581977@stu.ukzn.ac.za
Cell: 0849848322

My supervisor is Dr. Ronicka Mudaly. She is a Lecturer at the Science and Education Cluster, School of. Education, College of Humanities, Edgewood Campus, University of KwaZulu-Natal

Contact details:
Email: mudalyr@ukzn.ac.za
Phone number: 031 260 3643.

You may also contact the Research Office at:

University of KwaZulu-Natal

Humanities and Social Sciences Research Ethics

Govan Mbeki Centre

Tel +27312604557

Fax +27312604609

Thank you for your contribution to this research.

DECLARATION

I …… (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that:

- **I will participate voluntarily and am at liberty to withdraw from the project at any time, should I so desire, with no negative consequences**
- **I voluntarily give permission for the study's activities to be digitally recorded**
- **I give permission for my reflective diary to be used as a source of data**
- **My identity will not be disclosed**

……...

Name of Participant

…… **……**

Signature of Participant **Date**

APPENDIX 3

FOCUS GROUP INTERVIEW SCHEDULE

1. Do you think that teaching EE is valuable? Why?
2. What are your experiences of learning to teach EE topics?
3. Do you think EE is relevant to the sustenance of planet earth? Why?
4. How did your group design the lesson? What were some of the challenges/opportunities in designing the lesson as a group?
5. Did you enjoy learning to teach EE topic(s)? Please elaborate
6. What other views do you have about EE?
7. How did you learn to teach EE? What ways were used in achieving this?
8. Do you think EE is well covered in the CAPS curriculum?
9. What challenges do you think you have regarding learning to teach EE?
10. What suggestions do you proffer to address the perceived challenges?

APPENDIX 4

INDIVIDUAL INTERVIEW SCHEDULE

- Your focus group interview highlighted the following as challenges that you experienced when learning to teach EE; …

  …

  …

- How would you overcome these challenges
- How can teacher education be improved to support pre-service teachers to teach EE?
- Prior to studying this module (Natural Science Method 2), how did you learn to teach EE and after taking the module, what has been the difference?
- Are you aware of various approaches to teaching EE apart from the classroom teaching? E.g. case studies, team work, field trips, mature trails, group methods, buzz session, simulation games, role play etc. Did you use any of these to help you learn how to teach EE? Please elaborate.

APPENDIX 5

Reflective diary schedule

Name: …… Date…….

1) What aspect of EE did you try to incorporate into your lesson?

2) How did you attempt to teach this aspect of EE

3) Tell me about your experience of learning to teach EE. What were some of the specific challenges that you encountered when attempting to teach EE

4) What opportunities arose when attempting teach EE? Do you think it is valuable to teach EE? Explain.

5) What is your view on the value of teaching EE? How can teaching EE influence behaviour changes in learners?

6) Did you seek any assistance when learning to teach EE? …….
7) If so, from whom / which sources did you seek assistance/ info

APPENDIX 6

FOCUS GROUP INTERVIEW TRANSCRIPTS

FOCUS GROUP INTERVIEW 1 (FG 1)

Oluwakemi – Do you think teaching EE is valuable? Why

P1- Yes, because learners have to know about the purpose of the environment, how to care about it, know about issues related to environment like pollution, acid rain, global warming… so they won't burn hmm… wood for nothing because it produces gases into the air that pollute the air.

P2- I will also say yes because hmm… the environment itself is very important; as people we entirely depend on the environment, so they (learners) have to know about environment. We as teachers (trainees) have to teach them; we have to make sure that they understand and they know about the environment and how to take care of it and the advantages of taking care of the environment… so they have to know.

Oluwakemi- What are your experiences of learning to teach EE topics?

P2- Personally, I have experience; first of all, the environment that I grew up in is surrounded by trees, in a rural area where we have different kinds of plants and we interact with those plants. In BIO 210 module (another module in university) we also had a visit to Mtunzini; we were in the nature, we studied different things, things that we didn't know about and it was good and from that time I started to rethink about the environment thing… and that we should take our learners out there to… to actually be exposed to the environment and not to learn about it in books.

P3- For me, it has been a good experience… for instance… in terms of plants, we usually like the plants that are imported from the other countries due to the fact that it raises the economic status but during BIO 220, we then know that those plants are not good to the indigenous plants. We should teach children about indigenous plants because the foreign ones tend to destroy our native environment because they consume lots of water, food and all that… I'll say it's been a good experience in that…

P1- We also get to learn about the relationship of organisms, plants and animals… we learnt about the 'Eucalyptus tree', gum tree that it consumes 8 litres of water a day and it doesn't have predators and that is why it grows rapidly.

P2- They (foreign plants) compete with our indigenous plants.

P4- In fact, during our teaching practice, we don't … I don't think we get an opportunity to teach these things like EE in Natural Sciences but we do teach EE in Further Education and Training (FET) phase so I haven't yet experienced how to teach EE in NS… so I really like what my sister have said about BIO 220 module.

Oluwakemi- Do you think EE is relevant to the sustenance of planet earth? Why?

P2- EE is important to the survival of the planet because people need to be educated how to use the things in the environment

P3- Because we do all things unintentionally because we don't know what negative effect it has but if we are given the chance to learn about the environment… and what it needs, what it doesn't need, what destroys it, what doesn't destroy it… I think it can help solve or cure the diseases of what destroys the environment unintentionally or intentionally.

P4- Imagine we didn't have plants… if all plants went extinct, what will happen in our planet? We are all dead… we don't have oxygen, we don't have food… some animals which are vital to our ecosystem will go extinct because they do not have food.

P2- Food chain will be broken… the system ….

P4- The system will collapse

P2- Hmm… EE is important but we need to have laws that govern the plants because some people… they are doing it out of money… they will keep on destroying and destroying yet they know that what they are doing is wrong but because they need money; they will keep on overharvesting the plants… so we need laws that will govern

Oluwakemi- How did your group design the lesson? What were some of the challenges/opportunities in designing the lesson as a group?

P1- The first challenge, in lesson plan we did not know how to integrate IKS because we had to… our lesson was about 'Aloe Vera'… Medicinal Plants.

P3- With regard to our topic (for presentation) which was based on Medicinal plants, we had to choose Aloe Vera because it is easily accessible to learners; they can see it, they can find it.

Oluwakemi- Did you enjoy learning to teach EE topic(s)? Please elaborate

P1- I have never got a chance to teach about EE but I enjoy learning to teach it. It is something that the learners know… something that happens in our local … they (learners) are exposed to the plants

P3- Last year I did teach EE in Natural Sciences and I enjoyed it.

P1- They (learners) are exposed to the plants, about gases they know … about the animals… it is socially related.

P4- I will enjoy teaching EE if the school (university) itself will be able to assist us for example funding us to go on trips like going to Mtunzini which we had in BIO 220 module.

P3- I'd say like I had taught the topic ecosystem before and the challenges that I experienced when it comes to global warming, acid rain and all that … the problem was that I had to use scientific terms which I wasn't exposed to. You need to explain to the children what you mean by CO_2; where do we get CO_2 and all that but I did enjoy it like pollution… it's one of the topics that we used to enjoy in high school… even now when you speak of land pollution… when you are throwing the papers (littering), it is easy for them (learners) to understand because they can relate to their social life.

Oluwakemi- What other views do you have about EE?

P2- I think it should be incorporated in all learning areas (subjects taught in primary and secondary schools) because it is all our problem… it faces all of us. Even the Maths people should know about the environment… instead of saying… counting like the bubbles, they (Mathematics teachers) should say counting trees. If I have bubbles of CO_2, which makes 5 bubbles of CO_2 for

example… something like that but it should be in their system to know. All of people, even the elders at home should know.

P4- I will also say, the Department of Education made a good thing by introducing EE. It came just in time. I also learned that we are facing a major 6th extinction so we think … I think EE that if EE is introduced to learners we can… maybe save our planet, we can

Oluwakemi- How did you learn to teach EE? What ways were used in achieving this?

P3**- We consult various… various sources like library, get the textbooks, we mostly use the internet for hmm… the pictures…**

P1- the videos

P3- …even though we use the original pictures for hmm…the background of the presentation but then, we usually consult the internet… it's rich in information.

P1- We consult the lecturers

P3- …even the Dr(s) who have done research

P1- finished students (graduates)

Oluwakemi- Do you think EE is well covered in the CAPS curriculum?

P4- The time allocation, I don't think… it's enough. Well… I think the EE is covered but the time allocation is not enough. The amount of time that is dedicated…

P1- EE is taught for a short period of time

P3- It is also important subject

P2- I think they (policy makers) should also incorporate that they (learners) should be also taken out on field trips but it is not covered in the CAPS document. In other words, they (policy makers) are saying it should only be taught in the classrooms but they (learners) should also go out to experience what they are talking about

P1- Yes

Oluwakemi- What challenges do you think you have regarding learning to teach EE?

P1- Our plants are getting extinct, because people are not educated, all in for instance the African potato; it's one of the plants that we wanted to present with another medicinal plant but Bu…. was afraid she was going to be arrested because it's now regarded as endangered species, so that's the kind of problem we were facing in our training, people are overharvesting plants; even if we need them to demonstrate we are afraid that is now illegal

P4- I still feel that err… EE should be introduced in the lower grades as well; let me say from grade 3-4, if it can happen (if it can be done), because introducing it at the FET, senior FET level I don't think it has much impact

P3- In terms of what they (co-participants) have said that it's… it was… it's only taught in the classroom whereas we feel that children need to be exposed, you know, in the external environment of what happened if you burn the paper, if you speak of the different plants that are found in the environment, show them (learners) so that these things can be instilled in their feelings that they are disrupting the ecosystem… so they are constraints (not exposing learners/outdoor activities/field trips) when it comes to exposure to such issues.

We feel that children (learners) should go outside like we did because we can't forget the experience that we had (when they visited Mtunzini for excursion)

P3- During preparations, we can use our phones to access the internet to get information at that time when preparing. The problem could be the case of incorporating practical in this thing (topics of EE/presentation done), we don't know how to design the practical related to environmental issues; it is not an easy thing to do… we don't know which one directly to use

Oluwakemi- What suggestions do you proffer to address the perceived challenges

P3- It is in the hands of the government to provide us with more trainings in such things because just imagine, if you wanted to incorporate the practical about 'global warming', where can you start if you are designing it? I'm just not too sure where you can start

P3- We need to get permission to… to harvest (in the case of protected plants)

P1- harvest… and the rules on how to harvest the tree

P4- The university itself should help (in terms of the design of practical)… the gardens, the… the Aloe Vera garden, the ginger, for the indigenous plants

P2- so we won't have to carry the plants from Nkandla to here (university which is 273,8km away)

P3- …just for demonstration

P4- It took us about 2-3 weeks to incorporate practical… practical aspect together with our lesson, the one that we have just presented. We had to think about the plants and we didn't obtain it here

Oluwakemi- I think it has been wonderful chatting with you guys, I am very grateful

FOCUS GROUP INTERVIEW 4 (FG 4)

Oluwakemi- Good day, I am pleased to meet you. My name is Mr Adebayo, I am conducting a research based on 'Exploring the views of pre-service science teachers about learning to teach EE. The focus of the research is how pre-service teachers teach EE to Intermediate and Senior phases of the South African Education System.

Oluwakemi- Do you think that teaching EE is valuable? Why?

P1- Yes it is valuable, I think the most important thing to consider is that hmm… we are experience climate change, global warming and it is important for the learners to understand the importance of hmm… the environment and what we human beings can do to save our environment and maybe hmm… deal responsibly with the problem of global warming…

P2- Yes, I think it is valuable because the environment is where they (learners) live so they must know more about it and they should know how to act against the bad things and act good on the things that will help them. Hmm… the issue about global warming is the thing that we are facing here in South Africa; we need the learners to know about it so that they will be able to help in managing things like that.

P3- Yes, I think it is basically the same thing… at this rate, life on earth is unsustainable so teaching learners how to sustain… to help sustain life on earth

could help learners a lot and help future generations so we must teach so we must teach EE to stop issues such as global warming…

P4- and pollution… and since we are teaching (going to be teaching) learners who will, in future be out there; in the work place, be business people, we should teach them about the importance of conserving their environment so that they will be responsible citizens who also consider nature as the most important part of our lives

Oluwakemi- What are your experiences of learning to teach EE topics?

P3- I think in our experience on Natural Sciences Method 2 module, there is a lot of emphasis placed on indigenous knowledge and biodiversity, everything is centred around those two topics so that they (university) want to create teachers who are aware about EE and who are willing to teach EE as the presentation we've just done for our NSM2 class, every group that presented had a practical that involved something was eco or environmentally friendly such as the one we did… It showed that learners must be aware of the 'biodiversity' in the environment and help in every way to sustain it

Oluwakemi- Do you think EE is relevant to the sustenance of planet earth? Why?

P3- EE is relevant to the sustenance of the planet. We learned along the way that some habitats and ecosystems are being destroyed such as the one in Ukraine… in hmm… American Indian tribe, we learnt that in Natural Sciences 110 (a module taken in year 1 in the university) and so which shows that EE teaches people to sustain the environment and be eco-friendly and illustrated examples of where people who weren't eco-friendly and all that didn't survive because their environment fell apart which is what will eventually happen to the earth if we continue to abuse our environment and neglect teaching EE

P1- and also, environment is the… most important aspect of hmm… of the life and people are mostly interested in the things like developing yourself economically and they don't really hmm… prioritise being informed about environment, nature, the different species and how to conserve nature and instead they just… hmm… more interested in taking and taking… so it is important for people to learn about EE

P2- and as they said, we should conserve it, for example: if we keep on deforestation (clearing the forest); what will happen in the future if we no longer have

plants, where will we get oxygen?, so that will affect us in future so the learners should know about it as they grow up… grow with it.

Oluwakemi- How did your group design the lesson? What were some of the challenges/opportunities in designing the lesson as a group?

P1- **Usually when we designed the lesson, we stick to the CAPS document, the curriculum document but we as teachers (trainees) are required to also include something about the indigenous knowledge so stick to CAPS and follow the requirements that are on the CAPS document and also we have to go out of our way to include indigenous knowledge and it is a challenge to include it… we had to come up with strategies that will enable learners to understand the link between science and indigenous knowledge… so we usually use case studies, they are more accessible hmm… it is not easy to get hmm… people who will be able to demonstrate how they use indigenous knowledge, so we use case studies and pictures… we just present that to the learners**

P2- **The way we structured our lesson plan, let me talk about this one (presentation on biodiversity); we firstly look at what we want the learners to know and be aware of as we do the 'Specific Aims', so the way this lesson was done, the practical was included… also the indigenous knowledge. Previously when I was at school (high school), I've never had something that included indigenous knowledge in science… so they (teachers) were structuring their lessons as doing only science… just science and now we are taught to include the indigenous knowledge**

P3**- I comment that including indigenous knowledge is often a challenge as we experienced in this lesson.**

We actually decided on a topic before planning the entire lesson, when we came to planning our practical activity, we had a problem… a bit of a problem a problem there; our practical activity was mainly concerned with biodiversity… showcasing the biodiversity of the earth but then the problem is that we couldn't come up with err… an appropriate assessment for Grade 5 learners which made us shift to this practical demonstration

P4- I what I discovered (in terms of opportunities) when you are teaching (learning to teach), about biodiversity or any topic related to EE, it is always best that you do something out of the class and allow learners to be in close contact the nature

Oluwakemi- Did you enjoy learning to teach EE topic(s)? Please elaborate

P1- Yes

P2- Yes and we gained some strategies on how we will do it at school (place of work), the experience; it was interesting to think about diversity… you know I've never thought of doing a practical on diversity but now, I know what I can do and the remind goes broader; you can think of strategies… so that is experience.

P4- You can be creative when you're given a topic related to EE, you can be creative as a teacher, there are so many things you can do like the posters, pictures, hmm… ya

P2- and do something that is available not something that is impossible.

P3- It only took me learning about such issues (environmental issues) from Natural Sciences… to understand these issues. In the past, I would have rid (got rid of) the leaf of a tree without any problems but now I think before I do that which is why I think most learners in schools (primary and high) coming from background (rural) such as mine would discriminate the environment because they aren't aware… we weren't given the opportunity to learn about EE a lot in schools so if it is possible, EE could be focus (a focus) in our school teaching from now on giving everyone the opportunity to be aware

Oluwakemi- What other views do you have about EE?

P2- I think EE should be promoted because it's really important for the younger generation, especially, so that they will know what is good and what is bad because when you look far back, the indigenous people knew how to conserve biodiversity but now, we are not aware of that, for example, they (people) just burn fuel In any way they like, the gases from fridges and all

those things… the technology has an impact so the learners must be taught about EE so that they will know the strategies to overcome these problems.

Indigenous people… they didn't cut off many plants or trees when they need to do something… maybe they cut plants for fire, they don't cut many plants… but the modern society, they can cut maybe the whole forest for the economical use, the industrial use but the indigenous people, it's just the home use only for that moment and the plants get time to grow up

P4- For me, err… the emphasis is to hmm… as teachers (trainees), we should hmm… we should be initiative (have initiatives), create hmm… campaign against pollution… err during 'Arbour week', we should take our learners out learners to plant trees… basically we should be practical about EE; we should let our learners experience it, do it, so that when they are out in their communities they will be practising what they are doing in school… it should be a lifestyle

P3- EE hmm… is a bit difficult to apply in real schools (primary and high) rather than when you practice it here (in the university) in …when you are doing your degree from my experiences during my teaching practices. You actually found out it was really hard to incorporate it because the time frame you are working with and all that… and sometimes the resources… although it could be the teacher's responsibility to get the resources; in the real world, it is not really many things that most teachers in many schools focus on because it is very difficult to teach in schools… it's very difficult to teach.

Oluwakemi- How did you learn to teach EE? What ways were used in achieving this?

P1- What we were taught in our Method (education methods' modules) classes is that when you are teaching in a science classroom, you should present something to the learners; can be a question or something visual that will trigger learners' thoughts. We should let them… hmm… begin the lesson and you as a teacher; you must take on from what they said in the class

P3- I think it is developing the skills to be able to link the theoretical things we learned with actual things that are happening in reality regarding environmental friendliness… issues that are generally occurring right now and being able to link

them with how we're learning at school and realizing the importance because here… they are telling us in theory that cutting down trees and all that could be harmful and in some cases

Oluwakemi- Do you think EE is well covered in the CAPS curriculum?

P2- I am not familiar with all the topics in the curriculum

P1- Not familiar

Oluwakemi-What challenges do you think you have regarding learning to teach EE?

P1- Yes we did have challenges (on resources) as you saw our presentation; we couldn't get something that would represent the shape of the pyramid, ya… sometimes the resources are hard to find. Hmm… the CAPS requires us to do so much and the guidelines we were given required us to do so much.

We had an idea on what CAPS wanted us to do; we looked at the 'Specific Aims'

Oluwakemi- What suggestions do you proffer to address the perceived challenges

P2- The resources; we can use anything that is available

P3- Be creative

P1-Use recyclable materials

APPENDIX 7

INDIVIDUAL INTERVIEW TRANSCRIPTS

FACE TO FACE INDIVIDUAL INTERVIEW 2 (II 2)

Oluwakemi- Good day

Participant- Good day sir.

Oluwakemi- I welcome you to this face to face semi structured interview which is a follow up to our focus group interview which we held recently based on the title of the research 'exploring the views of how pre-service science teachers learn to teach EE' in the intermediate and senior phases of the South African education system. I want to get more insight about how you learn to teach EE as a trainee.

The focus group interview highlighted the following challenges that you experienced while learning to teach EE, you talked about designing the teaching, the equipment and time. How would you overcome these challenges that we have highlighted

Participant- Ok… for the equipment, I've decided that am just going to buy my equipment… whatever I can buy like what Dr Mudaly (change real name) (lecturer in charge) said it's just best to have your equipment or just ask people to sponsor… am just going to keep trying if I can't afford it and I will buy the equipment myself. And then time… I think I'm going to have to pit in extra time maybe after school or use double lessons, double periods or whatever because time is tight and learners do need to complete whatever has been planned for them to complete… so they do need the extra time.

With the design, I think it is best to consult other people have been in the field… somebody I could rely on like Dr Murray (pseudonym for lecturer in charge of NSM 2 module), my peers; somebody I can ask… I know that they can give me good advice or what not… maybe research, google (internet search engine) and ask what other alternatives I could do in… instead of what I can't do

Oluwakemi- So in relation to designing your topic; for instance when it comes to designing your topic, you want to design practical, or you want to design the methods of teaching…

Participant- Yes

Oluwakemi- You are saying that you are going to rely on google, lecturers, and your peers

Participant- Yes I think it is important that we have to be updated (up to date)… if the textbook maybe says, I know that… for instance designing an onion epidermis slide, you know that it has always been there, it has always been there, they've done it, we did it and they still expect learners to still do it… so I think if we see it on the internet and speak to each other, maybe they can modify it; something better instead of onion.

Oluwakemi- You know like if you want to design, let's take for instance in relation to EE, global warming, how will you do a practical on it?

Participant- There was a group presentation about global warming and carbon dioxide and I think it was very good. I'll probably ask around from those people who did it… I saw it and how easy… ok not easy but it is manageable… anybody could do it if you put yourself after which you can do it.

Oluwakemi – By improvising

Participant- …yes through improvisation also

Oluwakemi- Sometimes those things are not available… those equipment… they are expensive so you just look for other alternatives that can help you.

Participant- Yes… other alternatives that you can improvise in place of the real equipment.

Oluwakemi- How can teacher education be improved to support pre-service teachers to teach EE?

Participant- **I think that they (university) could do a lot of what they do in the method modules, they can actually put in the content modules… the things we**

go through in the method modules, some of them can be put in content module. Like my major in NS (Natural Sciences), maybe they could put in some things that will actually require me to go out there and do I'm supposed to do as in the method's class. I don't think that hmm… designing practical and everything should just stick to the method classes and the method modules only… I think they should be everywhere or I think they should be on modules about environmental studies, about being in the lab, …ok going outside, taking field trips… maybe a module like that could really help.

Oluwakemi – So are you saying in content module, it should be combined with method?

Participant- Yes because in the first year there are no methods so if I do not get it in my first year when I'm doing 110 and 120, obviously it's gonna be difficult for me to grab it the following year when I'm doing 210. Because I haven't been doing it all the time; the whole year but basically what I see is what I have been doing before the methods was basically nothing… I haven't been taught how to teach

Oluwakemi- So there must be a kind of integration? Every module should have teaching methods? How to teach it not that you just do only content?

Participant- **Yes so that when I get to higher level (in the university); I am well prepared, I know the basics, the foundation is good, so I won't struggle… even if I go for teaching practice.**

Oluwakemi- Do you always do EE aspects from your level 1 to 3?

Participant- Ok, that is the problem… cos my other major is biological science and there is a lot of practical there… I'm speaking a lot about it because Natural Sciences is a learning area but Biology, I really think that they should invest on that (do more EE methods in it) and maybe for physical sciences.

Oluwakemi –Well I'm looking at EE…

Participant- Natural Sciences?

Oluwakemi- … that do you enough from all the modules that you have been doing that has to do with Natural Sciences… Do you do enough EE? Although in Biology, there is also EE; do you think you do enough?

Participant- I don't think it's enough. I think it's like 30%. Even though the curriculum, when you look at the CAPS document, you could see that a lot of things lead to EE but then… you know, I don't think it's in the context of being in the environment and being practical… being hands on… you know, I think it is just theory based.

Oluwakemi- So they should make it more practical?

Participant- **Yes. Even for pre-service teachers, they (lecturers/university) shouldn't expect us to just make learners be more practical (engage in practical work) if we are not practical ourselves (do not engage in practical)**

Oluwakemi- Prior to studying this module, NSM 2, how did you learn to teach EE and after taking the module, what has been the difference?

Participant**- I think before NSM 2, I was focusing on theory… it was just the theory part, maybe if I could show the something I could (learning how to teach EE/teaching practice), if I could make them (learners) do something I will. I really didn't see the importance of learners actually meeting especially 'Specific Aim 2' which is investigating phenomenon in Natural Sciences. Now I have learnt to incorporate it at all times just to accommodate the multiple intelligence in the class**

Oluwakemi- So you were better now? Some things were difficult before?

Participant- **Yes… you know I thought that I had to have the right equipment… I didn't think that I could actually use anything… you know; I just didn't know… I just didn't know what to do. Now I know what to do… I can just figure out something, ask somebody, google it… you know, if you think about it and you have an idea of what to do**

Oluwakemi- There are these 5Es one member of your group was talking about the other day, I have them here because you were struggling to remember…

Participant- We could only remember 3 I think.

Oluwakemi- I've got 'Explore', 'Explain', 'Evaluate', 'Engage' and 'Elaborate' which are part of the theory of constructivism.

Participant- Yes

Oluwakemi- What… the member was saying that we should apply these, so in your teaching of EE, how do you think this can be of help to you?

Participant- It would be of help because… okay, the process right you start with exploring and explaining… it's a process that could help you in actually designing because it used to be a problem. If you could just go about these 5 Es and try design the task, I think it's going to be very easy… it won't be hmm… too difficult… like it won't be challenging like it's already is.

Oluwakemi- So it's going to make it easier because before the module, you didn't know…

Participant- what to do… even where to even start

Oluwakemi- So it's like 'scaffolding' for you to help you…

Participant- Yes

Oluwakemi- … to move to your 'zone of proximal development'

Participant- Yes, how to move from the 'known to unknown' from the 'concrete to the abstracts'

Oluwakemi- Are you aware of various approaches to teaching EE apart from the classroom teaching? E.g. case studies, team work, field trips, mature trails, group methods, buzz session, simulation games, role play etc. Are you aware of all these or you don't know all of them?

Participant- I know some of them like case studies, team work, field trips… I don't know what mature trails are… I don't know what buzz sessions are… simulation games…maybe I've seen it and don't know what it was.

Oluwakemi- Role play/

Participant- I've seen it in other contents and not Natural Sciences or I don't… I haven't imagined how to apply it in environmental studies

Oluwakemi- Did you use any of these to help you learn how to teach EE? Please elaborate.

Participant- No I haven't

Oluwakemi- But now after this module you know what to do and how to go and use it?

Participant- Absolutely

Oluwakemi- So you've not really been using them but you know them?

Participant- Yes

Oluwakemi- In closing, what has been the experience of learning to teach EE and what other general comments do you think you can give in relation to EE in Natural Sciences for Intermediate and Senior phases as you learn?

Participant – I think it has been very enlightening, you know… something we just take for granted and we don't think we can fix it ourselves but now that I know that if there is a problem and there is something you can do about it and if you know who to go to on what to do, I think you can actually fix it to save the earth… it's a lifelong process and by doing that, we are … what's this… hmm… principles of the curriculum… of CAPS, that talks about how they want learners to be responsible citizens… I think this is it… this is how you can be responsible citizens to your country and be faithful to this earth by giving it back what it deserves.

Oluwakemi- Thank you very much, I appreciate your time and contributions.

Participant- Ok sir, thank you

FACE TO FACE INDIVIDUAL INTERVIEW 7 (II 7)

Researcher- Good day to you

Participant- Good day

Researcher- Am happy you were able to make this semi-structured individual interview. It is a follow up to our focus group interview which we held recently. As you know, we are working on research titled; 'Exploring the views of pre-service science teachers about learning to teach EE' and our focus is on teachers who are training for the senior phases and the intermediate phases of the South African school system

Your focus group interview highlighted the following challenges that you experienced while learning to teach… if I can recap or recall, you highlighted lack of knowledge; designing the practical… suitable practical; and also integrating with IKS. I just want you to explain to me how you think you could overcome or she more light on the problems and then let's look at solutions… how did you overcome or how do you think in future, if you didn't really successfully overcome the challenges, how will you overcome them in the future?, thank you

Participant- Hmm… with regards to lack of knowledge, I think on a broad scale, for me that was because of… we weren't really taught about it in school (high school), well overcoming that will be a big change in terms of the school curriculum; to incorporate it more into the school curriculum as was previously. And then like on… an individual basis, with regards to lack of knowledge, before actually I attempted to plan my activities with lesson, I should be… be able to conduct my own research before even planning that lesson; to familiarize myself with the content first before even thinking about how am going to incorporate the knowledge into my lesson.

Hmm…, with regards to IKS, the only way I think that we could overcome that was or is to probably speak to senior citizens, like in our case with global warming and climate change and how we could use IKS to overcome climate change. So there maybe you will be looking at more farming methods or things like that there because crops are basically affected, like there if we could go on a research trips speaking to senior farmers who may have indigenous knowledge and then from there you can work from there.

Even though the IKS like… before knowing what you were taught, for integrating what you've been taught only, you need a fair amount of research on our own

Researcher- Then the third one is knowing the suitable practical, how will you overcome that?

Participant- Hmm… there I think if we have like a range or varieties of practical; like analyse each practical; analyse the content we wish our learners want to learn; look at the pros and cons of each practical and then maybe err… see which one will be most relevant to our lesson itself.

Researcher- Hmm… those practical, are you saying that some publishers or some writers or some scientists should those things and then you pick them up or how do you think we can have those array of practical which you can now select from?

Participant- Hmm… I think those practical have already been designed… like when we did it for our lesson… there were whole like together, we (group) generated like a few practical together so I think it just depends on the individual and what you want to learn.

Researcher- Who designed those practical?

Participant- Well it has been previous teachers who have conducted the lesson or it could have been scientific like experiments or things like that so it's not like they need to do it, it's already been done… it is just a matter of where you can modify it or how you can adjust it or make it suitable for your particular lesson

Researcher- So you are saying that those practical actually exist, the only thing is adapting it to your lesson and to your…

Participant- Ya… if doesn't exist but with regards to our topic it did exist, if it doesn't exist maybe consult different practical and maybe you could extract like few things from each practical to create a new one… so by taking a little bit from here… a little bit from there, putting them together and making it your own one.

Researcher- Thank you. How can teacher education be improved to support pre-service science teachers to support EE?

Participant- Ok. That will be more at the university level?

Oluwakemi- Yes

Participant- Ok, hmm… you see with regards to our university, we are only learning about it because of the module that we were doing but if it was EE, it needs to be something that is integrated across the board in all modules… in that way ensures that no matter what specialization you are going into, at some stage you are going to

be learning about EE. Like here (NSM 2) we are only learning about it in just the method module, so if you qualify to teach Natural Sciences, you'll only got to be learning about it in NSM 1 and 2 but if you look at the amount being done, it's not to a great extent… so for me I think that maybe a module on its own for EE maybe that could improve things.

Oluwakemi- You are saying there should be a module called EE…?

Participant- Yes

Oluwakemi- …or it should be integrated into other modules?

Participant- or integrated into or the modules that it's already being into like NSM 1 and 2 … there …it's there already so to enhance that maybe include a deeper module content in it... so intensify the module content

Oluwakemi- Are you saying both or either?

Participant- I am just saying that it's either way it might work but definitely integrating it across all modules or those modules that the content can be integrated into… like obviously if you look at maths, you can't really integrate EE there but if you look at History or maybe Geography… even like Technology to a certain extent then you could probably incorporate it there

Oluwakemi- Ok, what about having it as a module?

Participant- That will work

Oluwakemi- So it's either it goes across the board or it goes across board and we also have it as a module?

Participant- I think both

Oluwakemi- Thank you. Prior to studying this module (NSM2), how did you learn to teach EE and after taking the module, what has been the difference?

Participant- Hmm… when we saw EE in this module, it brought back slight memories of doing it at school (high school) level… like I said previously, it wasn't taught like a lot… so but the knowledge that we did manage to acquire from the school(high school) level… it could have enabled us a **little bit** to teach it… but other than that if we were given the topics, we obviously would have had to go and research it so the

research that we conducted on our own; the textbooks that we consulted; the lectures that we attended, that also did enable us to teach or to learn more about EE.

Oluwakemi- How has been your teaching now… learning to teach before and now? What is the difference?

Participant- With regards to learning to teach it or just learning the content?

Oluwakemi- Learning to teach because you are being trained to be a teacher…right?

Participant- Ok, we did touch on it a little bit in err… in method 1 (NSM1) last year when I did it but this year I think there is a great amount of focus on it as to not just knowing the content but we were actually taught as to how to convey the messages of that content given… like it is one thing for you to know it but it's one thing for you to be able to convey it effectively to your learners.

Oluwakemi- So…

Participant- And then obviously, with regards to the way you teach, in general teaching, there have been modules prior to this one like other Method modules or other teaching practice experiences that would have enabled us to, you know, err…we learn how to effectively convey our content, so integrating your EE and your basic methods of teaching… put them together… and I think that would have kept you to be able to teach it.

Oluwakemi- So… you can teach better now?

Participant- Yes

Oluwakemi- You've learnt how to teach better now compared to when err…?

Participant- Yes… like when I went for my first teaching practice year (at that time), it is much better now.

Oluwakemi- Are you aware of various approaches to teaching EE apart from classroom teaching like case studies, team work, field trips, mature trails, group methods, buzz session…

Participant- Ok… hmm… am aware of them… haven't really done them because I haven't really been given chance to do it because I haven't really taught EE in a

proper school (high school) setting but I'm aware of it like if we are to look at the presentation that we did in class, our presentation… we would have essentially required for learners to work together in groups; we would have required for them to engage in practical… so another group had a similar topic to ours but theirs wasn't so much of a practical work, as such, but they took their learners out on a field trip. So we are actually aware of these methods… it just a matter of saying ok… which method is going to work best for my lesson and how am I actually going to implement it or am I going to stand in front and teach theory to my kids?

Oluwakemi- So you are aware of all of them or most of them…?

Participant- Ya

Oluwakemi- …but the thing is knowing when to use them and having the opportunity, right?

Participant- Ya… but also it depends if you actually implement it because there are so many teachers who can make a lesson very exciting by taking children (learners) to do a field trip… others will just say we don't need to do that just listen to what I am saying… so I think it also depends on the individual

Oluwakemi- Finally, before we wrap it up, what general views can you say about learning to teach EE?

Participant- Hmm… for me it's (EE) not something that draws my attention. If I look at EE, for me I'll view other aspects of life more interesting than EE but once you come in contact with it like how we did in this module and the previous method module, you really see… you start to see how much you are actually neglecting… so hmm… it does, after coming into contact with it, you create an awareness in yourself so enables you to actually teach EE better. Like if you have no hands-on experience with it (EE), there is only so much you can convey from a theoretical experience but if you have both; the hands-on and theoretical, your lessons are obviously going to be much more effective and much more better because you'll have a stronger content to convey

Oluwakemi- How relevant has been the constructivism theory to…?

Participant- It has… because everything we do… it's like while learning to teach about EE one would be that we worked with peers with our fellow … so there hmm… I think we speak about constructivism and working with other people. So there we were like able to learn from others; what they know, what we didn't know… filling the gaps and from there how to enhance our own understanding which is eventually going to enhance our lesson itself

Oluwakemi- So it helped you in scaffolding… in moving you to the 'zone of proximal development'?

Participant- Yes

Oluwakemi- Initially like you said, you were not cut out for EE before but after but after going through this module (NSM2) and doing this teaching and so on and so forth…

Participant- But also learning about EE is not such that… I will like to say okay I'm only going to teach it to you, that's it but she (lecturer of NSM2 module) expected us to go on, to be active in our own learning about it, we had to take the initiatives ourselves… so it makes a big difference when you've been taught by somebody only and when you take the initiative yourself… for me that enhances understanding and learning

Oluwakemi- So thank you very much, it's been a great time talking to you.

Participant- Thank you.

APPENDIX 8

PRE-SERVICE SCIENCE TEACHERS' REFLECTIVE DIARIES

Grp 1

Natural Science Method 2: Reflection on group task

Name: ..... No name 28/7/14

1) What aspect of EE did you try to incorporate into your lesson?

The aspect of EE we tried to incorporate into our lesson
was conservation of medicinal plants in our communities

2) How did you attempt to teach this aspect of EE

In our lesson, there was a practical part where we demonstrated
how an aloe plant found in our homes or in our communities can be
used to treat certain illness e.g. flu and constipation instead of using western medicine

3) Tell me about your experience of learning to teach EE. What were some of the specific challenges that you encountered when attempting to teach EE

One of the challenges we experienced as a group is that some medicinal
plants are very difficult to obtain. To get them you have to travel
a lot of you can even obtain an access permit to obtain that
plant. One of the major reasons why we experienced this is because
of human impact on the environment. Some plants have been
distroyed.

resources

No name

4) What opportunities arose when attempting teach EE? Do you think it is valuable to teach EE? Explain.

One of the opportunities that arose is that Environmental
Education can be taught in different ways for example
learners can engage in Field work eg. visit places like Landfills,
where electricity is being generated. Environmental Education
can also be more interesting if Learners can do Role
play

5) What is your view on the value of teaching EE? How can teaching EE influence behaviour changes in learners?

Teaching Environmental Education is very important. I believe
that it can benefit the society. Teaching Environmental
Education can benefit the society if we as teachers
can be able teach learners in a way that Learners
can observe or realize that Environment is very important.
in their Lives.

6) Did you seek any assistance when learning to teach EE? YES

7) If so, from whom / which sources did you seek assistance/ info

I consulted the library books and the internet

APPENDIX 9

Professional editing approval letter

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EDITING CERTIFICATE
Re: **Oluwakemi Ayodeji Adebayo (UKZN)**
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I confirm that I have edited the text and references of this dissertation for language, clarity and layout. I am a freelance editor specialising in proofreading and editing academic documents. My original tertiary degree which I obtained at UCT was a B.A. with English as a major and I went on to complete an H.D.E. (P.G.) Sec. with English as my teaching subject. I obtained a distinction for my M.Tech. dissertation in the Department of Homeopathy at Technikon Natal in 1999 (now the Durban University of Technology). In my capacity as a part-time lecturer in the Department of Homoeopathy I have supervised numerous Master's degree dissertations.

Dr Richard Steele
9 December 2014
electronic