



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Research Commons

<http://researchcommons.waikato.ac.nz/>

Research Commons at the University of Waikato

Copyright Statement:

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

The thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- Any use you make of these documents or images must be for research or private study purposes only, and you may not make them available to any other person.
- Authors control the copyright of their thesis. You will recognise the author's right to be identified as the author of the thesis, and due acknowledgement will be made to the author where appropriate.
- You will obtain the author's permission before publishing any material from the thesis.

**Developing Pre-service Teacher Education in
Environmental Education for Sustainability
in Papua New Guinea**

A thesis submitted in fulfilment
of the requirements for the degree of

Doctor of Philosophy

at

The University of Waikato

by

Asaku Simiong Openg



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

August 2012

Abstract

Government policies in Papua New Guinea (PNG) identify the need for environmental education for sustainability (EEfS) to respond to environmental and sustainability issues faced within the country. However, little has been achieved to develop EEfS in pre-service teacher education. This doctoral study developed an intervention to address this problem in one PNG teachers college. The intervention design was underpinned by a theoretical framework comprising conceptual knowledge and pedagogical ideas from the EEfS literature, conceptions of teacher education and the local traditional knowledge of PNG, and a survey of pre-service teacher students and document analysis. The intervention was delivered to 300 year one pre-service teachers.

An evaluation of the intervention used pre and post intervention questionnaires, student reflective journals and student work of 81 pre-service teacher participants. The analysis involved simple statistical and thematic analysis, using themes that both were informed by the literature and emerged from the data.

Student perceptions indicate that knowledge, skills and attitudes for EEfS were developed during the intervention. After the intervention, the students identified land problems and biodiversity depletion especially that of endangered species, as important issues for PNG, but their views on poverty as an issue were more complex. The data further suggests that the pre-service teachers were motivated and confident to teach EEfS, using learning approaches that were modelled in the intervention.

While, it is unclear if the pre-service teachers will take personal action to contribute to future sustainability, it appears that the implementation of the intervention has had some impact on the pre-service teachers' awareness, interest, and confidence to deliver EEfS in their future classrooms. The study also indicated that further development of an EEfS course in pre-service teacher education in PNG may require changes to current teacher education practice.

Acknowledgement

I would like to thank people who have assisted me in completing this doctorate. Firstly, I would like to thank my Chief Supervisor Dr. Christopher Eames and my second supervisor Dr. Kathrin Otrell-Cass for their assistances and constructive criticism during the research; Prof John Williams and Raewyn for hospitality and other support and encouragement you provided for me during my study; the officers in the international office, post graduate office, student support learning and the libraries for support and encouragement they provided to help me write my thesis.

Secondly, I would like to thank science and social science lecturers, and administrators of the Teachers College for all the help and support you provided for me during the data collection and EEfS course intervention, and the student participants of my study in 2008 and 2009.

I wish also to thank my sisters and brothers in the Lord, and sisters who give me lift to church, pray for me and with me; my PNG, Vanuatu and Solomon Island friends who supported me in many different ways.

Finally, I wish to express my love and appreciation for my husband for his interest and support throughout this study; my children (June, Solomon, Yuro, Deborah, Timothy and Victoria) for putting up with my studies; my old mother who prays for me daily; brothers Botong, Steven, Bomege and Watson for their prayer and financial support they provided for my studies and my sisters Tina, Mimiba, Ruth and Laweko for their support and prayer during my study.

Table of Contents

Abstract	i
Acknowledgement	iii
Chapter One	1
1. Introduction	1
1.1 Chapter Overview.....	1
1.2 Context of the Study.....	1
1.3 Environment and Development Problems in PNG.....	4
1.4 The Significance of the Study	7
1.5 Purpose of Study	9
1.6 Research Questions.....	9
1.7 Research Outline	10
1.8 The Thesis Outline	10
Chapter Two	13
2. Environmental Education for Sustainability	13
2.1 Chapter Outline	13
2.2 Environmental Education for Sustainability (EEfS).....	13
2.2.1 The Goals of EEfS.....	14
2.2.2. Tilbury’s Framework for EEfS	17
2.2.3 Education about, in and for the environment	26
2.2.4 Traditional Education System.....	31
2.2.5 Summary of the Characteristics of EEfS	35
2.3 History of EEfS.....	36
2.3.1 History of EEfS in the world.....	36

2.3.2 History of EEfS in PNG	39
2.3.3 The History of Teacher Education in EEfS	46
2.3.4 Pre-service Teacher Education in EEfS in Asia Pacific	51
2.3.5 Pre-service Teacher Education in EEfS in PNG	53
2.3.6 PNG Pre-service Teachers College Curriculum Revision	55
2.3.7 Summary of history and development of EEfS.....	59
2.4 Summary.....	61
Chapter Three	65
3. Content and Pedagogical Knowledge.....	65
3.1 Chapter overview	65
3.2 Knowledge	65
3.2.1 Environmental issues.....	65
3.2.2 Concepts of EEfS	78
3.2.3 Summary of Concepts of EEfS	88
3.3 Pedagogy	89
3.3.1 Learner-centred approaches	89
3.3.2 Learning Approaches	89
3.3.3 Role of Teachers and Learners	100
3.3.4 Summary of pedagogy.....	104
3.4 Action competence.....	105
3.4.1 Experience	106
3.4.2 Knowledge	108
3.4.3 Critical Thinking and Reflection	111
3.4.4 Action.....	112
3.4.5 Commitment.....	113
3.4.6 Summary for action competence	114

3.5 Chapter summary	114
Chapter Four.....	117
4. Methodology	117
4.1 Chapter overview	117
4.2 Research paradigms	117
4.2.1 Positivist research	118
4.2.2 Interpretive research.....	119
4.2.3 Critical theory	120
4.2.4 The Research Paradigm for This Study.....	121
4.3 Research approaches.....	122
4.3.1 The quantitative research approach	122
4.3.2 The qualitative research approach.....	123
4.3.3 Triangulation of approaches	126
4.4 Research methods.....	127
4.4.1 The questionnaire	127
4.4.2 The interview.....	129
4.4.3 The Focus Group Interview	130
4.4.4 Document analysis	132
4.5 Research Design	133
4.6 Ethical issues.....	139
4.7 Chapter summary	140
Chapter Five.....	143
5. Intervention	143
5.1 Chapter overview	143
5.2 Policies and curriculum	143
5.2.1 The policies on EEfS.....	143

5. 3 Existing Practice in EEfS at the College	151
5.3.1 Content Knowledge	152
5.3.2 Pedagogy used in current practice	158
5.3.3 Barriers in current practices	163
5.3.4 Summary of current practice.....	164
5.4 Intervention - a New Course Design.....	166
5.4.1 Overview of the course	166
5.4.2 Content of the EEfS Intervention Course	169
5.4.2 Key Concepts Covered in the Intervention Course	171
5.4.3 The pedagogies used in the intervention course	174
5.4.4 Limitations of the intervention.....	177
5.4.5 Summary of intervention	179
5.5 Chapter Summary.....	180
Chapter Six.....	183
6. Environmental sustainability issues and key concepts. 183	
6.1 Introduction	183
6.2 Environment and Sustainability Issues	184
6.2.1. Biological Environment Issues	185
6.2.2. Physical Environment Issues.....	195
6.2.3. Developmental Issues.....	204
6.2.4. Social Issues	205
6.2.5 Summary.....	218
6.3 Findings on Key Concepts of Environmental Education for Sustainability	222
6.3.1 Interdependence	222
6.3.2 Sustainable development	230

6.3.4. Connectedness	236
6.3.4 Summary of pre-service teachers' perceptions of key concepts of EEfS	239
6.4 Summary of findings on pre-service teachers' perception of environmental issues and key concepts	240
Chapter Seven	243
7. Findings on Pedagogy	243
7.1 Introduction.....	243
7.2 Findings on participants' perceptions about pedagogy	244
7.2.1 Constructivist Learning	244
7.2.2 Socio-cultural Learning.....	246
7.2.3 Experiential Learning.....	249
7.2.4 Enquiry-based Learning.....	251
7.2.5 Cooperative Learning	253
7.2.5 Student-centred learning	255
7.2.6 Traditional teaching and learning method.....	257
7.2.7 Summary of the findings on pedagogies.....	259
7.3 The pedagogy for EEfS.....	260
7.3.1 Multidisciplinary Issues	261
7.3.2 Holism.....	263
7.3.3 Experience	265
7.3.4 Values	269
7.3.5 Critical reflection	270
7.3.6 Relevance	272
7.3.7 Summary of findings on EEfS pedagogies	274
7.4 The Traditional Education System.....	275

7.4.1 Traditional knowledge, skills and values	276
7.4.2 Facilitator of traditional knowledge, skills and values	277
7.4.3 Venue for Traditional Knowledge, Skills and Values	279
7.4.4 Pedagogy for delivering traditional knowledge, skills and values ..	281
7.4.5 Summaryof Pedagogies	282
7.5 Summary of Chapter Seven	283
Chapter Eight	285
8. Action competence	285
8.1 Introduction	285
8.2 Action Experience	285
8. 3 Knowledge	289
8.5 Attitude.....	294
8.5.1 Attitudes towards teaching environment and sustainability.....	295
8.6 Commitment to Action	300
8.7 Reflection.....	303
8.8 Summary on action competence.....	305
Chapter Nine	309
9. Discussion, Conclusion and Recommendation	309
9.1 Chapter Overview	309
9.2 Existing Practice	309
9.2.1 Policies in place.....	309
9.2.2 Content Knowledge	311
9.2.3 Pedagogy	314
9.3 The intervention	317
9.3.1 Content Knowledge	317
9.3.2 Pedagogical Knowledge and Skills	320

9.4 Impact of the intervention	321
9.4.1 Impact on Content Knowledge.....	321
9.4.2 Impact on Pedagogy	327
9.4.3 Impact on Action Competence.....	330
9.5 Conclusion	334
9.6 Recommendation	339
9.6.1 Implications for practice.....	339
9.6.2 Implications for Further Research.....	339

References..... 341

Appendices..... 371

Appendix One. A letter to the principle of Teachers College seeking permission to conduct research at the college in Papua New Guinea	371
Appendix Two. A letter of Information and Consent to the Lecturer Participant of Phase One Study	375
Appendix Three. A Letter of Information and Consent to the Lecturer Participant in Phase Two Study	377
Appendix Four. A Letter of Information and Consent to the Pre-service Teachers Participant in the Two Study.....	380
Appendix Five. Student Questionnaire for Phase One Study.....	383
Appendix Six. Student Questionnaire for Phase Two Study	389
Appendix Seven Lecturers’ Interview Schedule for Phase One Study	395
Appendix Eight. Interview Schedule for Student’s Focus Group in Phase One Study.....	397
Appendix Nine. Interview Schedule Phase Two Study lecturer Interview Schedule	398
Appendix Ten. Reflection journal Template for Phase Two Study.....	399

Appendix Eleven. The Course overview for the intervention course implemented at the pre-service teachers college in PNG.....	400
Appendix Twelve Lecturers Training Programme	404
Appendix Thirteen Sample Lesson Plan	407
Appendix Fourteen Sample Lesson Plan	410

List of tables and figures

Table 1 Modules for Environment Related courses for Pre-service Primary Teachers' College	56
Table 2 Environmental Issues in PNG and World	66 <u>6</u>
Table 3 Phase One Study Design	134 <u>4</u>
Table 4 Phase Two Study Design.....	136 <u>5</u>
Table 5 Environment and Sustainability	156
Table 6 Courses that Provided EEfS at the Pre-service Teacher's College....	162
Table 7 Subjects that Deliver EEfS in Primary Schools.....	163
Table 8 Key Concepts of EEfS in the intervention.....	171
Table 9 Learning approaches in the intervention	175
Table 10 Depletion of Biodiversity an issue in PNG	185
Table 11 Deforestation an issue in PNG	189
Table 12 Endangered species is an issue in PNG	192
Table 13 Land dispute and degradation in PNG	196
Table 14 Pollution is an issue in PNG	199
Table 15 Global Warming an Issue in PNG	201
Table 16 Mining is an issue in PNG	204
Table 17 Population growth issue in PNG	206
Table 18 Poverty an issue in PNG	209
Table 19 Unequal resource distribution an issue in PNG.....	213
Table 20 Summary of findings on issues	218
Table 21 Social and Economic Development and Natural Environment.....	223
Table 22 Social cultural background and behaviour towards environment..	225
Table 23 Rural lifestyle and environment.....	228

Table 24 Economic growth and environment	231
Table 25 Development and Quality of Life	233
Table 26 Advanced Technology and Environment	235
Table 27 People and Natural Environment	237
Table 28 Prior knowledge and learning	244
Table 29 Effects of social and cultural background on learning	247
Table 30 Knowledge development, and past knowledge and experiences ..	249
Table 31 Questioning and answering in knowledge development	251
Table 32 Learning in small groups	253
Table 33 Teacher centred learning	255
Table 34 Utilizing traditional teaching and learning methods in schools	257
Table 35 Environmental issues as multidisciplinary issues	262
Table 36 Holistic study of environmental issues	264
Table 37 Experiences in Environmental Education for Sustainability	267
Table 38 Values in environmental education for sustainability	269
Table 39 Critical reflection about environment and sustainability learning	271
Table 40 Relevance in environment and sustainability education	273
Table 41 Traditional knowledge about environmental problems.....	276
Table 42 Facilitator of local traditional environment and sustainability knowledge and skills	278
Table 43 Venue for delivering traditional knowledge and skill and values	279
Table 44 Pedagogies for delivering traditional knowledge and skills	281
Table 45 Environmental issues pre-service teachers proposed to address	286
Table 46 Pre-service teachers' perceptions of things learnt in the intervention	291

Table 47 Learning activities for delivering EEfS learnt from the intervention	
.....	292
Table 48 Factors that influenced pre-service teachers' thinking about teaching EEfS	
.....	295
Table 49 Factors that influenced pre-service teachers to use the learning activities	
.....	298
Table 50 Pre-service teachers' action plans based on knowledge and experience gained in the intervention	
.....	301
Table 51 Reasons for Teaching EEfS in Primary schools	
.....	302
Figure 1 Strong Sustainability Model	
.....	80

Chapter One

1. Introduction

1.1 Chapter Overview

This chapter describes the context of the study and the state of pre-service teacher education in environmental education for sustainability (EEfS) in Papua New Guinea (PNG). This thesis begins by examining the people and their natural environment, including the land and the cultural environment such as their traditions to provide a context for this study of EEfS in PNG. It then describes the problems, significance, purpose, and research questions and research outline. It ends with the outline of the remaining eight chapters.

1.2 Context of the Study

PNG is an Island nation which consists of 600 islands, including the eastern half of the island of New Guinea (PNGNDoE, 2004b). The country's topography is rugged and mountainous, ranging from sea level or coastal lands to high mountains of over 4000m (Cammack, 2009; Kambuou, 1995), with a total land area of about 475,000km² (Kambuou, 1995). The country is divided into 20 provinces (Openg, 1998), which are further divided into two or more districts, which in turn are divided into one or more Local Level Government areas.

The population of PNG is about 6 million (Cammack, 2009; Ormsby, 2007), with an annual growth rate of 2.7 percent (Esonu, 2009; PNGNDoE, 2004b). There are over 800 distinct languages and cultures amongst the people (Esonu, 2009; Ormsby, 2007; PNGNDoE, 2004b). As stated by Cammack (2009, p. 6), "the nation hosts nearly 6 million people divided into more than 850 language groups (clans or wantoks) with strong cultural identities and traditions". Although PNG's cultures are very diverse, the traditional social structure is based on the practice of wantok system and subsistence economy with bonds of kinship with obligations extending beyond the immediate family (Esonu,

2009; Okole, 2003). The people own and use the land communally in clans or in wantoks and have a strong attachment to each other and their land (Cammack, 2009; Ormsby, 2007).

The majority of PNG people live in rural areas (Cammack, 2009), outside the cash economy, earning hardly any cash income and trading very little, and are unaffected by modern lifestyles, and they use subsistence farming and resources from the environment for their survival (Esonu, 2009). These people are engaged on three levels of agricultural activity, including subsistence and semi-subsistence and commercial subsection (Kambuou, 1995), because some parts of PNG have developed rapidly since the first contact with Europeans, whilst the majority of people continue to live more traditional lives, which are directly connected to the environment and its culture (Eyford, 1993; Openg 1997). This is shown by this observation reported by Glennon (2008):

A deep boomp, boomp echoes from lizard skin drums and a dance mime commences ... a voice nearby whispers, sea eagle dance. The three sea eagles wear headdress of white cockatoo feathers, feed their young with cassowary plume wands, and coax them on first flight. The bling is all hand crafted, necklaces of orange shell disc and black wild banana seeds are looped twice round, and finished with pig tusk. A sash of white frangipani flowers competes, flowing down from one shoulder (p. 12)

This quote describes one out of many dances people in PNG have where people have dressed like birds and danced. Some plant and animal parts are used in the dance. The plants parts used in the dance are tree trunk, wild banana seeds and frangipani flowers. Animals including lizards, cockatoos, cassowaries, shells and pigs are killed, so that people have their flesh as food and parts such as skin, feathers, shells and tusk for traditional dances. This is a typical example of people in PNG using plants and animals as decoration for traditional cultural dances. The views, beliefs and values of how people sustainably use resources

from the environment is passed on from one generation to another by having young children or youth watch the occasions, listen to explanations and by participating in the event (Eyford, 1993). If education such as EEfS is to be successful, it has to be relevant to the culture of the students and developing local traditional knowledge, skills and values through the use of locally appropriate learning approaches (Openg, 1998; PNGNDoE, 1990). There have been some changes in PNG curriculum to make it more relevant but most schools and teachers maintained what they are used to following that is:

Western education system [which] was introduced to teach the knowledge, skills and attitudes of the colonialist, whilst traditional skills and values related to local communities and culture were not valued very highly as part of educational activities ... The cultural and spiritual values and resources development skills for the communities were largely ignored (Openg, 1998, p.13),

This includes the fact that:

Education was provided in English, a language that the children did not speak at home and this often gave them problems. The children ... struggled to learn how to use the language and use it to read and write. They were always expected to speak [read and write] in English and their own language had no place in the education system ... This alienated the many young people from their local languages. It even caused some of them to feel that their languages were not important and they need not learn them (Openg, 1998, p.17).

Achieving goals of education including goals of EEfS in PNG has been difficult because the curriculum was not relevant for the people of PNG. The students were alienated from their language and local traditional knowledge, skills and values when they were not valued and utilized as part of educational activities (PNGNDoE, 1990).

PNG has always had great potential to become rich and developed because it has significant natural resources from the environment, including land, biodiversity, in the forest and seas, and minerals (Kwa, 2003). Kwa (2003) has noted that, since Independence, there has been much development in the country, including an overall increase in the nation's wealth, and in health. For example, life expectancy increased from 47 in 1970 to 57 in 1993, and the World Health Organisation declared PNG as a polio-free nation with increased access to education. PNG mainly exports mineral resources (Kambuou, 1995), but it also exports cash crops. It exported about 300 million kina (about 140 million US Dollars) worth of crops between 1985 and 1993, it earned about 70 000 million kina (about 33 million US dollars) from forest resources including logs, lumbers and wood chips in 1991, and about 10 000 million kina (about 5 million US Dollars) from marine and water resources in 1991 (Kwa, 2003). However, despite this, "development [in PNG] is generally described as lagging, uneven, stagnant and even backward in some areas of the country" (Kwa, 2003, p. 168). Kwa (2003) conducted an appraisal of environmentally-friendly development practices in PNG and concluded there were problems with these practices as described below.

1.3 Environment and Development Problems in PNG

There is little doubt that PNG is experiencing developments which are accompanied by environmental issues, as documented by, for example:

the overall wealth of the nation has increased but it has been accompanied by an increase in the gap between rich and poor (Kwa, 2003, p. 167)

On average PNG can be seen as an economically-developing nation because some parts of PNG are well developed and resourced, but other issues remain such as:

- “financial prosperity has been achieved with unacceptable levels of environmental degradation and destruction thereby robbing the opportunity for future generations” (Kwa, 2003, p.167);
- “PNG’s natural resources have been ruthlessly destroyed by largely foreign companies which have not contributed sufficiently to PNG’s prosperity ...” (Kwa, 2003, p.169);
- “Poverty is a lack of something, whether it be lack of essential services such as health and education, [food, information, finance] and any basic need, and occurs both in extreme rural areas and in and around modern high rise cities” (Kwa, 2003, p.179);
- The Government has made some efforts to to achieve gender equality such as the appointment of Women’s Advisor to the Prime Minister, the establishment of National Council of Women under an Act of Parliament in 1979, the upgrading of women to divisional status in 1983, the establishment of the national women’s policy in 1990, and the women’s division five year management plan in 1995. However, inequality continues to exist because successive governments did not put emphasis on reducing it (Turia, 2003, p. 2);
- “A strong increase in access to education has occurred ... [but this has] not corresponded to an increase in the quality of education, and that many young people are still being denied the opportunity to be formally educated”(Kwa, 2003, p.168);
- PNG’s economy benefits from export of some crops, mineral and forest resources, but very little of that is used to improve public facilities or infrastructure (Cammack, 2009, p.6); and
- PNG Government may have the ability to manage the land, forest and other resources they contain but often has difficulty because almost all the land in PNG is owned customarily by people (Turia, 2003, p. 2).

These quotes indicate that there have been some forms of social and economic developments in PNG in recent years but these have been accompanied by environmental and social issues which have created problems for the country and its population. It also indicates there are environmental problems including

degradation of land and other natural environments, pollution (Aka, 2001), and social environmental problems including rapid population increase, inequality and poverty in PNG (Cammack, 2009; Kwa, 2003). Some of these problems are created by people while carrying out normal social and cultural activities (Turia, 2003), whilst the others are created by development activities like logging and mining (Kwa, 2003). These problems need to be addressed holistically by all people as individuals and as members of groups and institutions using all appropriate resources and approaches (Tilbury, 1995).

One solution to addressing these issues was identified and documented in intergovernmental conference documents, including the *Belgrade Charter* (UNESCO-UNEP, 1976), *Tbilisi Declaration* (UNESCO-UNEP, 1978) and *Agenda 21* (UNESCO, 1991). Education can help people to understand and use sustainable practices to promote sustainable social and economic development activities. The Education Department of PNG responded to the recommendation of these intergovernmental conferences by developing and implementing basic quality education, especially for primary schools. However, providing basic education or more education is not necessarily the solution to an unsustainable world. This is clearly indicated by the fact that the most educated nations of the world are leaving the deepest ecological footprints, and do more damage to the environment compared to less educated nations (Miller, 2007). Therefore, it has been argued that for EEfS to be effective it has to be education that is relevant, holistic, issue-based, action orientated, values-based and critically reflective, provided with the intention to provide knowledge and instil values, beliefs and behaviours for sustainability (Fien & Tilbury, 1996; Tilbury, 1995; Bolstad, 2003); and has to be delivered as education about, in and for the environment (Bolstad, 2003; Lucas, 1979; McLean, 2003). One way of developing action competence for environmental issues is by studying locally relevant issues and concepts delivered using locally relevant approaches with the intention to develop in the students the knowledge and experience which will promote future sustainable actions (Jensen & Schnack, 1997).

However, my experience as a teacher educator at a PNG teachers' college indicated that this was not happening in pre-service teachers' colleges in PNG, because the lessons were being delivered to the pre-service teachers using lectures only without providing them opportunity to participate in observing or practice in resolving environmental issues. The EEfS teacher educators did not appear to be providing opportunities for the students to experience the environment and the environmental issues, and to gain practice to resolve issues. According to Mclean (2003), EEfS delivered through such methods is not effective and will not influence the students to take sustainable actions. Thus, a course intervention was considered to address these deficiencies and as part of this study was developed, implemented and evaluated.

The intervention was informed by Phase One Study data and a literature review, including a very similar study conducted in Israel by Tal (2010) on 75 pre-service teachers, carried out on the pre-service teacher education in EE, was aimed at developing critical thinking, participation and reflection by using participatory processes and learning activities in which the learners reflected on a variety of learning activities and approaches that they were involved in.

1.4 The Significance of the Study

My roles as a former teacher education environmental science course writer, course lecturer for environmental science and science teaching methods, and head of strand that delivered environmental science and science teaching and learning method courses at the teachers' college, had led me to be concerned about the effectiveness of EEfS at pre-service teachers college in PNG. I also had experience as a member of the Syllabus Advisory Committee of Primary School Science in PNG, and as a member of the Morobe Provincial Education Board, so i understood that the practices at the teachers' college could have an impact on EEfS in primary schools. I could see a need for concerned people at all levels to know about effective ways of teaching EEfS, so that they can address it at their respective levels. However, there was apparently no

evaluation conducted on the implementation of new pre-service teacher courses in Environmental Science and Natural and Cultural Environment in the teachers' colleges, nor how these courses might have impacted on new teachers teaching the new subjects, Making a living and Environmental Studies, in primary schools. This study into pre-service teacher EEfS has significance now because these courses were developed or revised in response to the inter-governmental call for EEfS. It is also important that this research takes place now because a number of pre-service teachers' colleges are changing status from independent colleges to become faculties of education in some universities, and therefore this research could inform development of curricula through this process.

The data in this thesis reports the practices before the intervention was carried out, the design and implementation of the intervention and its evaluation. It is hoped that the findings can help the policy makers and curriculum writers of the Teacher Education Division, and the lecturers of EEfS courses at the college. Firstly, the policy makers need to have the information so that they can address the gaps and issues related to providing clear direction for preparation and presentation of EEfS in pre-service teachers' colleges and primary schools. Secondly, the curriculum writers need to know the information so that they can include most appropriate content and pedagogy when revising or developing EEfS-related curriculum materials. Finally, the college lecturers that teach EEfS-related courses need to know about the recommended learning approaches and activities, so that they can use them in their preparation and presentation of EEfS.

It is anticipated that the data collected in the study will be of interest and importance to the officers of the teachers' college involved, Teacher Education Division and the country as a whole, so that the people concerned can develop greater understanding about taking sustainable actions, both as individuals and as members of educational institutions, for successful development of sustainably action competent people.

1.5 Purpose of Study

The purpose of the project was to find out about the current practices of EEfS in pre-service teacher education in PNG, and design, implement and evaluate a course on EEfS. The study included creating a theoretical framework for design of an intervention, and the implementation and evaluation of the intervention for policy makers, curriculum writers and the staff of teachers' colleges. The aim of the intervention was to design and implement an EEfS course that would improve teaching and learning of EEfS and produce action competent pre-service teachers. It would also allow revision of the intervention course on the basis of the findings of the study, so it is ready for implementation in 2013. The questions used for guiding the study are listed in the next section.

1.6 Research Questions

The study is directed and guided by the following research question as follows:

1. What are the current practices of EEfS in pre-service teachers' colleges in PNG?
2. How can a course be designed and implemented at a teachers' college to reflect current ideas about environment and sustainability issues and teaching and learning strategies, to reflect local traditional knowledges of PNG, and improve teaching and learning in EEfS for pre-service teachers?
3. What impact has this EEfS course had on the environmental perceptions and development of action competence of the pre-service teacher education students?

The next section provides a brief description of the research that was conducted.

1.7 Research Outline

The study was carried out in two phases. In Phase One, a baseline survey informed by the literature review was carried out in 2008 to find out about current EEfS teaching and learning practices from the staff and students of a pre-service teachers' college.

1.8 The Thesis Outline

The thesis is organised in eight further chapters. The literature review follows in Chapters Two and Three which consist of a review of literature on current ideas on EEfS and current ideas on teacher education respectively. Chapter Two provides current ideas in environment and sustainability education in the literature related to the characteristics and history of EEfS in the world and PNG. Chapter Three provides current ideas for curriculum, pedagogy and assessment in pre-service teacher education in EEfS. The literature reviewed relates to the environment and sustainability issues and concepts, and pedagogies for EEfS.

Chapter Four presents the description of the methodology used in this project. It includes the description of the main educational research paradigms, the research methodology adopted in the thesis, a discussion of quantitative and qualitative research methods, and the steps taken to minimize threats and to maintain credibility, transferability, dependability, conformability, subjectivity, trustworthiness and authenticity of the research. The Chapter concludes with a consideration of the ethical issues associated with this work.

The description of the development and implementation of the intervention program is presented in Chapter Five. The new course in EEfS aimed to produce action competent pre-service teachers, beginning teachers who are qualified and ready to take sustainable action, as well as influence their students to take similar action. The new course aimed to have content and strategies that reflect PNG's environment and sustainability views, current environmental

issues, teaching and learning approaches, and environment and sustainability education using active student content activities, which includes providing opportunities for pre-service teachers to participate in resolving environmental issues.

Chapters Six and Seven contain findings from the data mainly collected by Likert scale and Semantic differential statements on pre and post intervention questionnaires. Chapter Six discusses pre-service teachers' perceptions about environmental issues in PNG, and the key concepts of environment and sustainability education, and Chapter Seven discusses findings related to general and EEfS pedagogies.

Chapter Eight contains findings on action competence. The data presented is from open ended questions from the questionnaire, action plans produced and reflection journals kept by the pre-service teachers as part of the learning activities.

The thesis concludes with Chapter Nine which discusses findings in relation to the literature and the research questions and the implications of the research findings for teaching and learning of EEfS in pre-service teacher education in PNG, and suggestions for further research.

Chapter Two

2. Environmental Education for Sustainability

Environment and sustainability educators knowledge about the goals and characteristics of EEfS, and the educational frameworks that are consistent in achieving these goals, is crucial. It is important that these EEfS educators understand the goals and characteristics of EEfS so that they can use models and frameworks that will effectively address these characteristics and achieve the goals. It is also important that they know EEfS history so they can access research findings and educational practices to develop more effective EEfS practices in their work.

2.1 Chapter Outline

This chapter presents a review of literature on environmental education for sustainability (EEfS) in two sections: the characteristics of EEfS, and the history of EEfS. Section 2.2 has three subsections on: the characteristics of EEfS; the approach of education about, in and for the environment; and EEfS and traditional knowledge systems. Section 2.3 has six subsections which present the history of EEfS in the world, the history of EEfS in Asia-Pacific, the history of EEfS in teacher education, the history of EEfS in teacher education in Asia-Pacific, the history of EEfS in teacher education in PNG, and the curriculum reform in teacher education in PNG. These sections describe how EEfS started and developed to its current state, especially in teacher education programs in PNG.

2.2 Environmental Education for Sustainability (EEfS)

EEfS has been described as a process that can help shape the ways people think, feel and act towards the environment (Parliamentary Commissioner for the Environment (PCE), 2004). It can tell people many things including what

their society/culture knows and believes about the environment and its components; it can help reproduce the society/culture that people live in and maintain existing systems and structures of power, but can also be transformative and develop the potential of people and allow them to achieve changes within themselves and across societies (PCE, 2004). It is an emerging concept that has many of its roots in the environmental education (EE) movement (Nolet, 2009). EEfS builds on and expands on EE because it recognizes that ideas such as human rights and social justice are just as essential as environmental sustainability to sustainable development (Nolet, 2009). EEfS provides a useful framework for the teaching of school-based EE. This EEfS framework provides relevance and context for learning areas and allows the students who are future citizens to engage in, and take responsibility for, creating a sustainable future. As an approach, EEfS requires learners to develop knowledge and understanding, attitudes and values, and competencies needed for sustainable action as stated in its goals, objectives and principles.

2.2.1 The Goals of EEfS

Tilbury (1995) and Breiting (2009) stated that the push for EE, and later EEfS, resulted from great concerns about environmental problems in the world. These environmental problems then and now include global warming and climatic change, destruction of rainforests, biodiversity depletion, accelerating rates of land degradation and desertification, population and resource imbalances, pollution, the disposal of wastes, and others that are threats to the quality of human life and the ecosystems (Goodland, 1995; Miller, 2007; Sterling, 2001). In other words, the concern for environmental sustainability which started in the early 1960's has led to EE which has been evolving with the goal of reducing environmental problems and their impact on natural and cultural environments (UNESCO, 1978).

People from many fields of life have tried to address environmental issues since the 1960's with different focuses depending on their experiences, professional

and social backgrounds (Braus, 1995; NZ Ministry of Education, 1999). Most educators understand EE in schools to be related to education outside the classroom, in the environment, where EE relates education directly to experiential learning, and attitude or behavioural change. Likewise, EE among scientists is often referred to as conservation and preservation of ecosystems and natural resources, while social scientists consider environmental education to relate to social, cultural and economic lifestyle, human behaviour management and protection (Goodland, 1995; Heimlich, 2002). Furthermore, economists relate EE to monetary gains or benefits (Braus, 1995; Goodland, 1995; Heimlich, 2002; Roth, 1970). Despite their backgrounds and main focuses, their common goal is sustainability of the biophysical environment which is the life support system without which neither economic nor social systems could exist (Goodland, 1995; UNESCO-UNEP, 1978).

Aims for EE were first proclaimed in the *Tbilisi Declaration* (UNESCO-UNEP, 1978) and were to:

- foster clear awareness of, and concern about, economic, social, political and economic interdependence in urban and rural;
- provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; and
- create new patterns of behaviour in individuals, groups and society as a whole towards the environment (UNESCO-UNEP, 1978, p. 3).

That is, these aims would help the students develop: (1) awareness and sensitivity, and knowledge and understanding of the environment and the impact of people on it; (2) attitudes and values that reflect feelings of concern for the environment; (3) skills involved in identifying, investigating, and problem solving associated with environmental issues; and (4) a sense of responsibility through participation and action as individuals, or members of groups in addressing environmental issues (Bolstad, 2003; Braus, 1995; Eames,

Cowie & Bolstad, 2008; Heimlich, 2002; Roth, 1970; Tilbury, 1995; UNESCO, 1978).

Firstly, EEfS can help learners to gain knowledge and understanding of the key concepts of sustainability issues (Tilbury, 1995). In particular, EEfS must focus on the underlying causes of issues which are usually unsustainable practices, instead of just concentrating on their symptoms (Jensen & Schnack, 1997). Both individual and systemic changes are required to resolve unsustainable practices. This requires redesigning many systems that are currently practiced in society (Sterling, 2001). Secondly, EEfS can develop attitudes and values that promote a concern for the present and future well-being of our planet and all of the life that it sustains (Tilbury, 1995). These attitudes and values include innovation, appreciation, participation, responsibility, cooperation, diversity, and sustainability (PCE, 2004). Thirdly, EEfS can help learners develop key competencies that promote active learning and future environmental sustainability including competencies such as thinking, communicating, managing, decision making and problem solving skills (Emmanuel & Adams, 2011; Jensen & Schnack, 1997). Fourthly, EEfS will provide the students with the opportunity to develop varieties of action skills that are needed for resolving problems by engaging them in identifying, investigating and resolving real environmental problems, making them action competent as individuals, and as members of groups and societies (Jensen & Schnack, 1997). In other words, EEfS can help students such as pre-service teachers to gain knowledge, values and competencies to take action for sustainability.

Despite the introduction of policies and curricula to support EEfS, in many countries, EEfS continued to languish at the margins of mainstream schooling, competing with other priorities (Eames et al., 2008; Tilbury, 1995). Researchers and theorists in EE began to examine the reasons why EEfS was not easily implemented, or in other cases implemented but not producing action competent people. Researchers and theorists sought to find out how schools might deal with the inherent challenges that EE raised for conventional

approaches to curriculum and pedagogy and to articulate and define the characteristics of EEfS within a framework of educational theory (Gough, 2006; Tilbury, 1995). In addition to that, a number of authors contributed to a body of literature which articulates the characteristics of EEfS, especially the action orientation aspect (Bolstad, Cowie & Eames, 2004; McLean, 2003).

With this consideration in mind, Tilbury's EEfS; Lucas's education about, in and for environment; and local traditional EEfS frameworks are examined because all aspects in each of the three frameworks are addressed to stimulate and shape an action competent citizen. All three frameworks stress the importance of experience by practice and participation leading to action or action competence. As Barker and Rogers (2004) stressed, the platform to promote action and action competence is the provision of a variety of formative experiences and opportunities in which the learners get engaged in addressing problems in a variety of ways; and it is thinking, feeling and doing people that will become the agents of change. Furthermore, Barker and Rogers (2004) added that while being in the environment promotes first hand experiences, interpreting education in, about and for environment is holistically engaging hearts, heads, and hands, simultaneously promoting action competence.

The three frameworks are now examined that consider these characteristics of EEfS. These frameworks stem from Tilbury's (1995) work, Lucas' education about, in and for environment (Lucas, 1979), and local traditional approaches to learning about the environment.

2.2.2. Tilbury's Framework for EEfS

Tilbury (1995) defines her framework for EEfS with six aspects of education that is relevant, holistic, issue-based, action orientated, values-based and critically reflective. These aspects are now discussed.

2.2.2.1 Relevance

EEfS “should always be implemented in a locally relevant and culturally appropriate fashion” (Mckeown & Hopkins, 2003, p.119). It has been argued that EEfS must be relevant to the students’ needs, culture and curriculum (see also Bolstad et al., 2004; Tilbury, 1995). In that way the issues and concepts studied must be relevant for the needs of present and future students as individuals and as members of their society and nation; it fails when the issues and concepts studied are not relevant and cannot be linked to students experience (Tilbury, 1995). Furthermore, issues to be addressed must be locally resolvable and ideas introduced must be locally workable (Tilbury, Stevenson, Fien & Schreuder, 2002). For example, Ernest and Monroe (2006) found out from their study on 23 Florida high school students that one thing that facilitated improvement in the students’ critical thinking and citizen skills was the use of locally relevant issues in environment and sustainability studies.

EEfS included in pre-service teacher education must equally be relevant to the students’ needs, culture and curriculum. PNG as a nation, part of the Asia-Pacific region and the world, is currently experiencing environmental issues and has to resolve these issues both directly and indirectly. It is hoped that focusing on local issues and utilizing local traditional knowledge and pedagogy could make these issues locally solvable or workable (Tilbury et al., 2002). Teaching and learning about the environment and sustainability issues and concepts are part of the curriculum for all levels of education in PNG, including pre-service primary teachers colleges and primary schools (PNGNDoE, 2004a). The uses of traditional and local knowledge in all PNG activities, including teaching and learning, is recommended by the constitution of the country (PNG Government, 1975).

Therefore, issues and concepts studied and the learning activities and approaches used must be relevant to the learners’ society, culture and values. It is important that the traditional and local knowledge are utilized when delivering EEfS, because in PNG the accumulated knowledge, skills, practices

and beliefs concerning the relationship between one another and their physical environment, which is held by people in relatively nontechnical societies, societies with a direct dependence on the local resources, are passed from one generation to another orally (Kemmerer, 2002; Snively & Corsiglia, 2000).

It is hoped that by studying the local environment and issues and by utilizing local traditional knowledge and pedagogy, any EEfS course and its learning process is made relevant to the culture of the people. These local issues are part of people's lives interconnected with other components of the society and require a holistic consideration.

2.2.2.2 Holism

Many attempts of providing knowledge about environmental issues failed because environmental educators treated the issues as simple, single discipline issues (Gough, 1997). However, it is argued that the concepts and issues of environment and sustainability are complex, multidisciplinary issues and have to be studied and addressed holistically (Barker & Rogers, 2004; Eames & Cowie, 2004; Gough, 1997; Tilbury, 1995; UNESCO, 1978). According to Barker and Rogers (2004), holistic responses to environmental issues occur naturally when people find themselves in a messy, complex and confusing environment. Being holistic means studying environment and sustainability concepts and issues together with all that surrounds and interacts with them, and considering and addressing them simultaneously (Barry, 2006; Sterling, 2001). Things that surround and interact with the issues include people, the different systems, substances, disciplines, groups and organisations involved, as part of their causes and effects (Chapman & Eames, 2007; Tilbury, 1995). For example, by seeing the whole picture surrounding a problem such as air pollution, mining or over-fishing, examining the processes that cause these problems and suggesting actions to solve them is being holistic (Tilbury, 1995). Sterling (2001) adds that a holistic study of issues is necessary because issues are usually caused by several things people use from the environment or do in the environment, all that are interconnected with each other, and so all or some of the components are affected if one part of it poses a problem.

Eames and Cowie (2004) noted that environmental issues and concepts studied holistically as multidisciplinary issues and concepts usually result in greater understanding of environment and sustainability concepts, and greater development of knowledge, skills and values. This is because each subject or discipline can be mobilised to explore different aspects of the complex issues, and at the same time help the learners develop insight and confidants for appropriate actions (Tilbury et al., 2002). It is also believed that studying of problems, their causes, their effects and the possible solution through many viewpoints will create better understanding and vision for change, which will result in informed actions (Tilbury, 1995). People cause environment and sustainability issues as part of social and economic activities, which affect them in some ways, and so by studying the relationship between different systems involved, they can also solve these environment and sustainability issues (Chapman & Eames, 2007).

This claim is supported by a study by Baker (2002) which showed that one factor that influenced better development of student knowledge, skills and values was learning about environmental issues through a range of subjects. Furthermore, learning about environment and sustainability issues using all human faculties, that is, engaging hearts, heads and hands simultaneously can make them aware of, and concerned for, the issues and take appropriate actions to address them, while at the same time developing more knowledge, skills and values for future actions (Sipos, Battisti & Grimm, 2008). This is consistent with a framework of education in, about and for environment which is discussed later.

2.2.2.3 Issue-based learning

Tilbury (1995), Bolstad (2003) and Stevenson (2007) have all argued that issue-based learning is more effective in making learners consider matters of fact, values and morality. That is possible because the learners are engaged in the process of identifying and investigating issues, seeking solutions and carrying

out action towards resolving these issues (Barry, 2006). This is consistent with a claim made by Oulton and Scott (2000) that hearing and discussing about solutions for environmental problems is necessary for creating awareness, but active exploration of issues and identifying potential solutions and acting upon them will promote future actions. Fien and Tilbury (1996) maintain that involvement in actions on issues can equip people with action skills and experiences which can promote future similar actions.

Jensen and Schnack (1997) noted that environment and sustainability issues are created by people while seeking to improve the quality of their lifestyle, and so people need to resolve them both personally as individuals and at societal level as members of their communities. Using issues as contexts for learning EEFS: promotes holistic learning and student participation or engagement; creates experiences which can promote future problem solving actions; and promotes development of knowledge about causes, effects and solutions, and needed skills, and attitudes and behaviours (Barker & Rogers, 2004; Jensen & Schnack, 1997; Tilbury, 1995). Tilbury et al. (2002) explained that when students are engaged in resolving a problem, they are engaged in the process of: (1) identifying issues; (2) investigating issues; (3) seeking solutions to issues; (4) carrying out actions to address issues and; and (5) evaluating the impact of the environmental action taken to resolve issues. The practice that will become an experience can promote future action processes (McLean, 2003). A case study on pre-service teachers studying EE by Baker (2002) showed that the students who learnt EEFS through issue-based learning were able to discover more about environmental issues.

Wals (1990) maintained that it is not enough to encourage students to make judgements on issues, have knowledge and positive attitudes towards the environment, but they must be effectively equipped with a variety of action skills to participate in the resolution of these problems by practicing taking action for sustainability. This is discussed next.

2.2.2.4 Action –oriented learning

Action-oriented learning in EEfS can develop students' ability to act with reference to environmental concerns (Bolstad, 2003; Stevenson, 2007; Tilbury, 1995). To bring about change, it is not enough to encourage students to make judgements on issues; action is also required towards resolution of these issues. Teachers need to be equipped with a variety of skills to participate in teaching EEfS to facilitate their students' thinking and acting towards resolving the problems (Breiting, Hedegaard, Mogensen, Nielsen & Schnack, 2009; McLean, 2003). Action-oriented refers to education that is working towards developing environmental action or participation in the study of environmental and development problems (Jensen & Schnack, 1997). Bolstad (2003) added that the students supported to identify real problems, determine possible solutions and participate in taking action can develop skills and knowledge such as: how to seek out information and resources; how to approach people in the community for advice and support; and how to take into account different people's needs and perspectives on issues relating to environment.

In teacher education in EEfS, the learners can be challenged on a personal level to change part of their lives, so that they are engaged in leading more sustainable lifestyles and as teachers to prepare units of work and deliver EEfS lessons using recommended strategies to develop action competent students (Esa, 2010; Fien & Tilbury, 1996).

Jensen and Schnack (1997) maintain that experiences are important for action competence, because where and whenever there is an action, it leaves experience. Experiences are results of actions performed in the previous experience, which in turn are the result of other actions before that. Thus, experience and action are closely linked, and so experience is one thing that needs to be accounted for when considering competency. However, not all gained knowledge is put into action in school due to time limitations, but clearly understanding and reflection on it can act as experiences for future

actions. In other words, not all actions get performed physically to become an experience, instead intentions to act or plans to act become experience from which future actions can occur. This shows that, without action people cannot become rich in experiences that promote action competence (Jensen & Schnack, 1997).

It has been argued that concern for the environment must be coupled with a corresponding concern for democracy; which means people are free to believe whatever they choose to believe about environment and sustainability, and take actions they consider as appropriate (Chapman & Eames, 2007; Jensen & Schnack, 1997). Apart from that, a democratic approach can also view everyone as equal and as having equal potential to participate in contributing to future environmental sustainability. However, there are often constraints on these ideals and this potential to participate is not always the case for primary school children or for poor people. Most primary school children may be too young to make informed decision and take sustainable actions, whilst poor people may not have many options to choose.

2.2.2.5 Values

Tilbury (1995) argued that people's values are important because they guide and control their actions and behaviour. The emphasis on values is in line with the Tbilisi objectives of EE (UNESCO-UNEP, 1978) that encourages development of people's values for living sustainably, including with other people and the physical environment. Feelings of compassion, cultural sensitivity, and respect for environment and recognition for the rights of people in this and future generation are values that can promote sustainable actions (Bolstad, 2003). Although there is no neutral or value-free environmental education (PCE, 2004), research into the relationship between environmental knowledge and values indicated little correlation between acquired knowledge and concern and values, and so developing values of responsibility, concern for others and nature must be targeted by the learning activities used in EEfS (Bolstad, 2003;

UNESCO, 1992). According to Tilbury (1995), the best way to help learners modify their values is by encouraging them to clarify their religious, cultural, gender and sociocultural values about the environment and sustainability, and then help them to integrate their own values with the targeted values of environment and sustainability. This is in line with the notion of continuity that is concerned with personal cultural identities, how truths are negotiated, how knowledge is attained, and how it relates with power (Barker, 2008). It is about why people accept or reject change; how or why they reject it; and why people care about what they care about; that knowledge is important for them to ensure their physical, psychological, cultural, and spiritual survival; and what fundamental truths inform that choice and sustain cultural identity. People's values can be modified when all of these are clearly understood. EEfS directed towards development of the affective domain fosters a sense of interest, concern, and motivation to learn more and do something about the subject or issue concerned (Bolstad, 2003; Littledyke, 2008).

Change in environmental and personal socially desirable values promote and cause individuals to become committed to working for, and with others, to gain equality, equity and sustainability, and leads to new revelations and gives rise to high level thinking (Sterling, 2001). This involves critical thinking and reflection, which is discussed next.

2.2.2.6 Critically Reflective Education

Critical thinking is considered important in many academic fields, including EEfS, because it enables people to analyze, evaluate, explain, and restructure their thinking and action (Huckle & Sterling, 1996). Tilbury (1995) added that critically reflective education is necessary for understanding concepts of environment and sustainability and issues associated with them, because it is the process of critical thinking that involves the careful acquisition and interpretation of information and use of it to reach a well-informed conclusion and action. Through critical thinking and reflection people can identify

prejudice, bias, propaganda, self-deception and misconceptions, and develop balanced knowledge, values and concerns (Breiting et al., 2009; Sterling 2001). Tilbury (1995) noted that the effectiveness of EEfS depends on the successful development of critical reflective knowledge about the environment and sustainability; democratic skills and values; critical thinking skills; and experience in the processes of environmental politics. As such, in an EEfS approach, the learners are encouraged to ask a lot of questions to challenge underlying assumptions in actions taken and the lessons they learn (PCE, 2004; Sterling, 2001). Critical reflections on social, economic and political knowledge, values and actions often result in deep learning and development of values required for participation in decision-making and problem-solving, and contributing to environmental quality (Bolstad, 2003; Huckle, 1991; Sterling, 2001).

Fien and Tilbury (1996) maintain that to produce teachers as active agents in the process of change towards a sustainable environment, teacher educators need to adopt a reflective practice approach to their work by: (i) the development of skills for critical thinking, self-evaluation and reflection, and (ii) the development of knowledge, values and action skills. Effective EEfS in teacher education needs to produce teachers who are competent to investigate environmental issues and evaluate alternative solutions, and to develop, select and/or implement curricular materials and strategies which will develop similar competencies in their students (Fien & Tilbury, 1996). This process usually takes place when students identify, think about and address the issues and then evaluate their actions (Breiting et al., 2009).

2.2.2.7 Summary of Tilbury's framework

In Tilbury's (1995) framework, EEfS is relevant, holistic, issue-based, action orientated, values-based and critically reflective. Firstly, environment and sustainability education is made relevant through the use of local environmental issues. Studying local issues and concepts makes learning relevant and easy resulting in development of knowledge, skills and values.

Secondly, studying environmental issues holistically at all scales, using a range of disciplines, all human faculties, and using all values and perspectives promotes clearer understanding of environment and sustainability concepts. Thirdly, as issue-based and action oriented EEfS engages learners in the process of identifying and investigating, seeking possible solutions and carrying out action towards resolving the issues. The actions they take in resolving environmental issues will become experience from which they can draw from for future actions. Fourthly, a recognition that values are involved in issues and that these need to be considered as important. Lastly, learning EEfS critically is important because by critically thinking about and reflecting of actions and lessons, students can develop greater understanding about environment and sustainability and be able take appropriate actions. Tilbury argues that consideration of these aspects in EEfS can lead to change.

Tilbury's framework is in many ways an elaboration of earlier work by Lucas (1979) which provided a framework of education about, in and for the environment. This Lucas framework appears regularly in the EEfS literature and is discussed next.

2.2.3 Education about, in and for the environment

This second framework for considering EEfS was originally proposed by Lucas (1979) and has since become a regularly used approach. This approach has been described by Barker and Rogers (2004) and TKI (2011b):

- Education *about* the environment is aimed at producing a knowledgeable individual;
- Education *in* the environment is the description of a teaching technique; and
- Education *for* the environment is intended to enhance or maintain the environment (usually by human beings).

It is argued that education about the environment which targets the knowledge of, and education for, which is the behaviour towards, the environment, associated issues and sustainable practices are all equally important and need

to be developed simultaneously through actual experience, which is education in the environment (Barker & Rogers, 2004; Emmanuel, & Adams, 2011; Esa, 2010). These three dimensions of EEfS are now discussed.

2.2.3.1 Education about the environment

Knowing about and understanding the natural and built environments, and appreciating the key social, political, ecological, and economic factors that influence decision making on local, national, and global issues, is critical if students are to be involved in taking action for the environment and sustainability (Chapman & Eames, 2007; TKI, 2011b). This includes awareness, knowledge and understanding of ecological, cultural and economic activities, political decisions, and ecological factors which influence decisions about the environment. Education about the environment could also be viewed as using and developing head knowledge (Barker & Rogers, 2004; PCE, 2004; Sipos et al., 2008; TKI, 2011b). The aim of education about the environment is consistent with the Tbilisi goal of EE that is to foster clear awareness of, and knowledge about, cultural, social, political and economic interdependence in rural and urban areas in the nation, region and the world. This is seen to help students to develop knowledge and awareness of, and sensitivity to the total environment, and issues and problems related to environment and development; and acquire knowledge and understanding of what is required to create and maintain a sustainable environment (UNESCO-UNEP, 1978). The developing awareness, knowledge and understanding about humans and their interaction with the environment, their impact on the environment, and why and how people can contribute in looking after the environment, will help students to establish their own environmental values and attitudes (Barker & Rogers, 2004; Bolstad, 2003; Cowie & Eames, 2004; Eames et al., 2008). Clear understanding of concepts and issues associated with the environment is important for changing attitudes towards the environment.

This claim is supported by the findings of a survey conducted by Gopa (2004) on 100 trainee teachers in Malaysia who studied EEfS holistically as an issues-based, multidisciplinary concept, especially to find out about their level of knowledge of environmental issues and assess their attitudes towards creating a sustainable environment. The study showed that acquiring knowledge about environmental issues can lead to positive significant correlations between knowledge and attitude, that is acquiring knowledge can lead to positive attitudes towards the environment and its issues. This in turn can help learners to make informed decisions on environmental and sustainability issues, and to take appropriate actions.

2.2.3.2 Education in the environment

Education in the environment is consistent with the goal of EE to provide every person an opportunity to acquire knowledge, values, attitudes, commitment and skills need to protect and improve quality of environment (Tilbury, 1995; UNESCO-UNEP, 1978). Students who are provided the opportunity to observe the environment and its issues, and are actively involved in identifying, investigating and resolving environmental issues at the same time, develop skills and values needed for sustainable living (Barker & Rogers, 2004; Fien & Tilbury, 1996; TKI, 2011b).

Tilbury (1995) and Lucas (1979) argue that if awareness and feelings of concern of people are to be translated into appropriate behaviour and action they need to be developed in the environment, or while working on environmental issues, having direct contact with the environment and its issues. Other authors see education in the environment as being concerned with the heart, because seeing actual or simulated environmental issues can create greater awareness and feelings of concern for the environment and its sustainability, and provide the motivation for action, rather than just discussing them during lectures (PCE, 2004; Sipos et al., 2008; Tilbury, 1995). Using learning activities that promote constructivist, inquiry based, experiential, socio-cultural, and cooperative learning approaches as part of EEfS can empower people to take sustainable

actions (Barker & Rogers, 2004; Bolstad, 2003; Cowie & Eames, 2004; Tilbury, 1995; TKI, 2011b). Learning through these approaches fosters greater understanding of the complex relationship between people and their environment, and leads them to feel responsible and take action, including teaching about it (Breiting et al, 2009; TKI, 2011c).

2.2.3.3 Education for the environment

Fien and Tilbury (1996) and McLean (2003) argued that for citizens to take action for the environment, they need to practice taking actions to resolve environmental issues and develop basic understanding of how the components of environment, including ecological, socio-cultural and economic systems, work and affect each another (Emanuel & Adams, 2011). It is commonly argued that genuine EEfS occurs when “it helps [to] shape the ways people think, feel and act” (PCE, 2004, p. 40). In other words, real EEfS results when people take responsible action towards environmental sustainability because of the knowledge, skills and feelings of concern they develop while being engaged in resolving environmental issues or by having direct contact with the environment or the issues (Bolstad, 2003; Eames et al., 2008; Sipos et al., 2008; TKI, 2011c). It is also seen as using their hands because the principle in this view is that learners participate in taking appropriate actions in solving simulated or actual environmental problems (Barker & Rogers, 2004; Bolstad, 2003; Cowie & Eames, 2004; Eames et al., 2008; Ministry of Education, 1998, 1999; Tilbury, 1995; TKI, 2011c). Although knowledge and attitude development are important, not everyone who has knowledge or feelings of concern take action to resolve issues (Bolstad, 2003). In other words, sometimes people gain knowledge about the environment, the causes of the environmental problems, and possible solutions for the environmental problems; and develop the skills necessary for taking responsible action, but they do not take any action (Bolstad, 2003; Kollmuss & Agyeman, 2002). For example, reports on a national evaluation project that investigated characteristics of EE practice in New Zealand schools in 2002–2003 state that

33% of the teachers surveyed hoped their students would take direct action for the environment but it was not clear whether teachers directly addressed this dimension of learning in the design of their EE programmes, or whether it was only a desired outcome (Eames et al., 2008). In other cases, sometimes learning about the environment and environmental problems and their severity can leave the learners feeling distressed and hopeless about the future, and stop them from taking any other action because they feel their action cannot make a difference (Bolstad, 2003; Hicks & Bord, 2001). Thus, it is recommended in EEfS to use an action oriented approach in which learners are encouraged to choose and resolve relevant and manageable, local issues as part of learning activities in schools (Jensen & Schnack, 1997; Tilbury, 1995).

On the other hand, Jensen and Schnack (1997) argued that practical engagement can be meaningless if students carry out activities such as planting trees or cleaning up a shopping centre without understanding the reasons for the activities. These authors argue that students should be helped to understand and make connections between the concepts of the environmental issue and any decision they make to take actions (TKI, 2011c). One way to achieve this is by encouraging them to critically reflect on the actions they take and lessons they learn (Breiting et al., 2009; Tilbury, 1995).

2.2.3.4 Summary of education about, in and for the environment

Student's environmental knowledge and understanding, feelings of concern for the environment and associated issues, and the motivation for taking sustainable action is developed by engaging them. They can be engaged in observing the components of the environment and by resolving local issues (Barker & Rogers, 2004; Bolstad, 2003; Cowie & Eames, 2004; Tilbury, 1995). This framework of education about, in and for the environment encourages learners to use their heads, hearts and hands in gaining a holistic view of environmental issues (Sipos et al., 2008)

Tilbury's and Lucas' frameworks are closely related in their outlooks. They both emphasise not only holistic study of environment and sustainability issues but also practical action on locally relevant and workable issues as part of EEfS.

Tilbury emphasises making learning relevant, issue-based and action-oriented, and studying local, relevant environmental issues and addressing them holistically, whilst Lucas emphasises that learning activities used in EEfS to develop knowledge about environment and sustainability must also develop learners' attitudes and behaviours, enough to take sustainable action.

Therefore both frameworks are concerned with how best knowledge, skills and values can be developed in learners so that they take actions to contribute to future environmental sustainability. Some of Tilbury's and Lucas' articulated characteristics of EEfS are in line with a third framework that is important in this study, that of local traditional education systems of PNG.

2.2.4 Traditional Education System

Local traditional knowledge refers to the knowledge, practices and beliefs that people hold concerning the relationship between one another and their physical environment, knowledge (McGregor, 2009, Tiu, 2007). The knowledge, skills and values which is held by people in relatively nontechnical societies, that is societies with a direct dependence on local resources (Ellen, & Harris, 2000; Kimmerer, 2002). It is also referred to as local knowledge by some authors, such as Antweiler (2004), who maintains that local knowledge is a better term to use than traditional or indigenous knowledge because it pertains to facts as well as skills, and capabilities are local to the extent that they are acquired and applied by local people with respect to their objectives, situations and problems. It is drawn on locally available resources which are culturally and economically situated (Antweiler, 2004). It can be used in teaching and learning in EEfS because it is a multidisciplinary knowledge system which can easily accommodate and facilitate a constructivist, holistic approach to learning (Van Damme & Neluvhalani, 2004). As such a combined term, local traditional

knowledge, that reflects elements within both these viewpoints is used in this thesis.

The significance of local traditional knowledge in sustainable development was perhaps first made known by the Brundtland Report, *Our Common Future*, and *Agenda 21* from the Earth Summit in Rio de Janeiro in 1992 (UNESCO-UNEP, 1992; McGregor, 2009). It emerged from a growing recognition that the indigenous people around the world can effectively contribute to environmental knowledge because it embraces their lifestyle. PNG Education policies such as the National Curriculum Statement, and the Teacher Education National Curriculum Guidelines echo the PNG Constitution of 1975 (PNG Government, 1975) and stress the use of local traditional knowledge in addressing all development issues, which includes educational development.

In recent years, in many countries, including British Columbia, Canada (Turner, Ignace & Ignace, 2000) and PNG, the utilisation of local traditional knowledge and skills have been encouraged in various fields of study, as well as school curriculum (Matang, 2008). Especially, in EEfS because traditional knowledge and wisdom, and skills and practises are around environment and sustainability (Turner et al., 2000). It has been argued that local traditional knowledge can be used in teaching and learning of subjects including EEfS (Kimmerer, 2002; Matang, 2008; Tiu, 2007), especially in the third world nations like PNG. This is so because local traditional knowledge in some ways is thought to be as powerful and equal to western scientific knowledge, because they both were derived from the same source, that is, systematic observation of nature (Kimmerer, 2002; Turner et al., 2000). As such, local traditional knowledge system is rational and reliable (Ellen, & Harris, 2000). It has the capacity to assess, monitor and make predictions about resources, succession dynamics, patterns of fluctuation in climate and resources, species interaction, sustainable harvesting, adaptive management and manipulation of disturbance regimes (Kimmerer, 2002; Obed, Unu, Tofuola & Tuia, 2007; Tiu, 2007; Turner et al., 2000).

In local traditional knowledge systems, observation and information collection is always done qualitatively, the record of observation is diachronic, that is, the record of observation is from a single locality over a long period of time and the observers are the resource users such as the hunters, fishers, and gatherers (Kimmerer, 2002; Turner et al., 2000). In contrast, Western scientific observations are often made by a few elite or professionals using qualitative as well as quantitative means, often from a wide range of sites that usually lack long term perspectives of local traditional knowledge (Kimmerer, 2002). Unlike western ecological knowledge, local traditional knowledge is woven into and is inseparable from the social and spiritual context of the culture (Obed et al., 2007; Kimmerer, 2002) and may expand its explanatory powers beyond empirical data, which may include an ethic of reciprocal respect and obligation between humans and the non-human world (Turner et al., 2000).

According to Ellen and Harris (2000) local traditional knowledge offers holistic understanding of environment and offers an alternative approach to EEfS. Van Damme and Neluvhalani (2004) argued for this by pointing to a study by Thakadu (1997), which indicated that a local traditional knowledge system has a holistic nature and gives a broad spectrum of coverage in all spheres of life, and that this should form the basis of EEfS (See Obed et al., 2007). Local traditional knowledge has much to offer in EEfS because the close relationship between nature and indigenous people can be used to learn all about the environment as well to manage the resources (Ellen & Harris, 2000). Students may understand the concepts involved more readily when they learn them through a culturally-relevant education system using cultural sensitive pedagogy (Obed et al., 2007). A study in PNG by Matang (2008) involving 125 school children from 14 elementary schools focusing on eight tasks relating to early number knowledge indicated that, on average, children who learnt counting systems in their own language spent a shorter time and made fewer

mistakes in solving each task compared to those who were taught in English only.

Content knowledge in a local traditional education system is the knowledge about the natural and cultural environments of people, how people sustainably use resources from their natural environment, and how they relate to one another (Kukari, 2011). Local traditional knowledge and skills are typically delivered to the learner in two types of lessons. One is a theory lesson in which knowledge is usually taught in a defined space and venue such as an initiation site, men and women houses, and family homes (Kukari, 2011) which is consistent with Lucas' idea of education about environment and Tilbury's idea that EEfS should be relevant. The other is a practical lesson in which the needed skills are demonstrated by more skilled older people including mothers to daughters, fathers to sons, uncles to nephews, aunt to niece or chief to the novice (Kukari, 2011). These practical lessons occur in the actual context, such as in a garden learning gardening skills, while fishing and hunting skills are learnt whilst fishing and hunting (Kukari, 2011, Tiu, 2007). The learners learn about their traditional knowledge by not only observing, doing or participating in real life events or activities, but also doing it persistently, rather than just listening to someone talking about it (Kukari, 2011). This is consistent with Lucas' idea of education in and for environment and Tilbury's idea that EEfS should be relevant, issue based and action oriented.

Local traditional education system shares several characteristics with Tilbury's (1995) framework and that of Lucas (1979). All three frameworks recognise the central importance of knowledge, and the role of local, relevant ideas in this. They focus on issues that are important to the learners. The frameworks also highlight the need for experience in the environment to develop attitudes and values, and critical thinking about the issues confronting the learners. Finally, in local traditional knowledge, actions are guided by the need for sustainability, which is also reflected in Tilbury's and Lucas' frameworks.

2.2.5 Summary of the Characteristics of EEfS

The goal of EEfS is to create awareness of, and concern about, economic, social, political and economic interdependence in urban and rural environments in the learners, by providing them with opportunities to acquire knowledge, skills, values, attitudes and commitment to work individually and collectively to resolve current environmental and sustainability problems and prevent new ones (Tilbury, 1995; UNESCO, 1978).

Some environmental education researchers argue EEfS should be delivered as education about, in and for environment and sustainability by engaging of their intellect (head), emotions (heart) and physical (hands) attributes to become active and informed citizens capable of achieving a sustainable way of life (TKI, 2011b; TKI, 2011c).

EEfS is an interdisciplinary approach to EE and provides a useful framework for developing knowledge, skills and values desired by EE for environment and sustainability. It provides relevance and context for learning and allows the students who are citizens of future to be engaged in and take responsibility and contribute to sustainable future.

As an approach EEfS adopts an issue-based and action-oriented approach which engages students in addressing locally relevant issues using locally available resources, knowledge and skills to contribute towards sustainable future to develop further knowledge, skills and values.

By observing and resolving local issues the students are encouraged to gain and utilize local traditional knowledge and values about environment and sustainability concepts and skills for taking sustainable actions (Schlosberg & Sisk, 2000). This also means pre-service teacher students can appreciate their own and other peoples' cultural values and beliefs and use them for delivery of EEfS in schools and for actions which will benefit people now and in future (Jenkins, 2003).

Having argued for what EEfS is in this thesis, it is now important to examine where these ideas have come from for teacher education in EEfS in general and in particular, in PNG.

2.3 History of EEfS

EEfS began as a result of growing concern over environment and development problems and it is still evolving (Tilbury, 1995). This section examines a brief history of EEfS in the world, Pacific and then particularly in PNG. It is important that EEfS educators understand its history and the reasons behind it, and know how it has developed since it started in the early 1970s. The focus is then placed on teacher education and the current place of EEfS in PNG education.

2.3.1 History of EEfS in the world

Environmental education (EE) was formally recognized in the mid 1970's through a series of international meetings sponsored by UNESCO, and the participants of those meetings recognized the urgent need to develop EE. This need was documented at many conferences, such as the International Union for the Conservation of Nature and Natural Resources (IUCN) *Conference on Environment* (1972), and an intergovernmental conference on EE held in Yugoslavia in 1975, resulting in the *Belgrade Charter*, which called on education to develop people who were aware of the environment and problems associated with it (UNESCO-UNEP, 1976). This call was developed further with three broad goals for EE at an intergovernmental gathering held at Tbilisi, Russia in 1977 which produced the *Tbilisi Declaration* (UNESCO-UNEP, 1978). These goals of EE were discussed in Section 2.2.1

A focus on sustainability developed in the 1980's and appeared in the International Union for the Conservation of Nature report in 1980 (IUCN, 1980), and was brought to prominence as part of the concept of sustainable

development in a report from the World Commission for Environment and Development (WCED), *Our Common Future*, in 1987 (World Commission for Environment and Development, 1987). The most significant progress in this development came in Rio de Janeiro in 1992 at the United Nations Conference on Environment and Development, called the Earth Summit, which highlighted the need to re-orient EE towards sustainability (UNCED, 1992).

At the Earth Summit, governments from around the world, including PNG, agreed that education was important for sustainability. This agreement was shown by the mention of education in all 40 chapters of *Agenda 21*, the output of the Rio meeting, and a whole chapter dedicated to education (UNESCO, 1991). In 1997, representatives from around the world met at a conference organised by UNESCO and the government of Greece and reaffirmed the urgent need for government to honour earlier commitments to education for sustainability (UNESCO, 1992). Then in 2002 at the World Summit on Sustainable Development, governments emphasised that education for sustainability was critical for sustainable development and agreed to integrate sustainable development into their education systems at all levels in order to promote education as key agent for change (Nolet, 2009; Tilbury, 2003). The United Nations countries have recently reaffirmed their commitments in this area by declaring a Decade of Education for Sustainable Development from 2005 to 2014 (UNESCO, 2005). The goals of the Decade (UNESCO, 2005) are to make efforts to help change the behaviour of people through integration of principles, values and practices of sustainable living in all levels of education, to create a more sustainable future in terms of environmental integrity, economic viability, and a just society for all people, in current and future generations (Chapman & Eames, 2007; Fien, 2006; Gough, 2006; Nolet, 2009).

As this review shows, a focus on EE gradually shifted to a focus on education for sustainable development. The United Nation Conferences created a conceptual framework for education for sustainable Development. As identified by Tilbury et al (2002), the conferences:

- Stressed the need for social and human development along with economic development and environmental concern;
- Called for the advance and empowerment of women;
- Demanded basic social services for all;
- Recognised the critical importance of sustainable livelihoods;
- Cited the necessity of broad enabling environments for social and economic development;
- Underlined the importance of human rights and;
- Identified the role of education as critical to achieving sustainability goals.

Since early 1990 then, there has been a global trend towards education for sustainability (UNCED, 1992), signalling an integration of social, economic and ecological concerns and trying to address long term social and ecological sustainability (Nolet, 2009). That is by encouraging and planning education that could change the pattern of life for individuals, communities, nations and the world. Such change required significant shifts in the attitudes and the practices of many people (IUCN, UNEP& WWF, 1991). In 1992, twenty years after Stockholm, the Earth Summit re-emphasised strategies for constructing a sustainable future (UNESCO, 1992). The action plan adopted at the Summit, *Agenda 21*, included Chapter 36 which focused on public education, awareness and training and confirmed the role of education and the need for positioning environmental education in the perspective of sustainable development. The objective was formulated for establishing national education programs for sustainable development by 1996 (Mckeown & Hopkins 2003; Rajaretnam, 1994; Tilbury et al., 2002). EE was viewed as an indispensable tool for sustainable development (Braus, 1995). As recorded in UNESCO (1988), it was widely agreed that education was seen to be the most effective means that society possessed for confronting the challenges of the future (see also, Nolet, 2009). Education, to be certain, is not the whole answer to every problem. But education, in its broadest sense, would be a vital part of all efforts to imagine and create new relations among people and to foster greater respect for the needs of the environment (UNESCO, 1988). PNG, like other countries,

recognised the need to take sustainable action which included providing EEfS for its people (Gough, 2006; UNESCO, 2004).

2.3.2 History of EEfS in PNG

PNG, like many other countries, attended world intergovernmental conferences and made commitments to implement what was declared (UNESCO, 1992). However, implementation has been slow but gradual, with support provided by countries such as Australia (Government of PNG & UNPNG, 2004).

Prior to Independence in PNG in 1975, there was little policy or legislation related to environmental management and conservation, except for some ordinances on fauna protection, the crocodile trade, and national parks and gardens. At Independence, PNG's founding fathers had the foresight to enshrine environmental and sustainability concerns in the national Constitution (PNG Government, 1975). The five National Goals and Directive Principles of PNG's Constitution reflect a commitment to sustainable development. The five National Goals and Directive Principles are:

- (1) Integral Human Development, Liberation and Fulfilment. All activity of the state should be directed towards the personal liberation and fulfilment of every citizen so that each man and woman will have the opportunity of improving himself and herself as a whole and achieve integral human development;
- (2) Equality and Participation. All citizens should have an equal opportunity to participate in and benefit from the development of PNG;
- (3) National sovereignty and self-reliance. PNG should be politically and economically independent and its economy should be basically self-reliant;
- (4) Natural Resources and Environment. The National Resources and the Environment of PNG should be conserved and used for the collective

benefit of the people and should be replenished in the interest of future generations; and

- (5) PNG Ways. Development should take place primarily through the use of PNG forms of social, political and economic organization (PNG Government, 1975).

The first goal of the PNG Constitution declared that all people of PNG would be dynamically involved in the process of freeing themselves from every form of domination or oppression and have the opportunity to be developed as a whole person in relation to others around them. All citizens of PNG should have access to education so that they could develop intellectually, morally and vocationally and become useful citizens. Integral human development offered to protect, educate and nurture people's beliefs and their ability to meet challenges. This is in line with the idea of learning about, in and for the environment and sustainability, using their heart as much as their heads (Sipos, Battisti & Grim, 2008; PCE, 2004) to develop their knowledge and values for action, which in turn should make people competent to act, meaning they are qualified and willing to take appropriate actions whenever required to contribute to future sustainability.

The second goal, Equality and Participation, declared all citizens have equal opportunity to participate in, and benefit from, the development of the country. The goal was for equal geographic participation, and distribution of the new nation's wealth and development. This is in line with the goal of EEFs which originated from the goal and objective of EE (UNESCO, 1978) that aims to provide opportunity for, and encourage all, people to actively participate as individuals, groups and societies, exercising their skills of environmental citizenship working towards a sustainable future (UNESCO, 1992). This agrees with concepts of sustainability indicating that all people everywhere now and in future share all forms of resources equally. Those who are here today satisfy their needs and aspirations without compromising the ability of future generations to satisfy their needs and aspirations (WCED, 1987).

In most countries, including PNG, the institutions in charge of development planning at national, provincial and local levels, have resisted the integration of women into their own ranks, particularly in decision-making. The National Goals and Directive Principles declared for equal participation by both genders in all political, social, economic and religious fields (PNGNDoE, 2004b). However, in reality PNG has been slow to implement this Goal and remains unequal in gender participation. According to Kekedo (1985), there were only 6094 women employed in the public sector in 1982 compared to 26,764 men during the same period. Gender inequality is also reflected in a study by the World Bank (1999) that indicated that 87% of women in PNG do the dirty job of producing sweet potatoes, while most men have less difficult and dirty jobs. Another study carried out by Tuaru (2006) with pre-service teachers, lecturers and other staff about gender inequalities and the cause of gender inequalities found that less than half, about thirty percent, of the students enrolled in five universities in PNG between 1997 to 2004 were female, while the majority were male. Tuaru (2006) also found that between 2004 and 2005 no female student was enrolled for Educational Administration in a PNG university, only 13% of students training to become secondary school science teacher were female, only 21% of students studying Mathematics and Computing were students, but 86% of the students training to become secondary schools Home Economics teacher were female, and 72% of the students studying Language and Literature were women. This imbalance may reflect that men and women themselves are influenced by cultural values and beliefs and women may perceive that they cannot be educational administrators, science, and mathematics teachers, but they can be home economic and language and literature teachers in schools.

The third National Goal declared PNG to be politically and economically independent and the economy self-reliant (PNGDNoE, 2004b). All people of PNG including leaders of Church, government bodies and business organisations were to be completely free of foreign control in making decisions

and taking action to promote social, political and economic development and prosperity for individuals, groups and country (PNGNDoE, 2003d; PNGNDoE, 2004b). This is in line with the concept of sustainable development where all people as individuals and as members of social groups and institutions are expected to live sustainable lifestyles, and that all development carried out should be sustainable development aiming to ensure better quality of life for everyone, now and for generations to come (Bolstad, 2003; Heimlich, 2002; Sterling, 2001). Social and economic development activities often occur in the natural environment and may have an impact on other people and components of the environment.

The fourth Goal is about natural resources and environment: 'PNG's natural resources and environment should be conserved and used for the collective benefit of all and should be replenished for future generations' (PNGNDoE, 2004b, p.5). There was a call for the wise use of PNG's natural resources and the environment, including all living things, in the process of development, and at the same time concern for future generations; the conservation and replenishment for the benefit and prosperity of all PNG people, of the environment and its sacred, scenic and historic qualities; and all necessary steps be taken to give adequate protection to all valued living things. This is in line with concepts of EeFS which requires sustainable use of the environment and its resources so that all people everywhere now and in future can also use it (PNG Government, 1975). The idea here is to ensure a better quality of life for everyone in this generation and future generations.

In other words, when people make decisions about how to use Earth's resources such as forests, water, minerals and wildlife, they must take into account not only the amount of these resources being used, but the processes used to get these resources, the people that have access to these resources, whether enough resources are going to be left for future children to use, and whether the environment will be left as it is today. However, since Independence, PNG has developed in many different unsustainable ways resulting in much of the resources being depleted (Aka, 2001). For example,

PNG land is covered by tropical rain forests which are the home for rich biodiversity; however, these forests were being rapidly deforested through logging activities (Aka, 2001). Aka (2001) emphasized that, if people of PNG do not take action to reduce deforestation, then the forests and all species that depend on them will soon be completely depleted.

The fifth National Goal (PNG Ways) emphasized the need to use PNG knowledge, skills and values to develop in every way including social, political and economic development (PNG Government, 1975). This is also in line with the concept of promoting local knowledge in sustainability and EEfS as described in *Agenda 21* (UNCED, 1992). While recognizing and promoting indigenous local knowledge, people can also promote sustainable living and sustainable education (Van Damme & Neluvhalani, 2004). This call for recognition, protection and utilization of local traditional knowledge has been reinforced for use in education for sustainable development and can be found in educational curricula (PNGNDoE, 2003a; PNGNDoE, 2003b).

As can be seen from this analysis, the Constitution of PNG was quite forward-thinking in creating these Goals at a time when the rest of the world was just beginning to address EEfS. These goals led to a number of initiatives in education and sustainability as described below.

Beyond these five Goals of the Constitution, in 1976 a Statement of Environment and Conservation Principles was accepted by the National Parliament (PNG Office of Environment and Conservation, 1976). Significant aspects in this Statement included: the need for ecological, social and culturally suitable forms of development and their consideration in project planning; sustainability; environmental responsibilities; environmental education and awareness; the role of the 'polluter pays' principle; and PNG's international role and responsibilities. The Government Ministries and Departments directly or indirectly related to environment and sustainable development, including the Departments of Education, and Environment and Conservation, were engaged

and encouraged to address these issues. A number of actions were taken towards addressing environment and sustainability issues but it was not explicitly clear whether or how the schools and teacher education institutions should address it. However, at about the same time, in the early 1970's the State was becoming more involved in providing national education, which included teacher education. Research into the provision of this State-led education soon found out some defects and calls were made by researchers and educationalists for reform to improve education in PNG. The defects found included:

- low retention of students in primary schools and the proposed universal primary education for all children was not achieved, and was claimed to be impossible to achieve, so calls were made for a reform in the education system (Avalos, 1992);
- much of education provided in PNG was claimed to be irrelevant for its people, so there were calls for a more relevant education for PNG (Eyford, 1993; PNGNDoE, 1999);
- primary schools were found to have a very rigid timetable, with much time given to English followed by Mathematics instruction, whereas practical areas including science, agriculture and basic technology often missed out on time allocation. This meant that subjects like science were very poorly taught (Avalos, 1992; Burke, 1996); and
- teaching approaches used in primary classrooms were claimed to be objective based, teacher-centred chalk and talk, which were condemned, and calls were made for a change in the approaches used (Avalos, 1992; Burke, 1996)

These issues signified problems for EEfS in many ways: firstly, low retention in schools means many PNG people were illiterate and would not understand environmental issues and their possible solutions, even if they are reported in the media. Secondly, rigid timetabling made it difficult for locally relevant issues including environmental issues to be included, so even if teachers had some ideas they would not include them in their teaching because of the tight school time schedules. Thirdly, irrelevant curriculum meant that although the

majority of students and their families employed traditional or local ways for existence, in schools they were learning from an Australian-based curriculum and were not learning about local PNG ways and practices. Lastly, students were taught many concepts using a teacher centred approach where students were required to learn what their teachers decided was right for them.

Calls were also made for reform in teacher education programs of PNG, which are further detailed in Section 2.3.5 on teacher education in PNG.

Since 1992, a number of responses were made to reform and improve education in PNG (PNGNDoE, 1995; PNGNDoE, 1999). These include:

- Restructure of the primary and secondary schools education system (Avalos, 1992; Openg, 1998). Review and change in primary and secondary curriculum content to make the curriculum more relevant to the majority of people in PNG (Norman, 2005);
- Policy on language of educational instruction changed from English only to bilingual system of instruction (Norman, 2005), in which all 840 languages of PNG could be used along with English to teach children. This was done to make education relevant by utilizing local traditional knowledge in educating the children, at the same time preserving both the languages and cultures of PNG (Matang, 2008);
- Reform curriculum in primary and secondary schools to focus on outcomes instead of objectives, where the outcomes are phrased in present tense and may be thought of as competencies, while the objectives were phrased in future tense (Norman, 2005);
- Three newly created primary school subjects were Environmental Studies, Making a Living, and Personal Development, while other subjects had their names changed, such as Language instead of English, Community Living instead of Community Life (Norman, 2005; PNGNDoE, 2003d); and
- Weekly time allocations for subjects were changed. For example, Language, Mathematics, Science and Social science were allocated 180

minutes per week, Personal Development was allocated 240 minutes and Making a Living was allocated 360 minutes (Norman, 2005; PNGNDoE, 2003b; PNGNDoE, 2003c).

According to the report compiled by Bhandari and Abe (2000), Environmental Studies as a lower primary science course and Making a Living as an upper primary community development course were developed in response to international and regional calls for development and implementation of EEfS. In particular, Environmental Studies was written to deliver education about, in and for environment and sustainability (PNGNDoE, 2003c; PNGNDoE, 2003d). The changes made to timetabling would allow teachers and their students to spend enough time learning about more relevant concepts and issues, and also plan and have lessons outside the classroom, including education in the environment. The change in approach of teaching and learning which now included constructivist, experiential, inquiry based and cooperative learning, and the change in language of instruction, which allowed the use of language, knowledge and approach which is locally relevant, enhanced the potential for delivering EEfS. These changes needed to be considered in teacher education to prepare teachers for delivering EEfS. This aspect is now discussed.

2.3.3 The History of Teacher Education in EEfS

Teacher education in EEfS has been recognized as a priority for all nations of the world. It is argued that the success of EEfS is dependent on the teacher's knowledge, skills and commitment for teaching EEfS (Fien & Tilbury, 1996). The first recorded international concern for adequate teacher training in the field of EE was expressed at an IUCN conference in Switzerland in 1971. At that conference, the representatives of over a hundred countries highlighted the importance of teacher education:

We recognize that teacher training forms one of the most important and significant aspects in the development of EE programmes and we recommend that:

- The training of teachers provides them with essential basic knowledge of ecological facts and an adequate background of sociology and its relationship to human ecology;
- Efforts should be made to develop in teachers a critical awareness of environmental problems to enable them to have responsible attitudes concerning environmental matters in their pupils;
- Environmental conservation is recognized as an essential part of the teacher training and that developments started in pre-service training should be continued by in-service training;
- As teacher training in EE involves the use of many techniques and methods, all prospective teachers should be given training in the use and evaluation of pedagogic methods, including those relating to interdisciplinary approaches and team teaching; and
- Media banks are established at the national and international level for the exchange of information, training aids and teaching materials (IUCN 1972, p.3).

Teachers were further recognised as principal audiences for EE by the *Belgrade Charter*, which called for institutions concerned to develop and implement well-designed teacher education programmes in EE (UNESCO, 1977). The participants of UNESCO-sponsored Asia Pacific regional meetings also recognised the need for training teachers in EE, and emphasised it during meetings held between 1976 and 1977 (UNESCO, 1977). They concluded that there was a need for further development of the existing training programmes, as well as creation of new ones to cater for EE. The Publication of *Needs and Priorities in Environmental Education: An International Survey* (UNESCO, 1977) was in response to the recognition of these needs.

Ministers of Education from around the world unanimously agreed that teaching EEfS was a priority activity for teacher education programmes and agreed that there was a need to include components of EEfS in their learning activities (UNESCO, 1978). Resolutions 10 and 11 of the *Tbilisi Declaration*

called for these programmes to include a basic level of training, which would enable teachers to incorporate EEfS effectively into other subjects and learning activities.

In addition to that, the International Congress on EEfS and Training in 1987 in Moscow also stressed the need for improving teacher education in EEfS in the nations of the world, including PNG, because the correct implementation of suggested teaching and learning materials and pedagogy aimed at producing environmentally-literate citizens was dependent on teacher training (UNESCO-UNEP, 1988). Thus, countries through their teacher education division or institutions were asked to identify the national objectives of their education and development plans for the training of teachers. Furthermore, the United Nations Conference on Environment and Development (UNCED) also highlighted the need for improving teacher education in the field in *Agenda 21* and so governments, including the PNG government, committed themselves to update or prepare strategies aimed at integrating environment and development as a cross cutting issue into education at all levels within the next three years (UNESCO-UNEP, 1992). The document specifically called upon educational authorities to assist in the development of teacher training programmes which would address the nature and methods of delivering environment and development education for teachers (Fien & Tilbury, 1996).

Despite these calls for prioritizing and including EEfS in teacher education programs, progress in doing so has been restricted in many countries due to reasons such as a crowded curriculum, lack of time and resources, difficulty in teaching across a range of learning areas, a lack of opportunity to orchestrate learning outside the classroom, lack of teacher preparedness, no teacher standards in EEfS, and the expected competencies are too broad to impact EEfS practices in teaching profession (Cutter-Mackenzie & Miles, 2006; Fien, 1995; Kennelly, Taylor & Maxwell, 2008; Miles, Harrison & Cutter-Mackenzie, 2006). Cutter-Mackenzie and Clarke (2008) and Kennelly et al. (2008) claimed increasing attention has been given to include EEfS in teacher education but

there is little research on how and when beginning teachers include EEfS in their own teaching and how successful they are in their delivery, and how teacher education can help. Since then, increasingly, pre-service teacher education in EEfS has been viewed as having potential for producing action competent pre-service teachers, who in turn can help produce action competent citizens (Ferreira, Ryan & Tilbury, 2007). It has the potential for producing pre-service teachers who can confidently deliver EEfS when they begin their teaching careers. Efforts have been made and increased attention has been given to the inclusion of EEfS in pre-service teacher education (Kennelly et al., 2008). However, there are limited research reports to explain why it has not been that successful, and how these teachers could include EEfS in their own teaching, or how teacher education providers can encourage and support their students to teach EEfS (Ferreira et al., 2007; Kennelly et al., 2008).

For instance, a study on EEfS teacher education program in Israel by Tal (2010) focused on pre-service teacher's knowledge which was collected from 75 pre-service teachers using pre and post implementation questionnaire. The course they took consisted of some classroom-based lessons and two field lessons which aimed to expose them to environmental issues so that they could become aware of, and be concerned about the issues, so that they can take care of the environment. The students reflected on all learning activities used and the actions taken. The findings showed that pre-service teacher knowledge prior to the course was poor but increased substantially after the course. However, the cause of the increase in the knowledge could be the critical reflection activities they were engaged in, or the experiential lessons they had or both. It is not clear in this study as they had engaged in critical reflections on all learning activities used and the actions taken, as well as the field or experiential lessons. Thus, one can assume that having both real experience observing environment and issues, and critically reflecting on the lessons and actions may have led to an increase in knowledge development.

Even after some effort have been made in response to all the pronouncements at conferences and the commitments by governments and the growing international and national support for EEfS, findings of several studies suggest that relatively little in the field of teacher education in EEfS was accomplished. This claim, is supported the result of a study by Van Petegem, Blicck and Pauw (2007) was carried out on two Flemish (Belgian) teacher education colleges. One of the two colleges (College A) had a long history of cross-curricular education, whereas the other college (college B) did not. In college A, for example, EEfS was taught as part of geography and biology, which did not occur in college B. The outcomes after inserting EEfS in the curriculum for pre-service teacher education, and having it implemented under the coordination of two lecturers from each of the colleges, were not promising. The leading lecturers in both colleges had very little success in getting their colleagues to join the EEfS workshops that were organized, indicating that they gave low priority to EEfS in the colleges. The authors took further initiatives by having the college staff identify the issues that affected the effectiveness of the programme for them, and then identified solutions to these issues, but hardly any implementation took place. It was concluded that the difficulties experienced during the process of implementation of EEfS were due to time and an overloading of responsibilities. The issues experienced could be used as a stepping stone for future implementation of EEfS. It seems, as if regardless of how good a programme may be, it may not produce the desired effect if the implementers of the intervention who are educators do not fully understand the objectives of EEfS and may not be able to direct the learning activities (Tilbury, 1996; UNESCO, 1980). Thus, it can be assumed that implementers must be involved in designing of any intervention, including the interventions related to EEfS in teacher education, so they include locally relevant knowledge, skills and values. At the same time, the implementers need to fully understand the objectives of an intervention so that they can direct the learning activities (Tilbury, 1996; UNESCO, 1980).

This situation is supported by the findings of a study reported in Cutter-Mackenzie and Miles (2006) and Miles et al. (2006) which was carried out in a pre-service teacher education faculty in rural New South Wales, Australia to find out if pre-service teachers were prepared and ready to teach EEfS after studying EEfS as part of their teacher education program. The authors concluded that teacher education was failing to provide adequate environment and sustainability training for pre-service teachers to prepare them to teach EEfS. The study began by examining the pre-service teachers' perceptions about their exposure to EEfS knowledge and to teaching EEfS to primary students, to find out if the knowledge and experiences provided in the teacher education programme had made them feel competent to teach EEfS. The study found that, although the pre-service teachers gained knowledge, they did not feel competent because they lacked lesson preparation and presentation practices (Cutter-Mackenzie & Miles, 2006; Miles et al., 2006). Thus, it can be inferred that beginning teachers may develop confidence to teach EEfS by gaining experience of participating in, observing, preparing and delivering EEfS lessons as part of their own teacher education programme.

2.3.4 Pre-service Teacher Education in EEfS in Asia Pacific

Asia Pacific nations also made some efforts in response to the pronouncements at intergovernmental conferences and commitments by governments and the growing international and national concern for EEfS (Kennelly et al, 2008; Pradhan, 2003)

Efforts were made to encourage the inclusion of EEfS either as a created course or by integrating it into learning areas and disciplines that already existed in formal and non-formal educational institutions and organisations. Bhadiri and Abe (2000) reported:

Analysis of status reports received from 36 countries in the Asia-Pacific region attempts to outline general trends, patterns and problems of environmental

education (EE) in the region. The findings indicate that EE is embedded in all forms of education. Initiatives such as “greening” the curricula and teaching composite courses in primary education and integrated courses at the secondary level are becoming common practices. Environmental concerns are incorporated into social science as well as physical science courses”(p. 1).

According to this and other reports, there was some progress made both in integrating EEfS concepts into subjects and learning areas and creating EEfS courses in many different disciplines and institutions (Bhadiri & Abe, 2000; Pradhan, 2003).

The institutions and organisations in Asia Pacific region were seen to be making efforts to include EEfS in their curriculums. However, the progress may have been affected because a:

“lack of national guidelines, institutional coordination and comprehensive governmental commitment are policy-level issues, whereas inadequate manpower, rigid curricula and conventional teaching, poor infrastructure, ambiguity of concepts and unavailability of information are the problems of managing EE programs” (Bhadiri & Abe, 2000, p.1)

There was no effective implementation of EEfS because most schools and institutions could not afford the required time or teaching and learning materials (Bhadiri & Abe, 2000).

The difficulty in implementation is also related to culture, poverty and population which links to environmental degradation and discrimination (Bhadiri & Abe, 2000). According to Fien (2003), the adoption and inclusion of EEfS has been ineffective in Asia Pacific because indigeneous knowledge and wisdom which used to sustain communities in the region for thousands of years

have been undermined by the influences of colonisation, industrialisation and globalization (Fien, 2003). The local traditional priorities of EEfS have been suppressed where the culture and environment are valuable only if they are economically productive. The local traditional knowledge, skills and values required for living sustainably with culture and environment were disregarded.

Educators around the world have been encouraged to utilize local traditional knowledge, skills and values for sustainability because it links well to economic well being (Fien, 2003). However, the utilization of local traditional knowledge in EEfS in Asia Pacific was slow because in many learning institutions and organisations, culture and local traditional knowledge and economic development activities are housed in separate disciplines. Thus, it is usually difficult to incorporate the two and develop further. Therefore, efforts need to be made to encourage utilization of local traditional knowledge in education, including teaching education (Fien, 2003) in EEfS.

Like in other countries, teacher education in EEfS in PNG is in theory a priority (UNESCO-UNEP, 1990).

2.3.5 Pre-service Teacher Education in EEfS in PNG

Teacher education in PNG was introduced in the late 1950's and early 1960's, and the State became involved in the 1970's. Prior to the 1970's, the teacher education programmes were provided mainly for people to deliver bible teachings (Openg, 1998), and these church-based training colleges later continued alongside the developed State-funded institutions. Since the 1970's, basic skills were used to train pre-service teachers how to teach using prescribed syllabi in Basic English and Mathematics, based on achieving simple and specific objectives (Burke, 1996). This was a manifestation of low entry requirements at the teachers colleges which were acceptable until 1979, when researchers and educators became aware that the programmes were not having the desired effect on pre-service teachers and teaching in schools.

According to Burke (1996) and Clarkson, Owens, Toomey, Kaleva and Hamad (1998), reform of teacher education was required in all teacher training colleges. Evaluations of teacher education showed that:

- The pre-service teachers lacked subject content knowledge so there were calls for changes that would facilitate increase of subject content knowledge of the pre-service teachers (Avalos, 1991, 1992; Solon, 1999; Waldrip, 1993);
- Entry requirement for pre-service teachers college in PNG was too low, so there were calls for increased entry requirement and length of pre-service teacher education (Burke, 1996; Solon, 1999);
- Learning approaches and activities used in teachers colleges such as objective-based, teacher-centred chalk and talk were viewed as inappropriate and calls were made for a change in the approaches (Avalos, 1992: Burke, 1996; McLaughlin, 1990; McNamara, 1989);
- Pre-service teachers were thought to lack critical reflective thinking (McLaughlin, 1990; McNamara, 1989);
- Pre-service teachers were thought to be socially and culturally alienated (Lake, 1993); and
- There were lots of differences or irregularities in the teacher education provided by churches and so there were calls made for a basic common curriculum for pre-service teacher education (Solon, 1999).

According to Avalos (1992), reform of teacher education was carried out in all teacher training colleges. There was a review in the teacher education curriculum materials, which included the use of student centred learning approaches to learning. The entry requirement for the students changed from grade 10 to 12 with above average or better grades and the length of pre-service teacher education changed from four semesters to six semesters (PNG National Department of Education, 2002). Training for teachers on teaching and learning now included planning, preparing and teaching subject knowledge (Maha, Flaherty, & Openg, 2002).

2.3.6 PNG Pre-service Teachers College Curriculum Revision

The PNG Government used funding from the Asian Development Bank and AusAID (Australian Development Aid) to revise existing course modules and develop some new ones for primary teacher education, including course modules for EE-related courses in science and social science disciplines (PNGNDoE, 2004). This was happening because the PNG Government embarked on a program of educational reform to have a curriculum that was relevant to PNG's cultures, needs and aspirations, which included a teacher education curriculum review and the provision of associated implementation support (PNGNDoE, 2004; PNGNDoE, 2005).

An AusAID project called the Primary and Secondary Teacher Education Project (PASTEP) assisted the primary teacher education program in PNG from 1999 - 2006 (Clarkson, Owens, Toomey, Kaleva, & Hamadi, 1998; Maha et al., 2002). Its goals were to assist the teacher education program and respond to research reports and pronouncements to raise the quality of teacher education to meet the requirements of the national Education Reform and *Agenda 21*.

PASTEP provided consultancy services primarily aimed at: curriculum revision and development and skills transfer; procurement of curriculum resources, computers and equipment; in-country and in-Australia training (PNGNDoE, 2005). As a result of that, and in response to international and regional calls for development and implementation of environment and sustainability education in teacher education, two environment related courses, 'Environmental Science' and a Social science related 'Natural and Cultural Environment', were developed for teacher education programmes with recommendations of learning activities and pedagogies aimed at helping pre-service teachers to develop some environment and sustainability concepts, skills and values.

The two courses have eight core compulsory modules and four optional modules as shown in Table 1.

Table 1 Modules for Environment Related courses for Pre-service Primary Teachers' College

Environmental Science Modules	Social Science Modules
Ecology (Core)	Geography Skills (Core)
Flora and fauna of PNG (Core)	Land Use and Settlement (Core)
Earth Science (Core)	Environmental Issues (Core)
Earth in Space (Core)	Culture (Core)
Weather and climate (Optional)	Resource Management (Optional)
Marine Resources (Optional)	
Earth Resources (Optional)	

Social science curriculum writers were aware of the need for providing EEfS for teachers. They were also aware of the fact that EEfS should be studied holistically. This included the pre-service teachers being aware of natural environments, resource use and management, economic development and issues related to them that are social environment issues. According to Lauer & Rifi (2002):

The most important part of the module is ... the concept of sustainable development and the need for careful management of resources. Students will become increasingly aware that the use of natural resources depends on the way people perceive their needs, the economic and social structure of their society and the level of available technology (p. 2).

The social science module on environmental issues was designed to help pre-service teachers identify local environment issues and think about how to promote resolving them using an action research process, and the module on resource management was designed to deliver knowledge the pre-service teachers needed to understand sustainable development, as stated in the lecturer's guide:

Environmental issues are a major concern in the world

today. All members of society need to be aware of, and knowledgeable about, the environment in its totality natural and built, technological and social (economic political, technological, cultural historical, moral, aesthetic). Teachers can play an important role in promoting the value and necessity of local, national and international cooperation in the prevention and solution of environmental problems (Lauer, 2002, p.1).

It is clear from the quote that the social science lecturers were encouraged to help pre-service teachers develop knowledge about components of the environment and their interconnections, environment and sustainability issues of PNG and the world, and the responsibility teachers should have towards future sustainability.

Another social science module on 'culture' was written to define and explore cultures in PNG and compare with other countries, but the module does not relate culture to the natural environment. Social science lecturers were not encouraged to utilize local traditional knowledge when delivering the natural and cultural environment course, but the presence of local traditional knowledge about the environment and sustainability in PNG was acknowledged in the lecturer's guide for social science lecturers:

People have occupied PNG environment for more than 40,000 years and contributions from many cultures have shaped and will continue to shape its unique natural, historical and cultural heritage. While indigenous inhabitants traditionally embraced a close relationship with the land, many early European settlers failed to appreciate the interdependence which exists between people and the environment (Lauer & Rifi, 2002, p. 9).

The lecturers were encouraged to acknowledge local traditional knowledge when discussing cultural and environmentally sensitive issues, but they were not clearly encouraged to utilize local traditional knowledge about environment and sustainability when delivering environment and sustainability related courses (Lauer & Rifi, 2002).

The environmental science modules were written to deliver knowledge about the natural environment with very little focus on human social and economic activities and their impact on the environment (PNGNDoE, 2004). The concepts and activities suggested for student learning do not relate to and reflect concepts of sustainability. However, since the science discipline in teacher education institutions is responsible for preparing teachers to teach environmental studies in primary schools, science lecturers are expected to deliver environment and sustainability concepts (PNGNDoE, 2003). This was indicated in environmental science lecturer's guide:

The practical component is strongly based on the application of ecological principles and problem-solving to PNG examples. Excursions or field studies are an integral part of the teaching program. Activities provided are hands-on approaches ... Throughout the teaching of this module there should be a strong emphasis on the constructivist approach to learning that can be readily applied to science teaching in the classroom. Students will be encouraged to apply their new knowledge and skills to the context of teaching at different levels in primary schools (Baroadfoof & Paullon, 2002, p. 14).

There appears to have been no research examining whether pre-service teacher training colleges are adequately preparing teachers to teach EEfS in schools. However, there has been research carried out on the impact of curriculum and support materials on teaching and learning in primary teacher education (e.g. Maha et al., 2002) and on the effect of reform curriculum on the teacher education programme (e.g. Norman, 2005). A study by Maha et al.

(2002) was carried out in five pre-service teachers colleges in PNG to find out their perception about the impact of PASTEP's support on teaching and learning approaches in teachers colleges and found there was improvement in the knowledge and practices of both the staff and their students after much of PASTEP's support was delivered through provision of teaching and learning activities, library resources, computer packages and training, workshops in curriculum development, teaching gender equity and special education. Another study by Norman (2005) who gathered the data by interview, observation and document analysis on primary school curriculum reform and its impact on teacher education at Madang Teachers College and Divine Word University concluded that the schools in the study were adequately supported by the government in making policies and providing resources needed to teach reform subjects. However, the study found that teacher educators at both institutions had not understood how and where to provide appropriate teacher training, and to make connections with concepts and practical activities between the college and reformed school curriculum (Norman, 2005). If this conclusion is typical for all reformed subjects and teacher preparation, then it may also be true for EEfS related courses. Although Making a Living and Environmental Studies courses in primary schools, and Natural and cultural environment and Environmental science courses in pre-service teachers colleges, were developed in response to international and regional calls for development and implementation of EEfS, it is inferred that EEfS delivered at pre-service teacher training colleges may not be adequately preparing teachers to deliver EEfS in schools. Thus, current practices of preparing pre-service teachers to deliver EEfS in schools were explored to address the gap between the policies and actual implementation. An intervention that addressed this issue in teacher preparation that formed the basis of this study is described in Chapter Five.

2.3.7 Summary of history and development of EEfS

EEfS is an evolution from original ideas about environmental education that recognizes humans and their activities as part of the environment.

EEfS concepts and sustainability issues require holistic consideration and resolution, because they are part of a complex network of systems and occur everywhere, in the local areas, nationally and globally. The need to resolve environmental and sustainability issues led to calls from world intergovernmental conferences for regions and countries to plan develop and implement EEfS. PNG participated in world and Asia Pacific intergovernmental conferences and made commitments to respond to these calls.

On the one hand, a response was easy because it was in line with the country's Constitution and philosophy of education. This included the five National Goals and Directive Principles of the Constitution, and new policies such as the PNG National Curriculum Statement and Teacher Education National curriculum guidelines, which were also based on the Constitution and philosophy of education.

The call for providing EEfS to create sustainable living was made to all levels of education and in several disciplines. Reforming the curriculum in primary schools and primary teachers' colleges was required to include environment and sustainability concepts and issues which are relevant to PNG in the curriculum, and the pedagogies that facilitate effective development of knowledge, skills and values necessary for leading a sustainable lifestyle.

Pre-service primary teachers colleges' lecturers, as part of the division of teacher education, participated in this development and implementation of environment and sustainability related courses. This led to the establishment of new courses in Environmental Science and Natural and Cultural Environment in all PNG primary teachers colleges.

There has been evaluation research published on the general implementation of the reformed curriculum materials in primary schools and teachers colleges, but as yet no studies on the effectiveness of this reformed teacher preparation

for implementation of EEfS in primary schools. Previous studies have indicated that pre-service teachers colleges may not have been adequately preparing teachers to deliver EEfS, and this current study set out to explore if this was the case from the pre-service teachers' perspective and to design an invention to address any issues that arose.

2.4 Summary

To summarise chapter two, EEfS focuses on environmental quality by adding relevance and value to EE by adopting issue based, action oriented and competency based approaches by stressing participation, action and critical reflection. Its development was driven by the concern for addressing environmental issues of the world.

The characteristics of EEfS are also stressed in the framework of education about, in and for the environment and sustainability where the concepts covered, and the learning activities and approaches used, facilitate action taking. This is promoted by the use of participation, action, experience, and critical reflection.

EEfS with its emphasis on relevant education points to the importance of local traditional environment and sustainability knowledge and pedagogy. Local traditional environment and sustainability knowledge are developed in the actual context by learners participating, and seeing and imitating peers or other more knowledgeable people. This learning approach is significant for the people in PNG, many of whom still embrace local traditional practices. It also connects with the principles within education about, in and for the environment.

EEfS is an emerging concept that has many of its roots in the EE movement but developed from this as people recognized that human rights and social justice are just as an essential part of environment and sustainability issues. EEfS provides a useful framework for gaining knowledge, skills and values about

existing environmental and sustainability issues and concepts. In other words, EEfS provides relevance and context and allows students who are citizens of the future to be engaged in, and take responsibility for, creating a sustainable future.

Over the past 40 years, there have been international and regional calls for providing EEfS at all levels of education, including teacher education. There were calls for providing EEfS in teacher education programmes because it was believed for EEfS to be effective, teachers must have the required knowledge, skills and commitment to deliver it.

On the one hand, implementation of EEfS in teacher education in PNG seems easy, as the Constitution of 1975 proclaimed several goals that aligned well with EEfS. However, curriculum advances did not reflect these goals clearly and only recently have some efforts been made in the education system of PNG, including primary schools and primary teacher education, to adequately address EEfS. This has included new subjects in the primary school curriculum orientated towards EEfS. In response to this change, teacher education curriculum also introduced new courses in an attempt to prepare new primary teachers to deliver EEfS.

Most of the research on teacher education programs in EEfS around the world seems to indicate that to date very little has been achieved in teacher development due to reasons such as crowded curriculums, lack of time and resources for good environment and sustainable learning experiences, difficulties of teaching across a range of learning areas, and lack of teaching practice on EEfS preparedness because the expected competencies are too broad (Fien, 1995; Cutter-Mackenzie et al., 2006; Miles, Harrison et al., 2006).

There is also little research on how and when beginning teachers include EEfS in their own teaching and how successful they are in their delivery, and how teacher education can help. In particular, there is hardly any research in PNG

on how effective is EEfS in pre-service teacher education programs in preparing the beginning teachers to teach EEfS to their students.

Thus, this research was carried out to find out about current EEfS practices in pre-service teacher education and the impact of designing an EEfS course that reflects current ideas about environmental issues in PNG. Before further discussing this research and how it was conducted, this thesis now examines teaching and learning practices in EEfS and creates a theoretical framework upon which this study was based.

Chapter Three

3. Content and Pedagogical Knowledge

3.1 Chapter overview

Having argued for the need for EEfS in PNG teachers' colleges in the previous chapter, it is apparent then that pre-service teachers' content and pedagogical knowledge would be crucial for delivering effective EEfS. Teachers of EEfS require clear understanding about the content knowledge relating to environmental issues and the most appropriate pedagogies to engage with in teaching this to students. There are many concepts in the content related to EEfS, however, studying environmental issues holistically can draw together concepts and create in learners a concern for sustainable action. Thus, this section of the literature presents the literature on content and pedagogies appropriate for delivering EEfS in pre-service teachers' colleges in PNG. Environmental issues and concepts of EEfS are examined as subject content knowledge, and learning theories and approaches are reviewed as pedagogical knowledge required for effective delivery of EEfS in pre-service teacher's college in PNG. Lastly, the action competence approach is reviewed as a promising idea in preparing pre-service teachers to teach EEfS.

3.2 Knowledge

Environmental issues and key concepts of EEfS are examined as subject content knowledge.

3.2.1 Environmental issues

It has long been argued that EEfS lessons should be delivered in the context of environmental problems (Tilbury, 1995). One reason is that environmental problems are occurring everywhere in the world, including PNG. Some of them are becoming severe and require immediate attention, understanding and resolution. Second reason is that environmental problems are part of people's lives; and many of these problems are created by people and affect them as

individuals and members of their society. Table 2 indicates the types of environmental issues that people experience in PNG, and in the world.

Table 2 Environmental Issues in PNG and World

Issue	World	PNG
Depletion of biodiversity	√	√
Deforestation	√	√
Endangered species	√	√
Land (ownership and degradation)	√	√
Land, water and air pollution	√	√
Climate change and global warming	√	√
Mining	√	√
Population growth	√	√
Poverty	√	√
Unequal resource distribution	√	√

(Aka, 2001; Lauer & Rifi, 2002; Ormsby, 2002)

This table shows that PNG has all these problems being experienced elsewhere in the world.

3.2.1.1 Depletion of biodiversity

PNG has a rich biodiversity which includes fauna, flora and micro-organisms , but many of the species are under threat. For example:

[Of] frog fauna which is thought to be over 200 species ... over the past twenty years there has been a general decline At least ten species have not been seen or heard for years despite wide-scale searches and many others are on the endangered species list (Coleman, 2008, p.19).

PNG has thousands of types of flora and fauna but many are under threat due to deforestation hunting and other human activities (Wolk, 2000). This biodiversity is important for the healthy functioning of the multiple ecosystems found in PNG, and for the functions these ecosystems fulfil. Some parts of the fauna and flora are culturally important to people in PNG because they use them as food, medicine, clothing and decoration (Steadman, White & Allen, 1999).

3.2.1.2 Deforestation

Aka (2001) has stated that deforestation in PNG is caused by a number of factors, including logging, gardening, and mining. The first and greatest cause of mass deforestation is clearing of the forest during logging for timber. The next major cause of deforestation is mining activity, followed by agricultural expansion, to create farms and gardens for local people (Ranch & Jackson, 1986).

PNG has only about 40% of its original forests intact and 85% of the remaining forests are under threat of destruction (Lauer & Rifi, 2002; Ormsby, 2002).

3.2.1.3 Endangered species

Some species of plants and animals in PNG are endangered due to deforestation and hunting for different purposes (Aka, 2001; Bhandari & Abe, 2000). Many plants and animals are in danger of extinction (Aka, 2001), including Matschie's tree kangaroo and the long-beaked echidna (Steadman et al., 1999).

3.2.1.4 Land degradation

Land degradation is a complex issue in PNG, with multiple causes, including agriculture (Ningal, Hartemink & Bregt, 2007), mining and deforestation (Bhandari & Abe, 2000). It is complex because sometimes what people consider a solution to one problem of human life creates another problem. For example,

the clearing of forest for the purpose of producing food and improving the economy results in soil erosion and degradation (Aka, 2001).

Land disputes are common in PNG and have become the source of new and more complex environmental problems in recent years (Westermarck, 1997). One factor is the land use associated with economic opportunities, whereby the land is used by government and multinational corporations for activities such as mining. Westermarck (1997) has explained that the complexity occurs because not only is there disagreement between the government, investors and landowner groups, there is also conflict and violence within the landowning clans. Similar issues are occurring among corporate investors who rent the land from local landowners and then sub-let that land to people outside the land-owning clan for production of cash crops such as oil palm (Curry & Koczberski, 2009). These users of the land tend to have less regard for the sustainability of the land than the actual landowners.

3.2.1.5 Global warming and climate change

One cause of changes in weather patterns and rising sea levels in PNG is thought to be global warming (Aung, Kaluwin & Lennon, 1998; Eroro, 2004). People in PNG are concerned about the changes in weather patterns they are experiencing because unusual weather patterns are affecting their lifestyles (Joku, 2009). In recent years the weather has been more unpredictable, for example, some areas experience a wet season when they should be experiencing the dry season (Joku, 2009). Heavy rainfall can affect people's food gardens, roads and land quality because they rely on agricultural products from their gardens for survival and on the sale of extra produce to earn income to use for other purposes (Freddy, 2007; Joku, 2009).

People are apprehensive about an increase in sea level along the coastal areas and islands in PNG. For instance, the populations of small Islands, including Manus Island in Manus Province and the Carteret Islands in North Solomons Province, are experiencing rising sea levels and have requested government

assistance to be relocated to higher ground on the main islands (Aung et al., 1998; Eroro, 2004; Freddy, 2007; Joku, 2009; Noho, 2010).

3.2.1.6 Pollution

Pollution is the presence of chemicals in the environment which can cause harm to people and environment if the level is high. Most pollutants are released by human related phenomena such as vehicles and industries. The root causes of these problems are often claimed to be population growth, unsustainable or wasteful use of resources from the environment, poor environmental management, ignorance and poverty (Goodland, 1995; Miller, 2007).

These problems are created by people (Gough, 1997) and are experienced at varying degrees in different communities and nations. It is arguably most important that people understand that many human activities cause pollution so that they will work out and take sustainable action to help reduce it (Goodland, 1995; Miller, 2007).

Various kinds of pollution are experienced in PNG, including land, water and air pollution. Water pollution has been caused by waste from industries such as mining (Wolanskit & Gibbs, 1994). In one case, according to Orathinkal, Tetang and Kilip (2011), an exploratory and analytical study investigated the level of mercury and its effects on the aquatic life in the Lower Watut River of PNG's Huon Gulf District. Samples of fish, water and sediment were collected and tested at the points where three villages have access to it. In addition to that, 40 alluvial miners from along the River were interviewed to explore possible health effects of mercury use for gold extraction. The study concluded that mercury concentration was high and was affecting the aquatic environment, and that there was a need for increased awareness about the toxicity of mercury and its effects on the environment (see also Esonu, 2009). Aside from such mining pollution, people in most parts of PNG contribute to water

pollution by dumping their household wastes into the rivers and ocean (Aka, 2001).

3.2.1.7 Mining

Mining is a problem in PNG and is the root cause of other issues, including water pollution, air pollution, unequal resource distribution, and poverty (Gibson et al., 2004). According to Esonu (2009), “mining in PNG continues to raise many environmental, social and economic concerns that government and private sector stakeholders have to date failed to address” (p. 1). Esonu (2009) adds that mining has detrimental economic, environmental and social effects. PNG Government’s fourth National Goal and Principle Directive and Environmental Act (2000) emphasise sustainable development, and give instructions to:

- (a) protect the environment from harm in accordance with national goal directives, (b) regulate the environment impacts of development activities and promote sustainable social and economic developments, and (c) provide for the management of and responsibility of national water resources (Independent state of PNG, 2000).

However, the Harmony Gold Mine has reportedly caused environmental destruction and shown no indications of sustainable management (Esonu, 2009). Esonu (2009) has also argued “that the PNG Mining Act 1992 is unfair to the people of Papua New Guinea” (p. 51) because a two percent royalty payment from mining earnings to both the hosting province and the landowners and landowner groups is insufficient.

3.2.1.8 Unequal resource distribution

The resources in PNG are unequally distributed. According to Cammack (2009), this is indicated by the fact that, although mining companies contribute a lot in compensation and benefits to local landowners and provincial governments, many mining provinces, including Western, Central, Milne Bay, Enga and New Ireland, remain amongst the most disadvantaged provinces of the country .

Cammack (2009) suggests that while resources are made available in the district, provinces and country, they are not then equally distributed; instead, a few benefit and the rest receive nothing at all. Gibson (2002) maintains that the main contributor to poverty in PNG is an increase in inequality.

3.2.1.9 Poverty

In PNG, people living in both rural and urban areas are experiencing poverty (Cammack, 2009; Gibson, Allen & Bourke, 2005). Gibson's analysis of data from an urban household survey in 1986 and 1996 indicated an increase in both the depth and severity of poverty, which is caused by growing inequality in resource distribution (Gibson, 2000), especially, the people in the rural areas because they lack basic infrastructures including transport (Gibson & Rozelle, 2003) and communication (Watson, 2009). People in the rural districts of PNG, such as Finschhafen and Menyama, are experiencing poverty (Gibson, Datt, Allen, Bourke, & Parajuli, 2004). Cammack (2009) states:

In terms of internationally accepted measures, the people of Papua New Guinea are poor. Worse yet, many are getting poorer ... To reduce its poverty is complicated and, by most accounts, beyond the government's ability or will to achieve, even with donor support (p.6).

Cammack (2009) goes on to say, however, that many people in PNG, including the elite, do not agree that half of PNG population should be labeled chronically poor, especially the people in rural areas. They consider that only a few people living in the squatter settlements in and around the cities are poor. The majority are not considered poor because their wantok system is:

...a system where people depend, care, and help each other in almost all of the societal affairs of the society (Para,2). Wantok system acts like a Western society's social security ... relative of the deceased people take care of the orphans ... poor, sick, old and disable etc are

helped in the same manner ... In economic activities, people invest in their wantoks, which they will demand or will be repaid when they are in need ... The system works very well in traditional setting in Papua New Guinea society. It can be termed or seen as unstructured communism with a biblical rule of love for your neighbour in the loose sense of the term. People do not need to work hard, when they are hungry someone will feed him, and s/he will reciprocate when his or her wantok is in need (Wantok system, Para, 3-7)

In this system, individuals may not have to have all the money they need to sustain themselves but their wantok system will help them when and if they need them. The Wantok system is useful for PNG people because most of the people live in societies that are very traditional in many ways (Okole, 2003).

Nonetheless, Cammack's (2009) claim that people in PNG are chronically poor is consistent with findings of previous studies reported by Gibson et al. (2005), including:

- A study by Wilson (1974) of access to hospital beds, administrative staff, primary enrolment and high school enrolment per thousand people, cash crop production, level of local government services, and socio-economic development which identified some as under developed districts of PNG;
- Another study by de Albuquerque and D'Sa (1986) that classified the same districts as least developed on the basis of population density, dependency ratios, rural urban migration, employment and cash income, and accessibility to basic education and health; and
- Hanson et al.'s (2001) study, which identified rural districts as disadvantaged on the basis of land potential, agricultural pressure on land, access to services, income from agriculture, and children's health in relation to nutrition (see also Cammack, 2009).

These are the problems that have been reported as experienced by many different communities of PNG by Western researchers.

3.2.1.10 Population Growth

Population growth is seen as a key challenge to the future sustainability of the environment in PNG (Miller, 2007). Miller (2007) noted from data from the United Nations and the World Bank (2006) that the world population is growing more slowly per year (1.23%) than in the past (2.2%) but that this has still meant a rapid increase in numbers of people. The growth is unevenly distributed between rich and poor countries, with 82% of the world's population living in the developing nations and only 18% in the developed nations (Miller, 2007). The world population was approximately 6.6 billion in 2006 so at that rate about 81 million people were added to the world population that year ($6\,600\,000\,000 \times 0.0123 = 81\,180\,000$). That is about 222,000 people per day, 9,250 people per hour and 2.6 people per second (Miller, 2007). Similarly, PNG's population was 6 million in 2008 with a growth rate of 2.4% per year, which means 144 000 people were added to PNG's population each year; this is about 394 people per day, or 16 people per hour (PNG Government & UNPNG, 2004; Cammack, 2009).

Rapid population growth is claimed to be one of the root causes of many other problems, including depletion of biodiversity, endangering and extinction of species, and land disputes and degradation (Aka, 2001; Miller, 2007). As the human population grows, demands and uses for resources, including living things, minerals, land and fuel, multiply; at the same time waste also increases, as well as other problems such as global warming and acid rain (Conway, 1995; Miller, 2007). At the level of local communities, with more people in the clan, there are tribal fights over ownership and use of land and the land is degraded because it is more frequently used by too many people. As an example, according to Ningal et al. (2007), between 1975 and 2000 agricultural land use in PNG increased by 58% whilst the population increased by 99%, indicating that population increase correlated with increased land use, and in fact

population grew much faster, and with it the need for increasingly intensive land use.

It is the basis of this thesis that EEfS can help people in PNG understand these problems, identify themselves as the creators of problems, identify unsustainable practices that create those problems, then replace them with practices that contribute to future sustainability. People need to learn about different environmental issues, identify the ones that are found in their own locality and work out ways to resolve them. It is therefore extremely important that pre-service teachers in PNG understand the bases of these issues to enhance their delivery of EEfS to students in schools.

3.2.1.11 Causes and effects of environmental issues in PNG

It is argued that through education people will learn and understand that they are both cause and solution for environmental and sustainability problems (Tilbury, 1995; Jensen & Schnack, 1997).

Firstly, people create problems when they take resources out of the environment. For example, forests in PNG are being rapidly depleted through unsustainable logging, which in turn is affecting many of the plants and animals that live in the forests, threatening their survival (Aka, 2001). This in turn affects biodiversity and the function of the forest ecosystem.

Secondly, problems are created by people discarding unwanted substances into the environment. For example, like other countries of the world, PNG is experiencing land, water and air pollution. The sea and rivers are continuously polluted by industrial activities such as mining and by the dumping of household waste (Aka, 2001).

Thirdly, people create environment and sustainability problems through their social and economic activities (Gough, 1997; Jensen & Schnack, 1997). In other words, environment and sustainability problems encompass social problems,

such as social injustice issues. For example, Miller (2007) also reported UN and World Bank (2006) data which demonstrated that 88% of the world's resources are used by developed nations, while only 12% of the resources are used by the developing nations. This gap between the wealthy and the poor of the world is widening (Goodland, 1995), and includes growing disparities in income, education and health care (Miller, 2007).

There is evidence of such unequal resource distribution and poverty in PNG. Cammack (2009) has contended that 85% of PNG people live in rural areas and employ themselves in a subsistence economy. One contributor to this situation is the lack of an effective transport and communications network. Generally, transport in PNG is limited by the rugged mountains. The capital city is not linked by road to other major cities, towns, or many villages. Other cities and towns can be reached only by plane, and some villages can only be reached by light aircraft, but all villages can be reached on foot only because there are no roads and airstrips, so despite the distance people walk to them, which is usually very difficult (Gibson & Rozelle, 2003). Air travel is the single most important and expensive form of transport for people and the freight cost too is usually very high (Gibson & Rozelle, 2003). As a result many of the basic services like schools, postal and banking facilities, and clinics have been closed because the infrastructure cannot be maintained (Gibson & Olivia, 2002; Gibson & Rozelle, 2003).

Lastly, people face problems that are hard to solve. Some of PNG's people have few external resources, so they deplete and degrade local environments such forests, grassland, soil and wildlife to survive (Cammack, 2009). For example, the majority of people in PNG live in rural communities, some of which are isolated from basic goods and services due to the rugged topography of the nation, which also affects development of road and transport (Cammack, 2009). Like in other parts of the world, PNG's forests, grassland, wetlands, coral reefs, and topsoil from croplands continue to disappear or become degraded as

human beings try to get more and more out of the environment (Aka, 2001: Miller, 2007).

3.2.1.12 EEfS as a solution for environmental issues

Understanding the causes and effects of environmental problems and their possible solutions can create in people the awareness of, and concern about, the environment, which can lead them to resolve environmental issues both directly and indirectly (Jensen & Schnack, 1997). According to UNCED (1992), education is seen as the most important indirect solution for environmental problems because it helps people to understand their unsustainable practices, and thus enhances their ability to resolve environment and sustainability issues by increasing their knowledge, changing their values and attitudes, and developing the skills and behaviour which are important for sustainable living (see also Mogensen & Schnack, 2010).

EEfS adopts Tilbury's suggestions for an action-oriented and issue-based learning process (Tilbury, 1995) and Lucas' education about, in and for the environment (Lucas, 1979), and works in parallel to the socio-cultural nature of learning in a traditional education system (Eames et al., 2008). Environmental problems are part of people and their society and are created by humans, and so have to be resolved by people as individuals and as members of societies (Jensen & Schnack, 1997). This can be achieved through EEfS.

It is contended that using environmental problems as a context for learning EEfS is appropriate because of its multidisciplinary nature (Tilbury, 1995). By studying the problems holistically, students can learn about concepts associated with all the disciplines. In that way, the learners are provided opportunities to practise using their knowledge, values and skills to solve the issues at the same time as they develop further knowledge, values and skills. This then leaves the students with experiences that they can use for identifying and resolving future environmental issues. On the other hand, some research

findings show that sometimes learning about the magnitude and complexity or severity of environmental and sustainability problems can make learners anxious and hopeless about the future, and stop them from taking action because they feel they cannot make a difference (Eames et al., 2008). However, it is hoped that by engaging learners to take some steps toward resolving local environmental problems they will gain experience, knowledge and skills and be confident about resolving development, environment and sustainability problems (Eames et al., 2008; Jensen & Schnack, 1997). Barry (2006) points out that EEfS is “purposeful when it is centred on issues that are typical and relevant to students’ lives” (p.4).

3.2.1.13 Summary of environmental issues

Environmental problems are experienced everywhere in the world, including in Papua New Guinea (PNG). In PNG those problems include: depletion of biodiversity and threats to endangered species, deforestation, conflict over land ownership and degradation, population increase, industrial and household pollution, global warming, and the complex challenges associated with poverty and unequal resource distribution. People need to understand the causes and effects of these issues if they are to resolve them.

Education can help people understand the problems, their causes and effects and also help them take constructive action to resolve them. However, teachers need to be aware that learning about the magnitude and severity of these problems can sometimes leave learners feeling distressed and hopeless. It is hoped that engaging learners to participate in resolving local environmental issues may encourage them to take further actions to solve other environmental problems now and in future.

In the wider context, population growth, unsustainable use of resources, poverty, greed, and ignorance are major causes of environmental problems. These environmental problems can only be understood when reference is made to social, cultural, economic and political activities. It is therefore

important for learners to understand that in its broadest sense the environment is made up of interdependent systems which include biophysical, social, cultural, and economic structures. All the socio-cultural systems can be thought of as interdependent; and all are dependent on the biophysical environment, which is also known as the life support system of the planet. That life support system is naturally viable and capable of supporting life, if people do not use up natural resources beyond the planet's capacity to naturally replace these resources, nor emit or throw waste into the environment in quantities which seriously constrain the planet's ability to cleanse and restore itself. When one system within the network is adversely affected, the rest will also be affected because of their links, and so sustainable action is required to maintain the balance.

These ideas are underpinned by concepts which are important to consider when delivering EEfS, which are discussed next.

3.2.2 Concepts of EEfS

Since 1990, environmental educators have become increasingly aware that humankind is an important part of the environment and the cause of many environmental problems (Fien & Tilbury, 1996). These have resulted from the way people use the natural environment and its resources to satisfy their needs and aspirations, so instead of just seeing problems in nature and natural systems, the EEfS educators began seeing the environment as the totality of people and their interactions with their surroundings (Chapman & Eames, 2007; Fien & Tilbury, 1996; TKI, 2011a). The environment was recognised as a complex web of social, cultural, economic and political as well as biophysical components which are all interdependent (Chapman & Eames, 2007; Fien & Tilbury, 1996; TKI, 2011a).

3.2.2.1 Interdependence

The concept of environmental interdependence refers to the relationship between all living things, including humans, and their physical environment (Broadfoot & Paullon, 2002; Miller, 2007). Living things depend on each other and on the non-living factors in their surroundings to survive (Broadfoot & Paullon, 2002; Heimlich, 2002). For example, green plants are viewed as producers because they can trap and use light energy from the sun whilst most animals consume the plants or other animals to get their energy. Plants produce oxygen which all living things need for respiration whilst the animals produce carbon dioxide which green plants need for photosynthesis. Plants also benefit from animals by using the nutrients from animal faeces and dead remains (Broadfoot & Paullon, 2002; Conway, 1995).

The other major form of interdependence is that of the biophysical, social, economic, and political systems (Fien & Tilbury, 1996; Chapman & Eames, 2007). This can be viewed as a set of interrelated systems. All social systems of human beings are dependent on the biophysical environment (Miller, 2007). Social systems are interrelated where social, economic and political systems are interdependent (Chapman & Eames, 2007; Goodland 1995; New Zealand Ministry of Education, 1999), as shown in Figure 1. The figure shows interaction between the environment, society and the economy, whereby society and the economy are subsets of the environment and exist only within the natural environment (Chapman & Eames, 2007). According to Porritt (2006), economic activity is a subset of human activities.

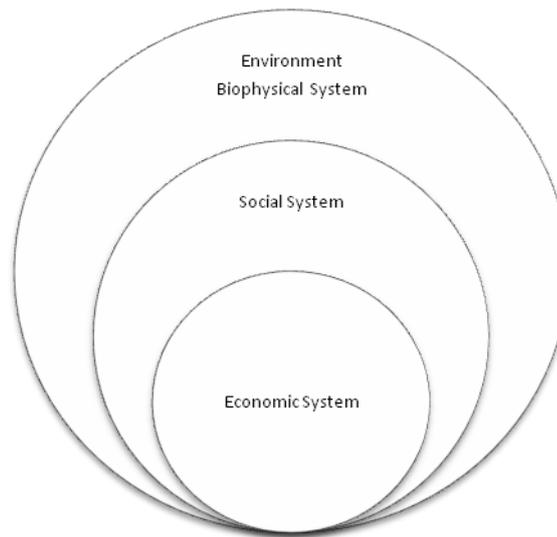


Figure 1 Strong Sustainability Model, adapted from Chapman and Eames (2007)

The social system is responsible for providing rules and structures which enable people to live together, whilst the economic system is responsible for production and exchange of goods and services (Chapman & Eames, 2007; New Zealand Ministry of Education, 1999; TKI, 2011a). Economic development is the development of the financial wealth of countries or regions for the well-being of their inhabitants. It can also be called socio-economic development, as efforts are made to improve the economic well-being and quality of life for a person, group, community or nation by creating or retaining jobs and supporting or growing incomes and the tax base (TKI, 2011a). Factors that cause socio-economic impacts include new technologies, changes in laws, changes in the physical environment, and ecological changes. Politics is the process by which groups of people make decisions on the distribution of resources (goods and services). The term is generally applied not only to behaviour within civil governments, but also to political behaviour of all other human group interactions, including corporate, academic and religious institutions. Politics consists of social relations which involve authority or power and refers to the regulation of a political unit and to the methods and tactics used to formulate and apply policy. It is through the political system that people make responsible decisions about how social and economic systems

interact with the biophysical environment (Chapman & Eames, 2007; TKI, 2011a).

According to the New Zealand Ministry of Education (1999) and TKI (2011a): the concept of interdependence emphasises the links between cultural, social, economic, and biophysical concerns that provide:

- a viable natural environment capable of supporting life, now and in the future;
- a sufficient economy that provides sustainable livelihoods for all;
- nurturing communities that provide opportunities for meeting social, cultural, and spiritual needs; and
- an equitable system of governance that ensures all citizens have fair access to levels of income and political power which allow them to participate fully as members of the society.

It is important that learners understand the link between these systems because when one system is affected, the rest will also be affected in some way (Chapman & Eames, 2007; TKI, 2011a).

3.2.2.2 Sustainable development

Most people value development and a good quality of life, however, in the process of development, this can lead to environmental problems (Chapman & Eames, 2007). For example, those who want economic development do not usually focus on the physical well-being of natural resources needed for production, while also emphasizing production and its quality (Goodland, 1995). On the other hand, education was seen to encourage and prepare people for development; however, a shift which began in the 1980's is emerging (IUCN, 1980; PCE, 2004). This is a shift from carrying out development to sustainable development and providing education to promote

sustainable development, which first appeared in International Union of Conservation for Nature report in 1980 (IUCN, 1980), and was brought to prominence in a report from the World Commission for Environment and Development, which described sustainable development as that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987, p. 8). There are many definitions for sustainability based on different concepts, theories, priorities and practices, but for many, it is linked to the concept of sustainable resource use and management, which deals with the use of both renewable and non-renewable resources. The survival and well-being of any society depends upon its supply of natural resources to maintain life to satisfy people's basic needs and to provide a certain degree of aspirations (Chapman & Eames, 2007; Mckeown & Hopkins, 2003). As discussed above, there are many developments in PNG that have not been sustainable by these measures.

People are often influenced by the values and expectations of their society, and as individuals and as members of their society will make lifestyle choices and consume resources. To achieve sustainable development requires a sound understanding of natural resources, their characteristics, distribution, status and present and future uses, in order to make informed decisions on how to use the resources for different purposes. This involves learning about the natural world and the functioning of ecosystems as well as about the way different cultures have perceived and used resources. Thus, any use of resources or developments including roads, bridges, airports and towns should be undertaken with careful consideration of both positive and negative impacts on the natural environment. The goal should always be a high quality and sustainable natural and social environment for all people in this and in future generations (Miller, 2007; PCE, 2004). According to Zandvliet and Fisher (2007) and PCE (2004), sustainable developments are those that: (1) meet needs of the present without endangering the ability of future generations to meet their own needs; (2) maintain the capacity of the ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time; (3)

take account of the environmental effects of economic activities and are based on the use of the resources that can be replaced or renewed and therefore not decreased; and (4) configure the societies so that their members are able to meet their needs and express their greatest potential in the present, while at the same time preserving biodiversity and natural ecosystems, and plan and act to maintain these ideas in every context (also see Hegarty, 2008; McKeown & Hopkins, 2003).

Decisions about the use of natural resources, including forests, water, minerals and animals, must take into account not only the amount of resources being used. They must also consider the processes being used to extract the resources, and the people who have access to them, to ensure that their development and use does not compromise the ability of future generations to meet their needs and aspirations (Hegarty, 2008). McKeown and Hopkins (2003) argued that the concept of sustainable development has been around for a number of decades yet the world continues to experience pressing global realities of unsustainable development. Thus, it is important in this case that EEfS creates awareness about, and encourages and prepares people to carry out sustainable development or take action to contribute to sustainable developments (Tilbury, 1995; UNESCO, 1992).

In the PNG context, while the need for development is as great as ever, that is all systems of environment including social and economic systems still have great need for development because they are pretty much under developed. However, future development has to be carried out sustainably, a new approach very different from the ones modelled in the past, which includes focusing on peoples' health and education development. Sustainable development provides that approach, by achieving economic and social development objectives at the same time as maintaining future sustainability to ensure a better quality of life for everyone (Baharuddin, 1995; Bolstad, 2003; Heimlich, 2002; Sterling, 2001). An important concept within sustainable development is diversity, and this is discussed next.

3.2.2.3 Diversity

Biological and cultural diversity are key concepts underpinning sustainability.

3.2.2.3.1 Biodiversity

Biodiversity is short for biological diversity in an area and there are three kinds of biodiversity which are all important for environmental sustainability (Miller, 2007). One is genetic diversity, that is, diversity of genes in a species or a population. This provides genetic resilience in times of change in environmental conditions, meaning that some individuals within the cohort will have a greater chance of surviving the change, and will be able to perpetuate the species. Species diversity, the variety of living things in habitats such as rainforests, reefs, grassland and mangrove forests, is the second type of diversity (Coleman, 2008). This helps maintain functioning ecosystems because different species occupy different ecological niches and contribute to the production and cycling of resources through the ecosystem. The last type of biodiversity is ecological diversity, which refers to variety of ecosystems (Miller, 2007). Diverse ecosystems provide different resource outputs and other ecological services which ensure the energy, water and air flow freely between them. Biodiversity increases ecosystem productivity of all the species in that ecosystem. All living things are important for maintenance of the ecosystem, regardless of their size or role. A diverse ecosystem can prevent and recover from stresses, including human use of plants and animals for medicines, clothing, decoration and food (Osborne, 1995).

PNG has very rich biodiversity in it including plants, animals and microorganisms, the genes they contain, and the ecosystems they form, and so PNG people need to develop an understanding of this (Newman, 1990; Ormsby, 2002). According to a report on 36 Asia Pacific countries, PNG amongst them, the “Asia Pacific is one of the most diverse regions in the world environmentally ...” (Bhandari & Abe, 2000, p.57). Sustainable actions are required to maintain this biodiversity.

As elsewhere, biodiversity is under threat in PNG because people are modifying and exploiting the natural environment (Aka, 2001; Ormsby, 2002). This threat is part of a wider issue in that “the natural resource of Asia-Pacific region is deteriorating in an alarming way, consequently the region is facing daunting problems of environmental degradation” (Bhandari & Abe, 2000, p.57). For example, the Huon Peninsula in PNG is a high-priority area for conservation efforts because of its large areas of intact rainforest, high species endemism and relative lack of protected areas for wildlife. Nonetheless, threats of mining, logging, and development challenge the continued existence of PNG’s unique flora and fauna in this area (Ormsby, 2002).

PNG people depend heavily on the environment for subsistence farming, hunting, gathering and fishing, and are therefore dependent on functioning ecosystems and rich biodiversity for their daily living. In addition, more than 97% of the land upon which these ecosystems are found is owned and controlled by the indigenous people (Cammack, 2009; Ormsby, 2002). This means a large number of plants and animal species, including the endemic species and their habitats, are vulnerable to depletion and degradation respectively (Aka, 2007; Coleman, 2008). Many of PNG’s indigenous plants and animals are listed as threatened (Aka, 2007).

Through EEfS, learners can become more aware of these issues and consider what actions they should take.

Tied up with the dependence of the people of PNG on their lands and their country’s biodiversity is a recognition of the diversity of cultural views that can impact on sustainability (Osborne, 1995). This point is discussed next.

3.2.2.3.2 Cultural diversity

“Culturally, PNG is extremely diverse and this is reflected in the fact that over [800] languages are spoken” (Osborne, 1995, p. 232), which, if understood, can be utilised to promote social and environmental sustainability. People in PNG

are brought up in one of those cultures and what they think and how they feel and believe is manifested in their decision-making. As a consequence, their actions and behaviours vary greatly (Baharuddin, 1995). However, all people in PNG are closely connected to their natural (Bhandari & Abe, 2000) and spiritual environment. They respect customary ownership of the land, and see forests, oceans and lakes as the homes of spirits and storage places for ancestral remains.

The cultural backgrounds of people affect the decisions they make about how social and economic systems interact with their biophysical environment (Baharuddin, 1995; Ministry of Education, 1999; TKI, 2011a). People with diverse cultural views tend to negotiate a better understanding and decision-making on the use of land and resources. Traditionally in PNG, land and its resources belongs to all the people who live on the land, or to the people who are part of the clan who live on that land, and they collectively decide how to manage, use, and transfer land according to their beliefs and values, which are time-honoured by the spirits. Negotiation of diverse perspectives about development can create types of development that are sustainable and in harmony with the needs and aspirations of all cultures, abandoning patterns that undermine the lives and perspectives of those cultures. However, the detail of how this is done varies between clan cultures. Some ideas that emerge from this diversity are listed below:

- (1) Some areas of forests with everything in them are left untouched because they are viewed as the home of ancestral spirits and guardian elementary spirits (see also Telban & Vavrova, 2010);
- (2) Some people do not eat certain plants and animals because their clans and places were named after those plants or animals (Bhandari & Abe, 2000);
- (3) Through the 'wantok' system, every person in the clan receives an equal share of all that is found on the land. In this wantok system, no member is expected to be poor, instead everyone is expected to share whatever

they have or produce, so that no individual is too rich or too poor (Government of PNG & UNPNG, 2004; Cammack, 2009); and

- (4) Clan members will live in harmony because they respect each other and their leaders.

According to Van Damme and Neluvhalani (2004), EEfS knowledge learnt in and through the environment by means of multidisciplinary issues which emphasise multiple perspectives is usually understood and addressed more clearly than through only one perspective. This includes developing alternative visions for sustainability and working creatively and cooperatively with others to achieve it in a democratic sense. This aspect of working together is discussed next.

3.2.2.4 Democracy

Taking action to produce or support sustainability in democratic societies is a great challenge because the “environmental problems are structurally anchored in society and [people’s] way of living” (Jensen & Schnack, 1997, p. 164). Solutions to the problems require change in individuals as well as communities (Jensen & Schnack, 1997). For example, education in schools cannot change the political problems of the society, but it can help develop students’ thinking and feelings through their programmes so that the students are able to take appropriate action when they encounter environmental problems. According to Jensen and Schnack (1997), “Experiences are results of actions performed on the basis of previous experiences which are the result of other actions”(p.166).

In addition, concern for the environment must be coupled with a corresponding concern for democracy, meaning that people are free to believe whatever they choose to believe and take whatever action they choose to take at whatever time and place they want to participate (Jensen & Schnack, 1997). In other words, no one should be indoctrinated to behave in a certain way; instead, EEfS should encourage people to think critically about and reflect on their own and other people’s values, and the values of the institutions that surround them, and on that basis decide on a course of action. This approach

will lead learners to a stronger understanding of their decision-making power and encourage clarity of thinking and valuing in order to argue a case.

3.2.3 Summary of Concepts of EEfS

A set of concepts that are important for learners in EEfS in PNG to understand includes interdependence, sustainable development, diversity and democracy. People's environment is made up of interrelated systems that include biophysical, social, cultural and economic systems. All the social systems are interdependent and all are dependent on the biophysical environment, also known as the life support system of the planet. When one of these interacting systems is affected the other systems may become unstable, producing an unsustainable situation.

Sustainable developments meet needs and aspirations of the present generation without jeopardising the ability of future generations to meet their needs and aspirations. Such development will improve quality of life without affecting the capacity of the ecosystem and the other systems to maintain their natural balance, processes and functions. All members of a sustainable society will be allowed and encouraged to meet their needs in sustainable ways. This will include recognition of the role of biological and cultural diversity, and full participation in democratic processes.

In EEfS the students' understanding of these concepts is connected to their knowledge and the experiences of and attitudes towards sustainability that are developed through meaningful student-centred learning approaches. These approaches are discussed next.

3.3 Pedagogy

3.3.1 Learner-centred approaches

Current literature indicates that learner-centred pedagogical approaches are effective because they focus on what the learners are learning rather than what the teachers are teaching (Latham, Balise, Dole, Faulkner, Lang, & Malone, 2006). These approaches are those in which the learners are supported by the teachers to determine and learn the concepts or problems they want to study. The learner-centred approaches that could be used in teacher education, especially in delivering in EEfS, include constructivist learning, inquiry learning, cooperative learning, experiential learning and socio-cultural learning.

These learner-centred learning approaches are based on the work of theorists such as Dewey (1899), Piaget (1950), and Vygotsky (1986). Each learning approach can be guided and directed by one or several learning theories. The theories listed above are now discussed in turn for their relevance in EEfS.

3.3.2 Learning Approaches

The learner-centred approaches that are identified as appropriate for delivering EEfS include constructivist learning, inquiry learning, cooperative learning, experiential learning and socio-cultural learning are discussed next, beginning with constructivist learning.

3.3.2.1 Constructivist learning

Constructivist learning approaches are based on constructivism theory, which sees learning as an active constructive process, and all learners as unique individuals with unique needs and backgrounds, who construct new knowledge using prior knowledge and experiences (Elkind, 2004; Piaget, 1950; Terwel, 1999; Von Glaserfeld, 1991; Vygotsky, 1986). Constructivism grew out of Vygotsky's and Piaget's work (Piaget, 1937, 1950; Vygotsky, 1934) which premises that all learners' ability to think, conceptualize and communicate their own perspective of their world are based on past and present knowledge

and experience. In other words, individuals construct new ideas or concepts based on prior knowledge and experience (Dewey, 1899).

According to Ballantyne and Packer (1996), students in all learning situations are likely to hold a number of different conceptual frameworks for explaining the same phenomena, and this will influence the way they act and interact with the world as observers, experimenters, or problem solvers. This implies that they will learn different things from the same events or lessons, and construct a range of different conceptions and apply them in many different ways. Ballantyne and Packer (1996) maintain that to design meaningful and effective learning experiences educators need to be aware of the range of conceptions held by the students, and how these might hinder or support new information being presented, or the desired learning outcome. Learners' existing notions or intuitive understandings are part of their personal belief system, and are usually difficult for them to modify or abandon.

In particular, it is important to recognise the views and the meanings of the world that the learners already have, and which they will be using to make sense of new information. They have to be guided to construct knowledge about a phenomenon using their prior knowledge and experience of it (Ballantyne & Packer, 1996; Elkind, 2004). Ballantyne and Packer (1996) argue that a constructivist framework is appropriate for teaching EEfS because knowledge is constructed by learners through the interaction of their earlier ideas with the present, new understanding of the world. EEfS links students' conceptions of the phenomenon with their knowledge, attitudes, values and behaviour, to develop new knowledge, skills and values.

The three key concepts in constructivist learning that account for the creation of new knowledge are assimilation, accommodation, and equilibration (Piaget, 1950). Assimilation occurs when people incorporate new and old experiences and knowledge or apply old knowledge in a new situation or context. This causes them to develop new outlooks, re-think concepts or issues, and make

necessary alterations to their perceptions. Accommodation is reframing or making changes to whatever is available in response to the new information. Individuals form a particular image in which the world operates and start to accommodate and reframe the expectations when things do not operate within that context (Block, 1982). Equilibration, according to Piaget (1950) the "motive" for cognitive growth, can also be a challenge, motivation, or the force which moves development along, then restores balance by mastering the new challenge or increasing knowledge (Block, 1982). Once the new information is acquired, the process of assimilation with the new schema will continue until new adjustment is required. An unpleasant state of disequilibrium happens when new information cannot be fitted into existing schemas (Block, 1982). Piaget's views on the development of thought are then related to the domain of personality. Equilibration is argued to be a manifestation of the individual's orientation to limit anxiety by maintaining or constructing an understanding of the world that is not disconfirmed.

The assumptions in constructivist learning are consistent with the assumptions that underpin EEfS in PNG because the majority of people are very dependent on their environment, and so they already have some knowledge and experiences about the environment and its sustainability that can be drawn upon in learning situations. The concepts of assimilation, accommodation and equilibrium are consistent with those goals of EEfS which aim to help people to understand their environment and any problems associated with it. In particular alignment with constructivist ideas are critical education, in Tilbury's EEfS framework, where learners are encouraged to think critically to analyse and potentially change their ways for sustainability (Tilbury, 1995; Bolstad, 2003), and Lucas's concept of education about the environment, which emphasises development of knowledge of the environment to promote action towards sustainability (Barker & Rogers, 2004; Bolstad 2003; Lucas, 1979). The quest for knowledge is advocated through inquiry, and this is discussed next.

3.3.2.2 Inquiry-based learning (IBL)

Inquiry based learning is another student-centred learning approach where learning is based on exploration and questioning, which leads to investigation into a worthy question, issue, problem or idea. Learning in this approach involves asking questions, gathering and analysing information, generating solutions, making decisions, justifying conclusions and taking action (Eames et al., 2006).

The central goal of inquiry-based learning (IBL) is for students to develop valuable skills, including critical thinking, research and independent inquiry skills (Moore, 2004). As with other student-centred learning approaches, the topic or problem to be studied and the methods to be used for learning are determined by the students (Moore, 2004). Inquiry-based learning is a form of active learning, where progress is assessed by how well students develop experimental and analytical skills rather than how much knowledge they possess. This is in line with Tilbury's issue-based and action-oriented learning, and critical education which is also in line with Lucas's education for environment and Jensen and Schnack's action competence (Jensen & Schnack's, 1997) idea of environmental issues as social problems caused by people and needing to be solved by people.

Inquiry-based learning, like constructivist learning, is a student-centred learning approach. Inquiry-based learning reflects Tilbury's (1995) notion of issue-based learning, which starts with an exploration and questioning and progresses to investigation into worthy questions, issues or ideas. Lipowski (2008) explains that inquiry-based learning involves asking questions, gathering and analysing information, generating solutions, making decisions, justifying actions and taking further actions. Apodoe, Walker and Reeves (2006) consider inquiry necessary for the development of critical-thinking and problem-solving skills and content knowledge. It also provides students with opportunities to participate and practise the skills and processes involved in effective action (Edelson, 2001). It is an appropriate pedagogy for delivering EEFS because the

approach engages students as active participants who are able to decide what and how they want to learn (Tilbury, 1995). Students in an inquiry-based learning programme work by themselves to solve problems rather than receive direct instructions from their teachers (McLean, 2003; Apodoe et al., 2006).

Inquiry-based learning activities can range from being quite structured and supervised, particularly at lower levels, where the teacher may pose the questions and guide learners in how to solve the problem, through to a high level inquiry learning activity such as independent research, where the learner generates the questions and determines how to search for the answers. According to Apodoe et al. (2006), a number of researchers have reported the benefits of inquiry teaching and learning approaches, suggesting that it fosters in students an appreciation of the processes and skills of problem solving and critical thinking. Apodoe et al. (2006) maintain that with careful consideration of course content, learning approach and activities, roles of both learner and instructor inquiry-based learning can be successful in developing skills as well as content knowledge. Inquiry can be undertaken alone or in groups, with the latter being discussed next.

3.3.2.3 Cooperative learning

Cooperative learning is a learning approach in which the learners work in small groups to learn from and help each other and complete tasks collectively toward academic goals (Johnson, Johnson & Smith, 1998). Cooperative efforts are made by learners in the group striving for mutual benefit so that all group members can gain from each other's efforts and success (Johnson et al., 1998). In other words, one's performance is mutually caused by oneself and others in the team. The cooperative learning approach is underpinned by social development, social learning and cognitivism theory. Social Development theory argues that interaction in social activities precedes social skill development; consciousness and cognition are the end product of socialization and social behaviour (Vygotsky, 1934, 1986). Social theory states that learners learn from other more experienced, skilled or educated people or peers, meaning some skills can only be performed if learners receive assistance from

more knowledgeable and skilled others such as their peers and teachers (Vygotsky, 1934, 1986). It has been argued that it is important that environment and sustainability issues are viewed and addressed as social issues by all concerned (Jensen & Schnack, 1997).

Mandal (2009) describes cooperative learning as a student-centred learning approach whereby the learners are active participants who work in small groups to help one another to learn as well as solve problems, complete tasks and accomplish common goals. Cooperative learning approach is identified as an effective learning approach by a number of researchers, including Acar and Tarhan (2007) and Lopato, Miller and Miller (2003). One example involved a case study in which two parallel classes were studied doing correction on their written work. One group worked on their corrections through a cooperative learning approach, while the other followed traditional teacher-centred and individualistic approach. To examine any differences in performance, both groups were given pre-test and post-tests and the findings indicated that those who were involved in cooperative approaches enjoyed learning and improved their performance between the tests than those who learnt through the traditional teacher-centred approach (Servetti, 2010). Another study was conducted on forty one 11th grade students' who were taught in two classes by the same teacher to investigate the degree of effectiveness of cooperative learning instruction over a traditional approach on their understanding of electrochemistry. The learners' misconceptions concerning electrochemistry were identified through a pre-test. Twenty one students were randomly assigned to a control group and the rest to an experimental group. The control group received knowledge through a traditional approach of learning whilst the experimental group received knowledge through cooperative learning based on a constructivist approach. After correction lessons, the same test was administered to both groups as a post-test. The results of the tests indicated that the students who were educated using a cooperative learning approach had significantly higher scores in terms of achievement than those taught by the traditional approach (Acar & Tarhan, 2007).

Cooperative approach can be effective learning approaches whereby learners actively help one another to learn as well as solve problems. All it requires is the commitment and creativity of both learners and their teachers in designing learning activities that promote cooperative learning, which in turn can promote development of knowledge and skills (Macaulay & Gonzalez, 1996).

This sharing of knowledge and perspectives supports Tilbury's emphasis for EEfS on relevance, and the importance of values education, which draws on multiple perspectives to create more holistic learning, in line with Jensen and Schnack's (1997) ideas of environmental issues as social problems caused by people. Working on these problems provides experiences which can lead to learning, as is discussed next.

3.3.2.4 Experiential learning theory

Experiential learning is a learner-centred process of making meaning from direct experience with the environment (Kolb, 1984). Learners do so by attempting to associate their new knowledge, skills and values with their prior knowledge and experience. It can happen when learners have contact with real life experiences or be engaged in problem solving activities. It is underpinned by experiential learning theory, constructivist learning theory and:

- As in constructivist learning theory students current and past experiences knowledge, skills and experiences are used to develop new knowledge, skills and values (Terwel, 1999);
- Social constructivist theory that proposes that authentic or situated learning, where the learner engages in activities which are directly relevant to the application of learning and which takes place within a culture similar to the applied setting;

Experiential learning is the process then of making meaning from direct experience with the environment. The theory began with Aristotle and was supported and expanded by Kolb (1984). Experiential learning is learning

through reflection on doing, is often contrasted with rote or didactic learning, and focuses on the learning process of the students (Heimlich & Daudi, 2002a, b). Thus, students make discoveries and experiment with knowledge first-hand, instead of hearing or reading about others' experiences (Beard & Wilson, 2006). Teachers in experiential learning are facilitators guiding the students through the meaning-making process of individual direct experience (Heimlich & Daudi, 2002a, b). Kolb (1984) stated that although the gaining of knowledge is an inherent process that occurs naturally, for a genuine learning experience to occur the learner must: be willing to be actively involved in the experience; be able to reflect on the experience; possess and use analytical skills to conceptualise the experience; and possess decision-making and problem-solving skills in order to use the new ideas gained from the experience. As Heimlich and Daudi (2002a) describe, Kolb's (1984) ideas lead to a four stage cyclical theory of learning which combines experience, perception, cognition, and behaviour. Kolb's (1984) four stage learning cycle shows how experience can be translated through reflection into concepts, which in turn are used as guides for active experimentation and the choice of new experiences. Svoboda and Whalen (2005) add that experiential learning is an effective way to develop action competence. They consider it is a useful model for EEfS lessons because "it engages the whole person, involving learners' mental, emotional and somatic intelligence" (p.58).

The first stage, the experience aspect of experiential learning, is based on actions and parallels Tilbury's (1995) issue-based and action-oriented learning and Lucas's (1979) education in the environment which encourage some form of authentic experiences . It allows the learners to learn first-hand by participating in new and challenging experiences (see also Svoboda & Whalen, 2005).

The second stage, diverging or reflective observation of experiential learning, which is consistent with Tilbury's (1995) critical education and holism, is when

the learner is concerned with reviewing and reflecting on issues and experiences from several different points of view (Svoboda & Whalen, 2005).

The third stage, converging abstract conceptualisation (AC), aligns with Tilbury's (1995) critical education, and Lucas's (1979) education about the environment. Learners conceptualise to find possible solutions to problems and make relevant informed decisions (Svoboda & Whalen, 2005). This is also allied to constructivism.

The fourth stage, the experimentation aspect of experiential learning, is consistent with Tilbury's (1995) action orientation and Lucas's (1979) education for the environment. At this point learners attempt to apply their understanding to new situations in the real world (Svoboda & Whalen, 2005).

Critics such as Freedman and Stumpf (1980) have questioned experiential learning approach, saying it is neither valid nor reliable. However, some studies have indicated its values. For example, in a study carried out with medical school students in Singapore, it was hypothesised that, for novices, experiential learning would improve the learning and retention of endotracheal intubation as compared with a guided learning approach (Ti, Chen, Tan, Tan, Tan, & Shen, 2009). A group of year 4 medical students were randomised to either guided or experiential learning. Students in the guided group were taught using the conventional step-by-step technique whilst the students in the experiential group had to work out the correct technique for intubation on their own. Both groups had further opportunities to intubate manikins and patients during their postings and were recalled three, six, nine and 12 months later, when their intubation skills were assessed in four major categories: equipment preparation; intubation technique; successful intubation, and placement confirmation. At three months, 64.5% of the students in the experiential group successfully intubated the manikin, compared with 36.9% from the guided group. This was repeated three monthly; for both groups the success rates improved with time, usually with better success in the experiential group. After

the study it was “suggested that experiential learning should be adopted for the teaching of endotracheal intubation” (Ti et al., 2009, p. 654). This suggests that experiential learning is an effective approach which could be used in teaching many other subjects, including EEfS. Moore (2004) assessed the impact and effectiveness of experiential learning on students' multicultural counselling competencies, and concluded that experiential learning is an effective learning method because learning occurs while things are actually happening or being performed by the learners, including inside the classroom through simulations and role-playing.

The approach could be adapted for delivering EEfS in teacher education, because experiential learning, according to Heimlich and Daudi (2002), occurs when learners are provided with opportunities to be involved in experiences, guided to discuss and generalise the experiences, and then to apply their new knowledge and skills. This is consistent with the participation EEfS objective in the Tbilisi Declaration (UNESCO, 1978), the action-oriented and issue-based learning approaches of EEfS (Tilbury, 1995), and the education in the environment dimension of Lucas's (1979) thinking. Barker and Rogers (2004) maintain that “experiential learning is the most commonly proposed theory of learning environmental education [for sustainability]” (p. 15) because the behaviour change aimed for in EEfS can best be achieved through experiential learning (see also Heimlich & Daudi, 2002a, b). Ballantyne and Packer (2006) add that ample research evidence has suggested that experience in the natural environment is a powerful medium for promoting learners' environmental knowledge, attitudes and pro-environmental behaviour. The reflective practice employed in experiential learning has important applications to EEfS, given that learners appear to learn better through reflecting critically on their observations (Miller, 2007; Tilbury, 1995). This reflection is framed by the learner's sociocultural background, and the impact of this on learning is discussed next.

3.3.2.5 Socio-cultural learning

Socio-cultural learning approach grew out of Vygotsky's (1934) work, which posits that all learners construct their own perspective of the world through their experiences with other people and their environment. It also stems from Bandura's social learning theory, which posits that behavior is developed through the process of observing (Bandura, 1977), and that people learn from one another through observation, imitation, and modelling. This theory argues that social interaction precedes development, and that consciousness and cognition are the end products of socialisation. The theory also proposes that knowledge development occurs in a social context and through the social experiences of individuals (Vygotsky, 1986). Mcleod (2011) contended that learners pay attention to the demonstrators or models, encode the skills or behavior demonstrated and imitate it when needed. Elkind (2004) echoed Luckman (1966) in saying that reality takes meaning and form from the natural and social interactions people have with their environment rather than from abstract instruction. People learn from others through observation and imitation of skills modelled (Mcleod, 2011). Cognitive knowledge development occurs in a social context and through social activities, preparing learners to solve problems in any situation or environment (Mcleod, 2011). Socio-cultural learning is identified as an appropriate approach for delivering EEfS because knowledge development of learners occur in a social context and through their social experiences where they learn from one another through observation, imitation, and modelling. Also because of the notion that environmental issues are social issues created by people while carrying out social activities and so should be studied and addressed holistically and critically (Tilbury, 1995). The assumptions underpinning sociocultural learning connect with Tilbury's ideas about relevant, value-based EEfS, which in turn connects with local traditional ways of learning.

As alluded to above, these student-centred learning approaches call for particular roles for teachers and this is discussed next.

3.3.3 Role of Teachers and Learners

The role of teachers and students in student centred learning approaches are described in this section.

3.3.3.1 Role of teachers and students in student-centred learning approaches

In each of the learner-centred learning approaches discussed above - constructivist, inquiry-based, cooperative, experiential and socio-cultural learning, teachers can be viewed as facilitators of learning. According to Elkind (2004), teachers as facilitators support the learning that is initiated and directed by the learners. Rather than teachers giving the students all the information, they assist them to ask and answer questions. Students build their own knowledge based on their prior and current knowledge and experiences instead of building knowledge on the teacher's knowledge and experiences (Elkind, 2004; Terwel, 1997). Learners are responsible for their own education and are expected to learn through active engagement in organised learning activities, so that they develop knowledge and skills which can be applied in real situations, such as solving problems (Prawat & Floden, 1994; Von Glasersfeld, 1991). At the same time they will develop feelings of competence to solve other problems because of their successful experience in completing a challenging task (Prawat & Floden, 1994; Vygotsky, 1978).

The teachers in these approaches are expected to know what is being acquired and how it relates to what has already been learnt, and to understand each learner's prior knowledge and experience (Terwel, 1997), as every learner has unique needs, interests, knowledge and experiences (Cooze, 2006). The learners' experience and prior knowledge may vary widely and they would need help and encouragement to make sense of their environment and to arrive at their own conclusions, which are influenced by their cultures or world view (Ballantyne & Packer, 1996). Ballantyne and Packer (1996) note that students are likely to use several different conceptual frameworks to explain the same phenomena, learning different things from the same event and applying their understanding in several different ways and actions. Thus, to

successfully guide development of the desired learning experience or outcome, the educator needs to be aware of the range of perceptions held by the students which might hinder, negate or support the information which is being delivered. The roles of teachers and students in these approaches are consistent with EEfS being value and issue-based, and action-oriented (Bolstad, 2003; MacLean, 2003; Tilbury 1995), the participative objective of EEfS (Jensen & Schnack, 1997; UNESCO, 1978), the focus on education for the environment and sustainability (Lucas, 1979) and PNG local ways of learning, and recognises that environmental problems are structurally anchored in societies (Jensen & Schnack, 1997). These characteristics lead directly to considerations of what is important in teacher education in EEfS.

3.3.3.2 Role of teachers and learners in teacher education

The role of the teacher educator in student-centred learning is that of facilitator of learning and imparter of the skills required (Harrington & Enochs, 2009; Loughran, 2006). Harrington and Enochs (2009) contend that while teachers often claim that the lessons they deliver are student-centred, in reality they deliver teacher-centred lessons because they do not really understand what constitutes learner-centred learning. Thus teachers have to be trained carefully in knowledge, skills and attitudes, and have a thorough understanding of the curriculum, knowing exactly what, when and how to teach different subjects or topics to the children, so that they can facilitate learning appropriately (Elkind, 2004).

Teacher educators as facilitators can support and guide the learners (in this study, pre-service teachers) to learn in their own way, at the same time as they learn how to be facilitators of learning. They will build their own knowledge about the subject, as well as the pedagogical content based on their prior and current knowledge and experiences, instead of just teaching what the teacher educator wants (Loughran, 2006). As pre-service teachers are learners responsible for learning both subject content and how to facilitate its learning

through active engagement in organised learning activities, they will develop knowledge and skills which can be used or applied in real situations (Loughran, 2006). At the same time they can develop competence for teaching EEfS using appropriate pedagogies based on their own experience (Barker & Rogers, 2004; Loughran, 2006; Tilbury, 1995). In other words, it is important to consider how these pedagogical ideas can be applied in pre-service teacher education in EEfS so that the novice teachers are empowered to teach EEfS using these pedagogies which are generally student-centred learning approaches.

One way of reinforcing the development of both content and pedagogy is by problematising knowledge gained and pedagogy used during the teacher education lessons and allowing the pre-service teachers to critically reflect on the lesson content and pedagogies. To implement these approaches effectively, teachers need to have a full understanding of the subject and of pedagogical content. This idea was explored by Cutter-Mackenzie and Tilbury (2003) who found that prospective teachers lacked the pedagogical content knowledge to effectively teach EEfS in primary schools, and concluded that this could have a significant effect on teaching.

To counter these problems, Loughran (2006) argued that teacher educators should model the approaches that they want the pre-service teachers to use in their classes. This can be done by teaching the content using an appropriate approach, and showing the students how to use that approach (Edwards & Protheroe, 2003). Furthermore, allowing the students to evaluate the approach demonstrated and to discuss its strengths and weaknesses can help them develop their knowledge, skills and experiences of the approaches. Working actively with others to identify and resolve the tensions and contradictions inherent in teaching can allow useful implementation of articulated theories of subject and pedagogical content knowledge, and skills required for resolving issues and teaching can also be acquired while learning about subjects such as EEfS (Edwards & Protheroe, 2003). This is consistent with Miles, Harrison and Cutter-Mackenzie's (2006) assertion drawing on earlier findings of Lortie (2002)

that teachers will often reproduce the pedagogies they have themselves encountered as primary, secondary and teacher education students. Thus, it is important that the EEfS teacher educators model appropriate pedagogical approaches (Miles et al., 2006).

Pre-service teacher education is just the beginning of the development of prospective teachers, who ideally will continue to evolve in their profession and career as long as they work (Russell & Loughran, 2007). Elkind (2004) adds that a teacher's knowledge, skills and values are in large part gained through their practice in the field, from their involvement in and reflection on their teaching and learning practices. Currently there is little evidence of this in-service development in EEfS occurring in PNG. This makes it even more important that pre-service teacher development be guided by some coherent conceptual framework (Russell & Loughran, 2007).

This is of significant concern, given that a number of researchers (e.g. Miles, Harrison & Cutter-Mackenzie, 2006) have noted that EEfS preparation is inadequate in pre-service teacher education. Miles et al. (2006) conducted a study into pre-service teacher education in rural New South Wales, Australia, to find out pre-service teachers' perceptions about their readiness to teach EE after studying it as part of their teacher education programme. They found that the pre-service teachers considered they had not learned much from the programme, and claimed they did not feel ready to teach EE in their classes.

Kennelly, Taylor and Maxwell (2007), commented after a study that pre-service teacher education in EEfS has the potential for producing pre-service teachers who can confidently deliver teach EEfS when they begin their teaching careers. Efforts have been made and increased attention has been given to the inclusion of EEfS in pre-service teacher education. However, there is a limited research report to explain why it has not done that, and how these teachers will include EEfS in their own teaching, or how teacher education providers can encourage and support them to do this. They concluded that, EEfS in teacher's college

should be focussed on helping individual to development their pedagogical content knowledge relevant to EEfS during the pre-service years.

Although the important role of providing fieldwork experiences for students in the natural environment is now well-established within environmental education literature, there is still little research evidence to guide teachers in their choice of effective teaching strategies (Kennelly et al., 2008)..

According to Terwel (1997), pre-service teachers in EEfS should be allowed to learn following the constructivist view that every learner is a unique individual with unique needs, interest, knowledge and experience. They can make sense of their world and arrive at their own version of truth, influenced by their backgrounds, cultures or embedded world view (Ballantyne & Packer, 1996). It would be important then to develop a pre-service course in EEfS in PNG that includes development of knowledge, skills and values that teachers need in order to be competent both in taking sustainable action in their lives and in teaching EEfS to their own students.

3.3.4 Summary of pedagogy

Student-centred learning is a learning approach that seems to fit the goals of EEfS. The focus in this type of education is on the students, who help determine both the topic or problem to be studied, and the methods to be used for resolution. Students actively participate in initiating learning and associated activities and then help direct them. Teachers in student-centred learning approaches are facilitators who provide guidance as the students work. The student-centred approaches that appear to be relevant for delivering EEfS are constructivist learning, inquiry learning, cooperative learning, experiential learning and socio-cultural learning.

Each of these learning approaches has potential for use in EEfS, as the characteristics of EEfS indicate that knowledge is constructed by learners

(constructivist learning) through inquiries based on their needs (inquiry learning) and interactions (experiential learning) with the world; the new information and the knowledge can be influenced by the students' sharing with each other (cooperative learning) and by their backgrounds (socio-cultural learning).

Using these learning strategies to deliver EEfS could empower the pre-service teachers to develop competence in facilitating their students to work towards a sustainable world. A final framework to be considered to bring this about is that of action competence.

3.4 Action competence

Concepts of action and action competence associated with EEfS are to build students' abilities to act with reference to environmental issues (Mogensen & Schnack (2010). Education for the environment (Lucas, 1979), an action-oriented approach (Tilbury, 1995) and action competence (Jensen & Schnack, 1997) are linked to the action aspects of EEfS, as they all aim to develop learners' concern for the environment and their willingness to make informed decisions about lifestyle choices so that both their quality of life and the environment are both improved (TKI, 2011c). Thus, students should be helped to develop and demonstrate their knowledge, values and skills to act during EEfS lessons (Jensen & Schnack, 1997). The awareness, knowledge and understanding about the environment and their practical involvement and experiences in and through the environment and sustainability issues should all enable individuals and groups to take effective actions. Action competence, as originally proposed by Jensen and Schnack (1997), and since built on by others, has been thought of as incorporating several aspects, the development of which in a learner can lead to the competence to act. The key aspects to be discussed here are experience, knowledge, critical reflection, action-taking and commitment to the environment and sustainability. In this study, the development of action competence in the pre-service teachers was of

particular interest, as well as ways of enabling these teachers to consider how they would develop action competence in the students that they would eventually be teaching.

3.4.1 Experience

Providing experiences associated with EEfS is in line with the Tbilisi EE objective of participation (UNESCO, 1978), issue-based and action-oriented learning (Tilbury, 1995), and education in the environment (Lucas, 1979). All contribute to producing action-competent people (Jensen & Schnack, 1997). Jensen and Schnack (1997) have suggested that learners should be provided opportunities to take action in both real and simulated activities, which then provide a basis for future decision-making and action. As Svoboda and Whalen (2005) added, experiential learning is one of the most effective ways of promoting positive change in individuals and organisations because the approach consists of acting, reflecting, reframing and applying.

Having experience of seeing, feeling and addressing the issues beyond the classroom in human and non-human environments not only provides opportunities for students to gain first-hand experiences in the environment but also enhances classroom or theory lessons in environment and sustainability education (TKI, 2011c). These opportunities can be used to develop skills in observation, data collection, practical inquiry and investigation (Tilbury, 1995; TKI, 2011c). Such situations can also require social and cooperative skills, communication skills and problem-solving skills. Opportunities may vary depending on the local environment, and curriculum statements provide opportunities for learning experiences outside the classroom (TKI, 2011c). Carefully considered practical or outdoor experiences that have a clear sense of purpose and are well managed can help students to develop an appreciation of, and a concern for, the environment (Jensen & Schnack, 1997; TKI, 2011c). Thus, for pre-service teachers to develop action competence they need experience in observing the environment and issues related to it, observing EEfS lessons prepared and presented, as well as being

involved in resolving environmental issues and critically reflecting on their lessons and actions (Daudi & Heimlich, 2002). These experiences can be drawn on for future sustainable action, and lesson preparation and presentation (Jensen & Schnack, 1997). Such experiences include learning in and about the environment and environmental issues and connecting themselves to the environmental issues so that their passion and motivation for action is created and they think about their environment, feel for it and take appropriate action (Sipos et al., 2008). Jensen and Schnack (1997) and Fien and Tilbury (1996) contend that students, such as the pre-service teachers, are empowered by being engaged in observing, and thinking about the environment and environmental issues.

Pre-service teachers also observe and participate in the EEfS lessons that are prepared and presented to them. Lortie (2002) contended that pre-service teachers will often adopt the pedagogy they observed in their training. Lortie (2002) emphasised that educators can influence their students' ideas about sustainability, and so pre-service teachers can learn to become EEfS teachers while they are themselves learning about it. This is consistent with Loughran's view:

... the teaching of teaching must not only encourage such an approach, it should overtly display it in practice. There should be an expectation that students of teaching will critically examine their teacher educators' practice and they will see that teacher educators similarly examine their own practice ... Teacher education should be a crucible in which the very practice of teaching and learning about teaching is the source of sustained inquiry and development (Loughran, 2006, p.28-29).

Loughran (2006) argues that teacher educators should demonstrate before the pre-service teachers the approaches that they want them to use. This can be done by teacher educators teaching the content, using the approaches, and showing the pre-service teachers how to use the approaches (Edwards &

Protheroe, 2003). Heimlich and Daudi (2002) contend that experience only becomes a learning experience for the students when they are provided opportunity to experience, discuss about and critically reflect on their experience. This includes allowing them to critically examine and evaluate the practices and discuss the strengths and weaknesses of each practices or approaches, so they can develop necessary knowledge, skills and values related to them (Tilbury, 1995; Loughran, 2006).

Experience thus becomes a key aspect for pre-service teachers to have in order to gain an understanding of environmental issues themselves and how to provide experiences for their own students that can lead them to understand these issues.

3.4.2 Knowledge

Gaining knowledge about and understanding of the environment, and the impact of social activities on it, is important and is in line with the Tbilisi EE objectives (UNESCO, 1978) and education about the environment (Lucas, 1979; TKI, 2011b). Knowing about and understanding the natural and built environments and appreciating the key social, cultural, ecological, and economic factors that influence decision-making on local and national issues are critical if students are to meet the aims of EEfS (Fien & Tilbury, 1996; Chapman & Eames, 2007; TKI, 2011c).

Being aware of cultural, social and economic activities and understanding social, ecological, and economics issues are all factors that influence education about the environment (Crown, 2010; TKI, 2011a). The PNG national curriculum statements (PNGNDoE, 2003d) provide frameworks for thinking about these factors which will help students to establish their own environmental values and attitudes. A study carried out by Harrison and Clarke (2003) of nine classes of 10-12 year old children in Australia showed that the children who were involved in simulated environmental issues gained additional environmental knowledge and that their attitudes towards the environment became more

positive. If pre-service teachers are to become competent teachers, they need to have subject content, general pedagogical and subject pedagogical knowledge, and curriculum knowledge (Bell & Gilbert, 1996).

Content knowledge is the basic understanding of the subject matter and the concepts which delineates it, and how the principles, theories, and concepts in the subject are related to each other and to other subjects (Bell & Gilbert, 1996). In EEfS, the pre-service teachers would need to know about the interrelated biophysical and socio-cultural environments and their relationships and be aware of the environmental problems in their local area; in addition, they would need to be familiar with the skills that could be used in solving these problems. They will then be motivated to take action themselves and with their students work to achieve an environmentally sustainable way of living (Roth, 1970; Heimlich & Daudi, 2002c).

General pedagogical knowledge, secondly, is knowledge about how children learn well and about the approaches teachers can use to best inform their students and to promote the development of useful skills and positive values. Subject pedagogical knowledge is knowledge about specific subject pedagogies and learning activities that will promote effective learning in that discipline (Bell & Gilbert, 1996). In this latter case, the pre-service teachers should know that learning activities that promote constructivist, experiential, cooperative, inquiry-based and socio-cultural learning are effective for developing knowledge, skills and attitudes appropriate to sustainable living.

Thirdly, curriculum knowledge is the knowledge about the official curriculum of the country or the institution, in particular about the recommended materials, pedagogy and assessment (Bell & Gilbert, 1996). In this case, the pre-service teachers in PNG should know that the Department of Education expects the students to learn EEfS, as this is indicated by having curriculum areas such as Making a Living and Environmental Studies, and that issues can be treated as multidisciplinary topics by having thematic and integrated teaching as a

suggested method of teaching, so that teachers can be prepared to use them in their teaching (Bell & Gilbert, 1996; Fien & Tilbury, 1996).

Lastly, knowledge of the educational context is awareness about individual students' backgrounds, including past and present knowledge, needs, interests, culture, beliefs and values. This is important because these contextual factors can either facilitate or hinder learning (Bell & Gilbert, 1996). Pre-service teachers in PNG should know about the environment and local environmental issues which affect and are affected by people so that they are motivated to use them as the context for delivering EEfS (Heimlich & Daudi, 2002c; Roth, 1970). This will include consideration of local traditional knowledge in PNG, and relates well to the ideal of relevance in EEfS (Tilbury, 1995).

Knowing about biophysical environments and environmental issues, their causes and effects, and the possible solutions for issues, can motivate people to take action or make a commitment to take action (Gopal, 2004; Fien & Tilbury, 1996; Roth, 1970). According to Miles et al. (2006), researchers, including Phipps (1991), Cutter (1998) and Cutter-Mackenzie and Tilbury (2002), who have undertaken evaluative research in teacher education, found that pre-service teachers often feel they have not gained enough subject and pedagogical content knowledge about EEfS in teacher education and so they are not prepared to teach EEfS. This finding is consistent with the study by Miles et al. (2006) on pre-service teachers' subject and content knowledge that found that the pre-service teachers felt they were not prepared to teach EEfS in schools because they have not gained enough subject and pedagogical content knowledge from their teacher education on EEfS. The pre-service teachers may not have felt that way if they were guided and led to critically reflect on and discuss the strengths and weaknesses of the knowledge they gained and pedagogies they observed in EEfS lessons, because critical reflection can help create more knowledge and make necessary connections (Eames et al., 2008).

3.4.3 Critical Thinking and Reflection

Ernest and Monroe (2006) contend that critical thinking improves learning, promoting encompassing of multiple disciplines by connecting fields of knowledge, and fostering higher order and critical thinking, problem-solving and decision-making skills. Tilbury (1995) and Bolstad (2003) argue that all gained knowledge and actions taken should be critically reflected on to promote effective further action.

Action-oriented lessons in EEfS are used to develop action competence in a way that is underpinned by critical theory (TKI, 2011c) Action competence is achieved when students and teachers work critically towards resolving environmental questions, issues and problems, because more and deeper understanding of concepts and issues is developed when students are engaged in critical reflection of the actions taken in resolving the issues, and of the lessons they learnt or observed (Jensen & Schnack, 1997; TKI, 2011c). Critical reflection involves and develops all human faculties of learners by making them think and feel when they examine activities, processes and events, and then take action when they identify steps towards possible solution (TKI, 2011c). This can motivate them to identify more issues and take practical actions to contribute towards more sustainable relationships with the environment (Mogensen & Schnack, 2010).

To be action competent, learners should enquire into their experiences through a process of critical reflective thinking; in this case, to reflect on their actions and lessons in EEfS (Eames et al., 2009; TKI, 2011c). It is important that pre-service teachers are guided to reflect on their observations on the components of the environment, environmental issues, and on learning activities used during the EEfS lessons. Reflection is necessary [for learners] to make connections between [their] thinking, feeling and acting, and for them to make connections between the lessons or actions and important concepts and issues and possible outcomes (Fien & Tilbury, 1996; Eames et al., 2009). As teachers to be, they should also reflect on EEfS lesson preparation and presentation in

the teacher education programme (Fien & Tilbury, 1996; Loughran, 2006). Loughran (2006) advises that student teachers be allowed to critically evaluate the practice and various approaches of their educators as part of developing their own knowledge and skills.

3.4.4 Action

According to Bishop and Scott (1998) and Jensen and Schnack (1997), action taking and development of action competence is very important in EEfS. A learner's participation in purposive and focused action as part of EEfS is often viewed as an indication of their action competence. In other words, action taken in EEfS lessons should be intentional and directed to promote behaviour which will support sustainability. It is argued that if learners are to be action competent they must be supported to take actions for sustainability actions such as making decisions, solving problems and transferring information about environment and environmental issues to others (Eames et al., 2009; TKI, 2011c). According to Jensen and Schnack (1997), the actions students take do not have to be direct or complete, however, as long as the learners are helped to understand the importance of the actions they have taken or they are in the processes of taking, because students cannot be expected to solve the world's problems (see also Eames et al., 2008). In the context of EEfS, direct actions are actions that contribute directly to solving environment and sustainability problems, whereas indirect actions are those which are taken to influence others to contribute to solving problems. Pre-service teachers should be guided to take some form of action (Eames et al., 2009; Jensen & Schnack, 1997; TKI, 2011c). This could include assisting them to prepare and present EEfS lessons for their students (Fien & Tilbury, 1996). However, research indicates that student action taking has not been a consistent part of EEfS in many parts of the world, because education in action-oriented EEfS lessons has not been emphasized (Cowie et al., 2004; McLean, 2003; Miles et al., 2006).

3.4.5 Commitment

Jensen and Schnack (1997) further argue for the importance of vision and commitment in EEfS. To be action competent the pre-service teachers should be encouraged to develop their own visions for sustainability and then to commit themselves to act in accordance with those visions.

This might include making a commitment to:

- Tell their family and community members about the environment and sustainability issues (Tilbury, 1995);
- Teach their students about the environment and sustainability issues (Fien & Tilbury, 1996);
- Use environmental issues in EEfS lessons to provide experience and practice for learners so they are also empowered to take sustainable actions (Fien & Tilbury, 1996);
- Provide opportunity for their students to observe the environment and environmental issues so they too can feel for the environment and will contribute to future sustainability (Fien & Tilbury, 1996);
- Draw on local traditional knowledge in EEfS lessons to help the students to appreciate and make use of the local traditional environmental and sustainability knowledge in their living, so that they can contribute to future sustainability; and
- Teach EEfS using methods and learning activities that promote active, inquiry-based, constructivist, and experiential learning (Fien & Tilbury, 1996).

These efforts are to be encouraged because not all educators who are concerned about the environment and sustainability teach EEfS. According to Archie, Simmons, Heimlich & Daudi (2002), even though 96% of the parents and 97% of the teachers said environmental education was important when they were asked about its importance in a nationwide poll, the authors noted that in practice few teachers consistently included EEfS in their curriculum.

3.4.6 Summary for action competence

Learners attain action competence through having experiences, developing knowledge through inquiry and critical reflection, gaining action skills, and then showing commitment towards a sustainable future. They gain experience from observing the various components of the environment and of environmental problems, from actions they take to resolve such problems, and from critically reflecting on the experiences and actions. On the basis of their experience they develop knowledge, useful skills and values, and commitment to taking sustainable action. Their thoughts and feelings are also drawn towards sustainable action when they analyse the ways in which decisions and actions taken in complex systems can have both immediate and future impacts on the environment. Apart from these experiences, for pre-service teachers their critical observations and experiences of the lessons presented to them can also make them competent teachers of EEfS. Their competence can be indicated by the actions they take as part of their EEfS lessons when those lessons are designed to develop the knowledge, skills and values required for sustainable action, and by their commitment to act thenceforth in ways which contribute to environmental sustainability.

3.5 Chapter summary

In order to work towards a sustainable future, PNG people, including pre-service teachers, need to know about the nation's environmental problems. These include depletion of biodiversity, deforestation, endangered species, land ownership and degradation, continuing population growth, mining, pollution, global warming, poverty and unequal resource distribution. They need to know not only the issues but also their causes, effects, and possible solutions. Human activity is a major contributor to environmental issues so it is essential that people consider what to do to reduce or solve the problems. Education has an important role to play in helping people, including pre-service teachers, contribute to these solutions.

The natural environment consists of a network of ecological, social, cultural and economic systems. All these systems are interdependent and they all depend on the natural ecological system for their survival. When one part of a system or the network of systems has a problem, the other parts of the system or network of systems will also be affected. The systems and network of systems are affected by people carrying out their everyday activities to maintain and improve their lives, and this highlights the importance of sustainable development. Being sustainable involves accepting and promoting cultural and biological diversity, because these diversities can help develop resilience to change in the social and natural environment. A goal of EEfS is to help the students understand the links between the systems and how they affect one another, so that they can choose to act in ways that are likely to be effective and that they feel comfortable about.

It is argued that educators need to use pedagogies such as constructivist, inquiry-based, cooperative, experiential, and socio-cultural learning that have potential for developing environment and sustainability knowledge, skills and values. They also align with the aims for EE as stated in the Tbilisi Declaration (UNESCO, 1978), and with the frameworks of Tilbury (1995) and Lucas (1979), as discussed in Chapter 2.

This chapter has further explored how these learning approaches can develop action competence in learners. To develop action competence, learners need to be provided with experiences, gain knowledge, critically reflect on this experience and knowledge, and take action, based on this reflection, with commitment supported by vision and values. Development of these aspects of action competence through a pre-service teacher programme would then be an important outcome for EEfS.

This idea that EEfS in a PNG teacher education programme should be delivered in a way that produces action competent teachers who are willing to take appropriate action with reference to environmental issues, and who are

prepared with knowledge of PNG issues and appropriate pedagogical approaches, was the basis for an intervention and its evaluation in a pre-service teacher education programme in PNG. These are described in the next two chapters.

Chapter Four

4. Methodology

4.1 Chapter overview

This chapter presents the methodology adopted for this research. It starts by presenting a description of the research paradigms used in educational research, then outlines the research approaches, methods used in this research, and design of this research. The chapter concludes with a summary.

Section 4.2 describes and gives a brief account of positivism, interpretivism and critical theory as the three main research paradigms used in educational research. It then explains why interpretive paradigm was adopted in this study. Section 4.3 describes and evaluates quantitative and qualitative research as approaches for collecting data and justifies the use of triangulation in this research. Section 4.4 discusses data collecting methods used in this research and why they were useful in this research. Section 4.5 and 4.6 present a description of the research design and the ethical issues relevant to this study respectively. The chapter ends with section 4.7, the chapter summary.

4.2 Research paradigms

All researches, whether quantitative or qualitative are based on underlying philosophical assumptions or paradigms about what constitutes valid research with appropriate research methods or techniques for gathering and analyzing the data (Cohen, Manion & Morrison, 2007; Neuman, 2006). A paradigm is defined as a “a deep-rooted set of perspectives that includes an ontological and an epistemological position and a set of values for operating in the world” (Costley, Elliott & Gibbs, 2010. p. 83). On the other hand, Basit (2010) and Burton and Bartlett (2009) describe research paradigms as models or conceptual frameworks that use a set of assumptions, beliefs about what

constitutes good research, and techniques for gathering and analysing data. These paradigms describe the nature of knowledge and reality and the roles of research and researchers. It is noted that research paradigms consist of ontology, epistemology and methods, each informing the other, and are linked to research questions and an appropriate conceptual framework (Cohen et al., 2000; Creswell, 2005; Hartas, 2010). Ontology can be defined as people's views about the nature of being, including whether reality exists outside people or inside them and constructed by them, whilst epistemology is the study of the nature of knowledge and how it is acquired, transferred, gained or created and validated (Gall, Gall & Borg, 2007).

Cohen and Manion (1994) and Burton and Bartlett (2009) identified positivism (objective) and interpretive theory (subjective) as two paradigms appropriate to social and educational research whilst Basit (2010) and Cohen et al. (2000) identified three: positivism, interpretive theory and critical theory. Each of this paradigm is distinguished by certain ontological assumptions which in turn give rise to epistemological assumptions, and these, in turn, result in methodological assumptions and ultimately in specific methods of inquiry (Cohen et al., 2007). For the purpose of this study, the three philosophical assumptions were carefully considered and are briefly described in the following three sections.

4.2.1 Positivist research

The positivist paradigm, also known as the normative paradigm, is a traditional approach to scientific research (Cohen et al., 2007). The positivist paradigm assumes that reality is objectively perceived and can be described by measurable properties which are independent of the observer (researcher) and the instruments used (Costley et al., 2010). It also argues that if the scientific method has been successfully applied to solve problems of natural phenomena, then it can equally be used to solve problems of social phenomena (Cohen & Manion, 1994; Cohen et al., 2000). It is further proposed

that the scientific approach allows studying the behaviour of individuals and social groups because human behaviour is governed by social laws learnt through observation (Burton & Bartlett, 2009; Cohen et al., 2000). This perspective posits that there is no free will and that causes always produce measurable effects (Cohen & Manion, 1994; Cohen et al., 2000; Burton & Bartlett, 2009; Neuman, 2006).

Positivism regards social reality as objective reality which means the reality exists out there independently of the individuals who create or observe them and the job of researchers is to study them in an unbiased way (Gall, et al., 2007, p. 15-16). Positivist researchers usually choose to use data collection techniques such as experimentation, observation and manipulation, which generally produced quantitative data (Cohen & Manion, 1994; Cohen et al., 2000; Neuman, 2006).

4.2.2 Interpretive research

Interpretive researchers start out with the assumption that reality is socially constructed. In other words, people create it while interacting with each other and their natural environment (Cohen & Manion, 1994; Cohen et al., 2000; Neuman, 2006). Gall et al. (2007) defined interpretive research as “[t]he study of the immediate and local meaning of social actions to the actors involved in them ... they take context into account; they acknowledge the researcher’s role in the study; and they are accepted as authentic by readers”(p.643). Researchers in interpretive studies try to understand and explain the phenomena through the meanings that people make as the situation arises (Cohen et al., 2000). Interpretive researchers do not pre-define dependent and independent variables, but they make sense as the situation arises (Neuman, 2006). In other words, interpretive researchers favour a more subjective approach and value the social world as a much softer, and personal and humanly-created kind than that seen from the positivist viewpoint. Typically they will use data collecting techniques such as participant observation and

personal constructs, which are promoted through qualitative methods (Cohen & Manion, 1994; Neuman, 2006).

4.2.3 Critical theory

Many features of the interpretive paradigm are found in critical theory because it blends objective or materialistic with constructivist views of reality (Cohen et al., 2000; Neuman, 2006). Cohen et al. (2000) comment that this paradigm assumes that positivist and interpretive paradigms present incomplete accounts of social behaviour by neglecting the political and ideological context of educational research. Thus this paradigm desires to put knowledge into action on the basis of a belief that research is not value free, but a method of creating knowledge which people can use to advance their lives (Neuman, 2006). As Cohen et al. (2000) state:

Critical theory is explicitly prescriptive and normative, entailing a view of what behavior in social democracy should entail. Its intention is to give an account of society and behavior but realize a society that is based on equality and democracy for all its members. Its purpose is not merely to understand situations and phenomena but to change them. In particular, it seeks to emancipate the disempowered, to redress inequality and to promote individual freedoms within a democratic society (p.28).

According to Cohen et al. (2000), critical researchers consider that the multilayered nature of social reality tends to be ignored by researchers and others such as politicians and policy makers, resulting in people being misled and manipulated. Cohen et al. (2000) argue that the main task of critical research is social critique, whereby the restrictive and alienating conditions of the status quo are brought to light by focusing on the oppositions, conflicts and contradictions in contemporary society and help to eliminate the causes of alienation and domination (Neuman, 2006).

4.2.4 The Research Paradigm for This Study

Careful consideration of the underlying assumptions in the three paradigms found that this research project is not underpinned by most assumptions in positivist paradigm. This includes that in the positivism point of view the reality is seen to exist and exist external from the perception of people and experience; knowledge is seen as hard and can be identified and is capable of being transmitted or acquired in tangible form; and that there are discrete and distinct, prescribed steps to replicate results because they believe that the knowledge is unchangeable and that different observers looking at the same data will get the same results (Cohen et al., 2007; Creswell, 2002; Neuman, 2006). In contrast, the interpretivism view believes that reality is embedded in the human mind and experience, and is created by people through their social interactions; that the data is soft, more subjective, and based on experience and insight of individuals involved; and interpretive, new knowledge is soft, unclear, unique and personal, so it is not usually easy to communicate (Cohen et al., 2007; Creswell, 2002; Neuman ,2006). Although critical theory has some features of the interpretive approach which includes being subjective or materialistic within the constructivist view of reality (Neuman 2006); having the desire to put knowledge into action and a belief that research is value based and a method of creating knowledge that people can use to advance their life (Neuman, 2006); and assumes there are multi-layers of social realities. However, it has been claimed that critical researchers often mislead and manipulate people to be too critical about social and political issues (Neuman, 2006).

This research study is located closest to the interpretive paradigm because it seeks to explore the perception of the participants about the EEfS at a preservice teacher education institution. Critical to this research is the acknowledgement of the interactive nature of the study, that is any environmental issue and EEfS has multiple layers of realities, and causes, effects and solutions. These interpretations are dependent on the views of

individuals and groups concerned. In addition to that, it is seen and believed that experiences and views of the participants are embedded in and evolved from the social and cultural context that they are involved in. In other words, the study is based on the view that reality is inside people rather than exterior to them, and that they create knowledge and meaning about the world around them on the basis of their past and present knowledge and experiences (Cohen et al., 2007; Creswell, 2002; Denzin & Lincoln, 2003). Along with that is the understanding that people's actions and behaviour towards environment and sustainability, and EEfS are based on their values and beliefs about themselves, their environment and their actions (Tilbury, 1995). A more critical approach to this research was thought to be inappropriate for the context of this study at this time.

The assumptions implicit in research paradigms usually underpin the research approaches. These are discussed in the next two sections.

4. 3 Research approaches

Two main research approaches are used in interpretive studies: quantitative and qualitative methods.

4.3.1 The quantitative research approach

Quantitative research as defined by Creswell (2008) as “a research approach that is useful for describing trends and explaining the relationship among variables found in the literature” (p.645), whilst Gall. (Gall et al., 2007) defines it as an “inquiry that is based on the assumption that a social environment constitutes an objective reality that is relatively constant across time and settings...The [main goal of researchers] is to describe and explain features of this reality by numerical data on observable behaviors of samples and by subjecting these data to statistical analysis” (p.650). Quantitative researchers believe there is a hard and objective reality ‘out there’ which can we studied to establish cause and effect relationships (Basit, 2010, p.15-16).

Quantitative research involves mainly assumptions of meaning for the phenomenon, and the examination of the distribution of its occurrence by asking specific, narrow questions on the basis of numerical data (Creswell, 2008, p. 645). The causes of an occurrence are explained through objective measurement and analysing the distribution of its occurrences using statistics (Burns, 2000; Cohen et al., 2000; Creswell, 2005). The instruments used for measuring, observing or documenting gathering data in quantitative researches usually include pre-set questions and responses.

Reliability and validity of results are derived from the careful design of data collection instruments used to collect information in an unbiased, objective manner from selected representatives of a population (Burton & Bartlett, 2009; Creswell, 2005). The quantitative research approach aims to isolate causes and effects, operationalising theoretical relations, measuring, quantifying phenomena, and developing the generalisation of findings about human behaviour that will enable greater levels of prediction and control (Burns, 2000; Cohen et al., 2000; Denzin & Lincoln, 2003).

4.3.2 The qualitative research approach

Qualitative research as Creswell (2005) defines it is an inquiry approach useful for exploring and understanding a problem or phenomenon. Information about the phenomenon is typically collected from the participants by inquirers asking broad and general questions and collecting detailed views of the participants in the form of words or images, then analysing the information for descriptions and themes (p. 596). Whilst Gall et al. (2007) defines it as an:

inquiry that is grounded in the assumption that individuals construct social reality in the form of meanings and interpretations, and that these constructions tend to be transitory and situational. The [main aim or the researchers] is to discover these

meanings and interpretations by studying cases intensively in natural settings and by subjecting resulting data to analytic induction (Gall et al., 2007, p.650).

Creswell (2005) continues that qualitative research is conducted in a subjective biased manner using open-ended questions and collecting largely word or text based data which are thematically organised, analysed and described (Gall et al., 2007).

Traditionally, qualitative research is more closely associated with the interpretive paradigm than with the positivist paradigm (Cohen et al., 2000; Denzin & Lincoln, 1994). In the qualitative approach, “reality can never be fully apprehended, only approximated” (Guba, 1990, p. 22) and thus often relies on multiple methods to capture the socially-constructed nature of reality, the relationship between the researcher and individuals, and constraints in the situations of interest (Cohen et al., 2000; Denzin & Lincoln, 1994). Such a view of the nature of qualitative research emphasises its value-laden nature.

According to Creswell (2005), qualitative research explores understanding about an individual, case, history or a group’s experience(s) where little or nothing is known; using broad statements or questions; collecting data in the form of words and pictures; analysing data by developing descriptions and themes; and reporting it using flexible and emerging structure (p. 45-50). Janesick (2003) notes that qualitative research encourages observations of naturally occurring issues, concepts and systems without imposing any control or influences. Janesick (2003) states that it is also concerned with understanding individuals, in their immediate social setting, which may take longer to understand the occurring issues, concepts and systems and their relationship (see also Basit, 2010; Creswell, 2005; Gall et al., 2007).

Like quantitative researchers, qualitative researchers emphasise the discoveries and verification of hypothesis and theories; however, in contrast to the

sequence of the quantitative approach, the theories and hypothesis of qualitative research are derived from the data when they are analysed (Cohen et al., 2000). Quantitative researchers and qualitative researchers alike consider and address internal reliability and external validity, by using multiple data sources and methods that lend themselves to the formation of meanings and patterns (Cohen et al., 2000; Creswell, 2005). Qualitative research can also lead to structured analysis or sometimes statistical analysis, which is normally conducted within the positivist paradigm but can be conducted in the interpretive paradigm if the nature of the data makes it necessary (Burton & Bartlett, 2009; Cohen et al., 2000). This latter approach can employ, for example, computer-assisted methods to calculate frequency, tabulations, and statistical analysis. Quantitative research, on the other hand, typically uses more complex statistical measures so that the processes of analysing may be facilitated and double checked by the use of specific software (Burns, 2000; Denzin & Lincoln, 2003).

Validity and reliability are important in research. Both have internal and external aspects (Wiersma & Jurs, 2009). Wiersma and Jurs (2009) explain that “internal reliability is the extent to which results can be interpreted accurately and external validity is the extent to which the results can be generalized to populations, situations and conditions” (p. 5). Generally, external validity refers to consistency of data collection, analysis and explanation if given the same conditions over time, over instruments and groups of respondents, whilst external reliability refers to whether a study can be replicated by other researchers under the same or similar settings. In quantitative study, reliability and validity of results derive from the careful design of data collection instruments in an unbiased way (Johnson & Christensen, 2004). Like quantitative researchers, qualitative researchers consider and address internal reliability and external validity. This is done by the use of multiple data sources and methods that lend themselves to form meanings and patterns, and is called ‘mixed’ method research by Creswell (2009), and triangulation of methods by other researchers, such as Wiersma and Jurs (2009).

4.3.3 Triangulation of approaches

Both qualitative and quantitative approaches were used in this research (Cohen et al., 2007; Creswell, 2002; Neuman, 2006), which can also be viewed as triangulation of methods. Triangulation of method is used to improve the reliability and validity of the data that was collected and analysed in this study (Creswell, 2005; Wiersma & Jurs, 2009). Efforts were made to ensure that the findings were what they appeared to be and that the instruments were measuring what they were supposed to measure and providing results that were agreeing with each other. In addition to that, triangulation was used to help reduce limitations in the study and yield a more complete picture of the issues and practices (Neuman, 2000).

Quantitative aspects included some data being collected using clearly and logically stated statements and questions in numerical forms which were analysed using simple statistical analysis (Cohen et al., 2007; Creswell 2003; Neuman, 2006; Silverman, 2004); and the qualitative aspect of the data were from participants' own written or spoken words from the actual settings (Merriam, 1988; Neuman, 2006). This addressed a concern for developing and generalizing with richness, texture, and feeling of the collected data (Cohen et al., 2007; Neuman 2006).

Mixed methods were used in this study, including the questionnaire, the interview and document analysis, to strengthen reliability and validity. A questionnaire can collect both quantitative and qualitative data while the interview and document analysis are generally more qualitative because they use open-ended questions.

Use of triangulation in this study contributed to the verification and validity of qualitative analysis by checking out the consistency of different data sources within the same study. The validity and reliability of the instruments and data

in qualitative research was addressed by the use of multiple data collection techniques (Cohen et al., 2000; Creswell, 2005; Neuman, 2006). On the basis of the effort made in considering and determining the research questions, data gathering and analysing methods, it is believed that the data collected and presented in this study are valid, reliable and free of research biases, and that the results are useful for a wide audience (Burton & Bartlett, 2009).

The next section describes the methods used in this interpretive study.

4.4 Research methods

The research methods and data collecting instruments that were used in this research include the questionnaire, the interview, the focus group interview and document analysis. These will be discussed in the following sections, beginning with the questionnaire.

4.4.1 The questionnaire

Questionnaires are the most frequently used data collection tool in social and educational research (Creswell, 2005; Neuman, 2006). They are implemented via printed or online forms completed by the participants and returned to the researchers (Creswell, 2005; Gall et al., 2007). The layout and the content of a questionnaire is shaped by the nature of the research questions or hypothesis, theoretical and conceptual frameworks, qualitative and quantitative approaches and the paradigm selected for the study (Gall et al., 2007). The main function of a questionnaire is to translate research aims, objectives or questions into specific questions (Cohen et al., 2000; Creswell, 2005; Neuman, 2006).

The advantage of administering questionnaires is that they are inexpensive and easy to analyse. It is easy to ensure anonymity, they can be quickly and effectively administered to a relatively large population, and they can provide a lot of data (Burton & Bartlett, 2009; Cohen et al., 2000). The other advantages

include that every respondent receives an identical set of questions and respondents can respond without fear or embarrassment if the questionnaire is kept anonymous (Burns, 2000, p. 581).

Two types of questions are commonly used in questionnaires: structured (closed or closed-ended) and semi-structured (open-ended) questions. Closed-ended questions are questions to which the respondents choose from a fixed set of answers whilst open-ended questions are questions to which they are free to provide any answer (Burton & Bartlett, 2009; Neuman, 2006).

Closed questions can be useful because they are quicker and easier for both respondent to answer and researcher to analyse (Burton & Bartlett, 2009; Neuman, 2000). However, because responses are limited to a set of alternatives, closed questions have the potential to be biased or limited; in addition, respondents may wish to provide further details about their answer but be unable to do so because of the restrictive nature of the question type (Burton & Bartlett, 2009).

Open-ended or unstructured questions are qualitative in nature and allow the exploration of many themes because respondents can write about anything they consider relevant in response to the question (Burton & Bartlett, 2009; Cohen et al., 2000; Neuman, 2006). They may raise issues that had not been anticipated or even thought of by the researcher (Burton & Bartlett, 2009). The main problem with collecting data using open-ended questions is that they are more time-consuming than a closed question format for respondents to complete and researchers to collate or analyse (Burton & Bartlett, 2009; Neuman, 2006).

Questionnaires have other shortcomings. The wording of questions might bias responses and can be impersonal, and responses may be inadequate. Responses may not be true or not suitable for examining complex issues. The researcher has little control for misunderstood questions or where ambiguous

interpretations by respondents cause a distortion of the data analysis results and costs (Burns, 1997; Gall et al., 2007). Other disadvantages include that using questionnaires can make it difficult to obtain comprehensive information. Also, return rates can be very low; as Neuman (2006) has said, the greatest problem with questionnaires is that people do not always complete and return them.

4.4.2 The interview

Interviews are a common form of data gathering methods used in social and educational research (Burton & Bartlett, 2009; Cohen & Manion, 1994). In an interview, the interviewer asks questions and the participants respond. Interviews are usually conducted with individuals, face to face or over the phone, using open or closed questions, although open-ended questions are most commonly employed (Creswell, 2002; Kvale, 1996). Interviews are particularly useful for getting the story behind a participant's experiences because the interviewer can ask for more information about a topic (Cohen & Manion, 1994). Interviews may be useful to follow up on responses provided in questionnaires (Burton & Bartlett, 2009).

Interviews can be formal and structured or informal and unstructured. In a structured interview the topics and issues to be covered and all the questions to be asked are decided in advance (Burton & Bartlett, 2009; Cohen et al., 2000). Cohen et al. (2000) have echoed Lincoln and Guba (1985), who suggested that the structured interview is useful when the researchers are aware of what they do not know and thus able to frame the questions that will provide the required knowledge, whilst the unstructured interview is useful when the researchers are not aware of what they do not know, and thus depend on the respondents to inform them.

Advantages of interviews are that respondents speak in their own words; response rates are high; and data can also be gained from illiterate people. The

interview allows researchers to develop a relationship with the participant and get a full range and depth of information. In an interview, the researcher can be flexible with the participants to clarify responses. The interviewer controls the situation and can probe ambiguous or evasive answers. Interviews can provide useful open-ended comments, often with rich detail and new insights, and are best used if extensive information is required (Cohen et al., 2000). The disadvantages of the interview method are that the wording of questions might bias responses, and that interviews can be very time-consuming if only one person conducts them, and very expensive if several interviewers are employed (Gall et al., 2007). In addition, there is little control if participants misunderstand questions or if the data is missed or contains untruthful responses. This method is not suitable for: younger children, older people, people who do not know the language used; and for examining complex topics or sensitive issues (Burns, 2000; Creswell, 2005; Neuman, 2006).

Understanding the rules, experiences, advantages and disadvantages of interviews can promote useful data collection and analysis (Burton & Bartlett, 2009). The main way of achieving this is by developing and piloting the instruments before administering interviews and by audio-taping the actual interview (Creswell, 2005; Cohen et al., 200; Kvale, 1996). For this study, the rules, advantages and disadvantages of the interview method, and concepts and issues to be covered were considered before the semi-structured interview was selected as a useful data collection method.

Interviews can also be conducted with participants in small groups. This is known as a focus group interview, and is discussed next.

4.4.3 The Focus Group Interview

A focus group is a gathering of two to five individuals which can be used to carry out a group interview. According to Creswell (2008), "focus groups can be used to collect shared understanding from several individuals as well as to get

views from specific people“ (p. 226). Basit (2010) adds that a focus group interview is:

...a kind of interview which is conducted by the researcher with a group of participants ... [The] focus group is particularly useful when the researchers do not know what issues are involved in a particular research situation and want to generate ideas... The participants chosen for the focus group are assumed to have an insight into, and experience of, the issues discussed (p. 104).

The focus group interview is useful if information collected through observation, questionnaires, documents and other artefacts needs to be clarified.

Focus group interviews are useful when time is limited for doing individual interviews and when individuals are hesitant to provide information by themselves (Creswell, 2005). The group can provide more and better information because together they are more knowledgeable about the issues or concepts concerned (Creswell, 2008).

However, the focus group interview has some weaknesses. Creswell (2008) says:

Focus groups can be challenging for the interviewer who lacks control over the interview discussion. Also, when focus groups are audiotaped, the transcriptionist may have difficulty discriminating among the voices of individuals in the group. Another problem with conducting focus group interviews is that the researcher often has difficulty taking notes because so much is occurring (p.226).

The data collected from interviews are qualitative and are analysed by extracting themes or generalisations. Document analysis is discussed in the next section.

4.4.4 Document analysis

Written documents, including policy papers, textbooks, teaching programmes, examination results, maps, computer printouts of school data, teacher guides, student guides, reading books, student journals, students' completed homework, assignments or tests, worksheets, course evaluations and memos or letters can also be used as sources of data (Basit, 2010; Gall et al., 2007; Wolff, 2005). The documents can be small and short or large and lengthy (Burton & Bartlett, 2009; Wolff, 2005).

Basit (2010) adds:

In a research project documents can be used in two ways. First, existing documents can be pursued to gather data and to analyse these data. Second, new documents can be produced by the researchers themselves or requests can be made by them to research participants to generate documents as part of the data collection process (p. 138).

Basit (2010) lists the advantages of document analysis (earlier noted by Lincoln and Guba, 1985). He points out that they "are available either free or at low cost; offer a rich and stable source of data which may offer accurate data and can be analysed over and over again, offer data which is contextually grounded and relevant and often appear in the natural language of the setting; and are usually formal and legal" (p.139). Furthermore, the data in documents cannot be manipulated or distorted by the researcher and are ready to be analysed without transcription. On the other hand, because the documents were not written specifically to provide data for the study concerned, the data needed in the research may not be available (Basit, 2010). The advantages and limitations of documents as sources of data must be kept in mind while planning,

collecting and analysing the data from the documents (Cohen et al., 2007). This principle was adhered to in the current study.

The design of this research and how methods were used within it is described in the next section.

4.5 Research Design

This research study was carried out in two phases. Phase One Study was carried out to collect data to inform the designing of the intervention, whilst Phase Two Study was carried out to evaluate the the process and impact of the intervention. The study was situated within the interpretive paradigm collecting both quantitative and qualitative forms of data. Mixed methods were used in this study, including the questionnaire, the interview and document analysis. Questionnaires used in this study collected both quantitative and qualitative data as they had structured and semi-structured questions and statements, while the data collected from the interviews and document analysis were qualitative. In the questionnaires, questions one to five were structured, and questions six to nine were semi-structured questions (see Appendix Five & Six), as were interview schedules (see Appendix Seven, Eight & Nine), and document analysis such as reflection journals kept by the students (see Appendix Ten).

Phase One Study

This study began with a review of relevant literature, before considering the methodology and methods of the study. Upon having ideas about issues and concepts concerning EEfS, the methods for collecting data were decided including questionnaire , interview and document analysis. The instruments were designed and used in both Phases. A questionnaire, document analysis protocol and interview schedule for Phase One Study were designed and used in 2008 in a pre-service teachers college in PNG as shown in Table 3.

Table 3 Phase One Study Design

Instrument	Participants	Data Analysis Method
Questionnaire	100 students	Simple statistics
Interview schedule	5 lectures	Thematically analysed
Focus Group interview	8 students	Thematically analysed
Document analysis	10 documents	Thematically analysed

The participants of the Phase One Study consisted of 100 pre-service teachers, and five lecturers, of which one of them later took part in implementing the course intervention. The pre-service teachers were firstly asked to complete a questionnaire (see Appendix Five) of approximately 30 minutes duration about their perceptions about environment and sustainability education practices in their teachers college. The questionnaire had previously been piloted with a small group of students who had completed the existing Environmental Science course at the College in the previous year. This helped to enhance the validity of the questions.

In this Phase of the study, eight out of the student participants volunteered and participate in two focus group interviews, four students in each, to allow for further exploration of the issues raised in the questionnaire (see Appendix Eight). The interview questions were peer reviewed prior to use, and the interviews lasted approximately 45 minutes each. In the focus group interview they were asked general questions as a group and were expected to respond as a group (Creswell, 2005). It can be assumed that useful information can be collected during the interaction amongst interviewees because the participants usually have-similar backgrounds and experience (Basit, 2010); in this study all the participants studied both Environmental Science and Natural and Cultural Environment at their College.

The limitations of focus group interviews were considered and addressed in this study. First, the researcher/interviewer was part of the conversation and controlled the interview by asking additional question to make the participants

clarify their answers or asking the next question if there was a need to move on. Secondly, the interview was audio taped to make note everything that was said in the focus group, which may be difficult to write out. Third, members were asked by the interviewer to briefly introduce themselves at the beginning of the interviews to help the interviewer distinguish the voices of the participants.

In addition, the five lecturers who had been involved in teaching aspects of sustainability within their courses at the College participated in individual interviews. Interview questions were again peer reviewed and the interviews lasted approximately 45-60 minutes each (see Appendix Seven).

Lastly, in the Phase One Study, documents were analysed, including policy and curriculum documents of the College as further described in Chapter 5. In this study both existing and new documents were used as the source of the data. The data in existing documents are records of plans, events and facts about a social group which are relevant to the members of that group (Wolff, 2005, p.184). For this study information from existing documents, including constitution teacher education policies and guidelines, and students' and lecturers' guides, course overviews, and assessable tasks were analysed (Burton & Bartlett, 2009).

The data from the Phase One Study informed the design of the intervention as well as the Phase Two Research Instruments. The intervention course on EEfS had concepts and issues, and pedagogies which were then informed by the participants of the Phase One Study and contemporary literature on EEfS (see Chapter 5). As part of the intervention, a three day lecturer training package was designed to assist the intervention course lecturer to deliver the intervention (see Appendix Twelve). The lecturer concerned was trained before the semester began. The training involved going through the proposed lessons and discussing the importance of the content and pedagogies selected (see Appendix Eleven).

Phase Two Study

Phase Two Study was carried out in 2009 where the data was collected prior to, during, and after the implementation of the intervention using different measures as shown in Table 4.

Table 4 Phase Two Study Design

Instrument	Participants	Data Analysis Method
Pre intervention Questionnaire	81 students	Simple statistics
Post intervention Questionnaire	81 students	Simple statistics
Post intervention Interview	1 lecturer	Thematically analysed
Reflection Journal	81 students	Thematically analysed
Document analysis (action plans)	81 students	Thematically analysed

The intervention course was implemented in 2009 as part of a six trimester Diploma program and 300 First Year students took the course, of which 81 of them were the participants in this study. Although, all the pre-service teachers in the year group agreed to participate in the study and handed in the documents they completed for the study, only 81 of them submitted all five sources of data so they were used as the participants in this thesis. These participants completed the same questionnaire before and after implementation of the course intervention on their perceptions as pre-service teachers about the EEfS practices at the College (see Appendix Six). The questionnaire had previously been piloted with a small group of pre-service teachers who had completed the existing Environmental Science course at the College in the previous year. These perceptions were then explored through the use of a questionnaire administered to the pre-service teachers both before and after the intervention course on EEfS. The questionnaire had three main types of questions:

- Semantic differential questions and statements, which are Questions One and Two;
- Five point Likert Scale, which are Questions Three, Four, and Five; and

- Open ended questions, which are questions Six, Seven, Eight and Nine.

The pre-service teachers' perceptions were probed using semantic differential questions in the pre- and post-intervention questionnaires. The data in this section was collected and analysed to find out about pre-service teachers' perceptions of key concepts of EEfS prior to the intervention, and to find out if these perceptions had been modified after the intervention. The key concepts explored in this study were interdependence, sustainable development, and connectedness between people and their environment. The semantic differential questions asked the student teachers to indicate their level of agreement to a pair of opposing statements on the concepts of environmental education for sustainability by circling a number between 1 and 5, where: 1 means Strongly Agree with the statement on the left; 2 means Agree with the statement on the left; 3 means the participant's views are evenly balanced between the two statements, or they are unsure; 4 means Agree with the statement on the right; and 5 means Strongly Agree with the statement on the right.

Questions three, four and five were organised as five point Likert Scale (Likert, 1932) and were used to probe pre-service teachers' perceptions about environmental issues and delivery of EEfS where the pre-service teachers were expected to indicate their level of agreement to statements in each of the questions. Their responses were gathered by asking participants to circle 1, 2, 3, 4 or 5 where 1 represented Strongly Agree, 2 represented Agree, 3 represented Not Sure, 4 represented Disagree, and 5 represented Strongly Disagree.

Further data was collected from the reflection journals that the pre-service teachers kept, action plans which they completed as part of the coursework, which included information that could not easily be collected using the questionnaire. The participants reflected on the lessons and actions on a template which had five questions which guided their reflections (see Appendix

Ten). The participants' action plans were also analysed to find out what were the common issues the pre-service teachers identified, if they identified the causes and effects of the problems, and what were pre-service teachers' most common plans of actions to address the identified issues.

The data from the research project was analysed in two different ways. The numerical data collected were analysed using statistical analysis against the variables, while the qualitative data was analysed thematically by coding or organising data into themes or categories which were then interpreted and recorded. The data collected on Likert scales on the questionnaire (Likert, 1932) were analysed by calculating percentage agreement, mean, standard deviation and variance of each set of data using Microsoft Excel spreadsheets. Percentage agreement indicated the frequency on each item and the mean and standard deviation indicated the significance of each choice in relation to each other (Burns, 2000).

The data collected from semantic differential statements and questions which are questions one and two on the questionnaire, were analysed by calculating percentage agreement on the choices. The semantic differential questions asked the pre-service teachers to indicate their level of agreement to a choice for pair of opposing statements on the concepts of EEfS. The percentages of pre-service teachers agreeing with the statement or question on the left or right, and those that were evenly balanced between the two statements, were calculated.

These data are reported in tables showing changes in percent of each choice, and mean and standard deviation of each item between the pre-intervention and post-intervention questionnaires. The statistical information in the tables are supported by thematically analysed data.

While being mindful of developing and presenting a coherent consistent picture of the richness, texture, and feeling of the collected data (Cohen et al.,

2007; Neuman 2006), the data from open ended questions in the questionnaires, the interviews, and the information in the documents were examined and coded in themes. The themes came mostly from the questions in the questionnaire, which in turn were guided by Tilbury's framework of EEfS (Tilbury, 1995) and Lucas' framework of EEfS as education about, in and for environment (Burns, 2000; Creswell, 2005; Gall et al., 2007).

Some statements from the questionnaires, reflective journals and action plans were directly quoted to support the data from the surveys. The directly quoted data were coded as follows: PREQ for the pre-intervention questionnaire; POSQ for post-intervention questionnaire; RJ1 for reflection journal entries on the lesson on endangered species, including the excursion; RJ2 for reflection journal entries on the lesson on biodiversity with an imaginary story and group work; RJ3 for reflective journal entries on the lesson with the use of the KWL chart and Follow Me game; AP for student work in their action plans; and the numbers after the comma in the code refer to the number codes of the participants.

4.6 Ethical issues

In accordance with what Gall et al. (2007) have stated, three ethical principles underpinned the ethics of this research: respect for democracy, respect for truth and respect for persons. Firstly, researchers have freedom to investigate, provide and collect information, and express their values and perceptions. Secondly, the data collected and reported reflect accurately what was supplied and implied by those people involved. Finally, participants were recognised as the initial owners of the data, and their dignity and privacy were respected throughout the data gathering and reporting process (Gall et al., 2007). All participants took part voluntarily after being informed by letter of the aim of the study and about the confidentiality of the information-gathering process (Wiersma & Jurs, 2009). The participants' consent was obtained before they were involved in the study (see Appendix two, three, and four). Permission to

conduct the study in the college was sought from the principal of the college verbally and in writing (see Appendix, One) . Specific details such as permission for having access to their students' work samples were sought verbally from students and their teachers as that is more appropriate and acceptable in PNG culture (Wiersma & Jurs, 2009). The researcher was always mindful of the ethical issues related to the questionnaire, interview and document analysis when developing the instruments and while collecting the data (Gall et al., 2007). An application was made to the University of Waikato Human Research Ethics Committee and approved.

4.7 Chapter summary

All research is underpinned by paradigms. In education research the three most common paradigms are the positivist and interpretive paradigms and critical theory. Positivist research projects begin with hypotheses and theories which are then tested through data gathering, analysis and interpretation. Interpretive research begins with data collection and attempts to understand and interpret data so that the data form theories and conclusions. The critical paradigm has some characteristics of both positivist and interpretive paradigms, and aims not only to understand the issues or situation but also to lead to constructive change.

This research is situated within interpretive paradigm because of the nature of the study of environmental issues and EEfS practices. This is consistent with knowledge gaining and development in EEfS because it is based on people's interpretation of events, actions, concepts and issues which is also influenced by their culture and their past experiences.

Both quantitative and qualitative data can be collected for interpretive research. Both approaches have strengths and weaknesses, but data can be successfully collected and analysed provided there is a clear understanding of the issues concerned, the data required and the research context.

The use of a mixture of research methods has become a common approach to educational research because it creates the flexibility of using data from other sources if unforeseen circumstances mean that plans made in the research proposal are no longer able to be implemented (Creswell, 2009). For example, the researcher in this study planned to observe two lecturers while they were delivering the lessons and interview them at the end of the intervention. However, only one lecturer was interviewed at the end of the intervention because only one lecturer was available.

Thus, the data in this study were collected using mixed methods in both phases of the study. In the Phase One Study, data were collected through questionnaires, interviews, focus group interviews and analysis of existing documents, and in Phase Two Study through pre- and post-intervention questionnaires, interview, and analysis of new documents (Cohen et al., 2007; Neuman, 2006). The methods complemented each other, providing triangulation of data sources.

The researcher gained ethical approval for the study from the University of Waikato and permission from the College authorities before the research began, and was always mindful about the ethical issues related to the data gathering, analysis and reporting. All participants were informed about the purposes and benefits of the study, and their right to refuse participation. The data collection in this research study is presented in Chapters Six, Seven and Eight.

The next chapter describes the intervention that was delivered, including the data from the Phase One Study that helped inform the design of the intervention

Chapter Five

5. Intervention

5.1 Chapter overview

This chapter presents the analysis of ideas and educational practices in Environmental Education for Sustainability (EEfS) in a pre-service teachers' college in Papua New Guinea (PNG) prior to the delivery of the intervention. It also discusses the delivery of the intervention which was designed to make EEfS effective. Section 5.2 reviews the policies and significant curriculum documents on EEfS within PNG and within the teachers' college where the research was carried out; Section 5.3 presents a description of the practice in EEfS at the college prior to the intervention; and section 5.4 describes the intervention. Section 5.5 summarises the chapter.

5.2 Policies and curriculum

The policies reviewed include the policies in place and the curriculum expectations regarding the content knowledge delivered and pedagogy used at the time when this research project started.

5.2.1 The policies on EEfS

The policies that influenced the delivery of EEfS at the teachers' college included the National Goals Directive Principles (PNG Government, 1975), the Teacher Education National Curriculum Guideline [TENCG], the teacher education lecturer and student guides, the National Curriculum Statement (NCS), and primary school syllabi and teacher guides. These are now discussed.

5.2.1.1 National Goals Directive Principles

The Constitution of PNG (PNG Government, 1975), the NCS (PNGNDoE, 2003b) and the TENCG (PNGNDoE, 2004a) are based on the National Goals and

Directive Principles. As discussed in Chapter Two, the five National Goals and Directive Principles are:

- Integral human development;
- Equality and participation;
- National sovereignty and self-reliance;
- Natural resources and environment; and
- PNG ways (Hulum & Hills, 2002, p. 26).

Chapter Two illustrates how these goals and principles could be seen to align with EEfS, therefore providing a strong underpinning of the development of an intervention in EEfS. In theory, all policies concerned with EEfS should recognise these goals and principles. The next section discusses what the TENCG says about EEfS.

5.2.1.2 Teacher education policies about EEfS

The TENCG provides the principles to guide curriculum development and implementation in teachers' colleges in PNG (PNGNDoE, 2004a). The curriculum guideline was analysed to find out what it says about environmental education for sustainability and currently advocated pedagogies for pre-service teacher education. The TENCG was examined because what happens at the Teachers' College should be guided by this guideline. It was discovered that the TENCG generally emphasises active student-centred learning approaches for teaching all subjects, but has no specific mention about environment and sustainability or EEfS in the 13 guidelines, and no specific instruction for Science and Social Science teachers on EEfS. However, there is some mention about environment in the aims as follows:

Diploma in teaching (primary) aims aim to produce beginning teachers who [are] ... concerned about and care for and respect the environment, sensitive to cultural diversity and gender equity [and] are competent and confident to apply their knowledge for the benefit of the wider community in which they work ... [and] are competent and confident to apply their

knowledge for the benefit of the wider community in which they work.

There is also very little mention of environment in the list of objectives as follows:

The Diploma in teaching (primary) objectives are to produce beginning teachers who ... are co-operative, fair, respectful and empathetic towards peers, pupils and community, accept respect, assess and value traditional knowledge, recognise and promote equal roles of women and girls in all fields of study, appreciate the unique flora and fauna of PNG and promote care and concern for the protection of the environment for the benefit of future citizens (p. 6).

This indicates that the teacher educators are expected to provide some form of environmental education for pre-service teachers so they can understand about the environment and its components, and appreciate and care for them (PNGNDoE, 2004a). The analysis also reveals that the teacher educators are expected to provide knowledge and experience for teaching and learning of EEfS through many active, student-centred approaches and activities so that the pre-service teachers develop both pedagogical and content knowledge and skills, which would enable them in turn to deliver EEfS effectively in primary schools. However, the expectations for delivering environment and sustainability concepts and issues to create awareness in pre-service teachers are not clearly stated in TENCG for the lecturers in teachers' colleges to understand and follow. An analysis of lecturer and student guides used at the teachers' college is presented next.

5.2.1.3 College-level policies about EEfS

Lecturer and student guides were analysed to find out what these documents say about EEfS and how the college addresses what is advocated by the Constitution (PNG Government, 1975), the NCS and TENCG. The analysis revealed that the academic programmes of the college are organised into Strands with their roots in the Philosophy of Integral Human Development in

the Constitution and the Christian principles of nurturing the holistic development of all trainee teachers. These philosophies have guided the development of the structure of the College Programme and the content of the courses offered in the Programme.

In addition, the college assessment policy emphasises integral human development, which is in line with the Constitution. The assessment policy has been formulated to ensure equity and comparability of standards across the courses at the same time accountability measure of the college programmes and

In addition, the college assessment policy emphasises integral human development, which is in line with the Constitution. However, there is no specific emphasis on evaluation of knowledge, skills, processes and attitudes related to EEfS.

The next section presents the analysis of lecturer and student guides.

5.2.1.3.1 Curriculum documents

The lecturer and student guides at the Teachers' College were analysed as evidence of curriculum in use. Two environment-related courses (Environmental Science and Natural and Cultural Environment) had some topics and concepts on environment and sustainability with recommended learning activities and approaches to help pre-service teachers develop environment and sustainability knowledge, skills and values (Broadfoot & Paullon, 2002; Lauer, 2002; Lauer & Aitsi, 2002; Lauer & Rifi, 2002). It was clear that the Environmental Science lecturer guide and student guide were designed to present information about the natural environment as if there were no problems in the social environment (Broadfoot & Paullon, 2002). The pre-service teachers are expected to learn about the environment, biodiversity, population, ecosystems, interdependence, weather and climate, and greenhouse effect and global warming without linking them to social, cultural

and economic activities and development (Broadfoot & Paullon, 2002). On the other hand, an analysis of the Natural and Cultural Environment lecturer guide and student guide shows that this course was more aligned for delivering EEfS (Lauer, 2002; Lauer & Aitsi, 2002; Lauer & Rifi, 2002). It appeared that this social science curriculum had tried to create awareness of the need to provide EEfS for pre-service teachers holistically, so that they could develop skills and values for-understanding issues related to the management of resources and to economic development. Lauer and Rifi (2002) stated that:

The natural and cultural environments of any nation, state or region connect in many ways. Combinations of physical and human factors shape the natural environment. People interact with their environment to fulfil their needs and wants in ways which reflect the nature of the environment they occupy and/or have created. Consequently, the process of environmental change is continual. People can affect natural systems and the processes at work in them. At the same time, natural systems influence people's cultural, social and economic activities. Through the study of natural environments and different cultures in [PNG] and throughout the world, students will come to understand the processes which shape natural and cultural environments, develop a critical sensitivity towards the use of the environment and develop an awareness and understanding of other cultures and places (p.1)

In other words, through their studies the pre-service teachers are expected to cover concepts including natural and cultural environment, interdependence, human impact on natural environment and diversity in culture. The pedagogies which the teacher educators are expected to use in their natural and cultural environment lessons with their students are in line with currently advocated

teaching and learning strategies and thus are expected to be used by the new teachers in their own classes (Fien & Tilbury, 1996).

The guides for the teaching methods courses for the Teachers' College were analysed to find out which courses at the college were responsible for preparing pre-service teachers to teach the primary school subjects Making a Living (PNGNDoE, 2003b) and Environmental Studies (PNGNDoE, 2003c). It was discovered that the Science departments in teachers' colleges are responsible for preparing pre-service teachers to teach Environmental Studies in primary schools, and the Agriculture department is responsible for preparing them for teaching Making a Living. The problem is that the Social Science Department at the College is expected to deliver college level EEfS but it is not directly responsible for preparing pre-service teachers with knowledge, skills and methods for preparing and presenting EEfS as part of Making a Living and Environmental Studies in primary schools (PNGNDoE, 2004a). The Science department, on the other hand, is not expected to teach college level EEfS but is responsible for preparing pre-service teachers to teach Environmental Studies in primary schools. Neither Science nor Social Sciences departments are directly responsible for preparing pre-service teachers to teach 'Making a Living'. Thus, there is a need to have a course that will deliver teachers' college level EEfS and also prepare pre-service teachers to teach EEfS in primary schools, especially as part of 'Making A Living' and 'Environmental Studies' (Broadfoot & Paullon, 2002).

5.2.1.4 National Curriculum Statement

The NCS (PNGNDoE, 2003d) is based on the National Goals and Directive Principles in the National Constitution, and provides a national framework for curriculum developments in PNG from Elementary to Grade 12. Analysis shows that it stresses the need to address environmental and sustainability issues in PNG schools.

According to PNGNDoE (2003d), PNG's rich biodiversity is under serious threat because of the rapid use of resources from the environment for cultural, social and economic purposes, and because of the pollution which results from rapid population increase. Cultural diversity is also threatened by exploitation and commercialisation of sacred cultural practices. In addition, familiarity with these diverse cultures and living resources is not being passed to younger generations as it used to be. PNGNDoE (2003d) also indicates that males in PNG hold almost all leadership positions, carry out decision-making and have a higher quality of life than females, who suffer more violence, health problems, lower literacy rates and income levels than males. PNGNDoE (2003d) stresses that these imbalances and problems can be addressed by providing relevant education and helping young people to understand and value the environment and each other (PNGNDoE, 2003d).

In considering pedagogical approaches, the NCS (PNGNDoE, 2003d) also seeks to:

... encourage teachers to use different ways of teaching to give all students a chance to learn... [S]ome students learn best through activities such as reading on their own, working in small groups talking observing, drawing pictures, and finding out information for themselves ...[S]tudents should be encouraged to think critically about what they are learning and to take responsibility for their learning, ... [to] teach each other and to learn from each other... [and] learn to think in ways that make sense, using their experiences, their knowledge, their intelligence and their imagination (p. 18)

The NCS highlights the need for teachers to use student-centred activities to promote learning which is issue and inquiry based, cooperative and socio-culturally relevant (PNGNDoE, 2003d). These pedagogies are not only in line with currently advocated teaching and learning strategies but also consistent

with teaching and learning strategies suggested for the delivery of EEfS and other subjects in primary schools.

5.2.1.5 Primary School Curriculum

Making a Living and Environmental Studies syllabi are underpinned by the NCS and were developed in response to the call in *Agenda 21* for environmental education for sustainability (PNGNDoE, 2003b; PNGNDoE, 2003c). The pedagogies recommended for use in Making a Living and Environmental Studies lessons are active, student-centred approaches which focus on making learning meaningful and effective by linking practical learning experience with knowledge and values by using students' heads, hearts and hands (Sipos et al., 2008). This is in line with the objectives of EE in the *Tbilisi Declaration* (UNESCO-UNEP, 1978) and Lucas's model of education about, in and for the environment (Lucas, 1979). As noted above, the pedagogies emphasised by the National Curriculum Statement are consistent with current teaching and learning strategies and with teaching and learning strategies for EEfS as described in the contemporary literature. Accordingly, a revised course for the intervention in this study should include some of the recommended teaching and learning strategies as part of the pedagogy and pedagogical knowledge, and opportunities for the trainee teachers to learn about them and be prepared to utilise them in their own teaching.

The study's analysis of the TENCG, which should be underpinned by the Constitution and in line with NCS, reveals that, although there are no clear statements of expectations regarding EEfS for a teachers' college, of what the people of PNG, including pre-service teachers, are expected to learn about the environment and sustainability (PNGNDoE, 2004a).

5.2.1.6 Summary

The concern of the PNG Government for the country's environmental sustainability is stated clearly in the PNG Constitution and people, including teacher educators and teachers, are expected to contribute environmental,

social and economic sustainability. The TENCG appears to have similar concerns; however, the Guideline's expectations for teacher educators to provide EEfS are not clearly stated. The Teachers' College curriculum documents showed evidence of modules on EEfS, but these were not being delivered as they should be due to lack of clear direction from the TENCG regarding which department was responsible for delivering college level EEfS and preparing pre-service teachers to teach EEfS in primary schools. The NCS indicates concern for the environment and sustainability and provides clearly stated concepts and strategies for primary school teachers to follow, which is also consistent with the concepts and strategies in primary school syllabi. The successful implementation of EEfS in primary schools is dependent on how well the teachers are equipped. However, there are gaps in the preparation of pre-service teachers at teachers' colleges to teach EEfS in primary schools. The social science department in the colleges is directly responsible for providing college level EEfS but it is not responsible for preparing pre-service teachers to implement EEfS in primary schools. Thus, there was a clear need for a course that would provide both college-level EEfS and at the same time prepare pre-service teachers to implement EEfS in primary schools. To understand how such a course could be designed, a review of the current practice at the Teachers' College which was the focus of this study was conducted, and this review is discussed next.

5. 3 Existing Practice in EEfS at the College

"Existing practice" here refers to practices of teaching and learning of environment and sustainability-related subjects in the pre-service teachers' college at the time this research project started. This section presents findings based on the analysis of college documents and the perceptions of staff and students of the college.

Beginning with the college documents, the practices examined included the content covered and the learning approaches and strategies used. This

information was collected from reviewing course documents, interviewing five lecturers and two focus groups of students, and by administering a questionnaire to 100 students. The first section presents content covered in the course, beginning with content knowledge.

5.3.1 Content Knowledge

The content knowledge section consists of: environmental issues, key concepts of environment and sustainability, and local traditional knowledge.

5.3.1.1 Environmental issues

Examination of course overviews at the Teachers' College for Environmental Science and Natural and Cultural Environment showed that they contained topics and concepts related to EEfS but did not include local environmental issues (Ninzipa, 2008). Students' assessable tasks were also analysed and it was discovered that Natural and Cultural Environment had assessable tasks based on environment related topics but did not emphasise environment and sustainability issues. This may suggest that issues were not highlighted during the delivery of Natural and Cultural Environment courses. On the other hand, there were evidence of addressing environmental issues in science as written in two essay type questions in the unit test:

(1) The increase in the world's population has put a tremendous pressure on the use of natural resources. Identify two of these natural resources and describe how effectively they can be used to satisfy the needs of the current population and at the same time they are sustainable for future generations.

(2) Global warming is a serious threat to the Earth's atmosphere because we are already experiencing its side-effects in PNG. In a brief essay, explain what it is, its effects and how it could be controlled in small ways (Unit test, 2008, p.1).

This finding may be a reflection of individual initiatives of the lecturers concerned because there appears to be no clear correlation between the policy

of the division, the college and the course overview, and the actions of the environmental science lecturers.

When lecturers, and students in the focus group, were asked during their interviews to list topics or concepts covered in the course at the college, they did not mention environmental problems. However, when they were asked to state what they wanted included in any new EEfS course they identified the following:

- deforestation due to logging and mining (3/5 lecturers and both focus groups);
- deforestation due to gardening (3/5 lecturers);
- land degradation due to human activities (3/5 lecturers and one focus group);
- habitat destruction (3/5 lecturers);
- endangered species (2/5 lecturers and both focus groups);
- pollution of water, land and air (3/5 lecturers and both focus groups);
- global warming (4/5 lecturers and both focus groups);
- overfishing (3/5 lecturers);
- population explosion (2/5 lecturers and one focus group);
- social issues such as poverty (3/5 lecturers); and
- inequality in gender and wealth distribution (2/5 lecturers and one focus group).

As one of the lecturers stated during the interview:

Topics such as endangered species, air, water and land pollution, population and economic developments, global warming and poverty and equity are some topics, issues and concepts that are very important and needed more attention; I wish we had time and resources to cover all of them effectively (Environmental Science lecturer).

The above statement implies that this lecturer knew about the importance of learning about environmental issues but felt that they needed more time as

part of the EEfS course to address them. In addition, a cohort of 100 pre-service teachers were asked in question two of Phase One survey questionnaire if they agreed or disagreed whether the following were problems in PNG and the findings were: air, water and land pollution (75% agreement , n=100); global warming (89% agreement); ozone depletion (74% agreement); biodiversity depletion (90% agreement); endangered plants and animals (78% agreement); deforestation (85% agreement); land degradation (75% agreement); over-population (87% agreement); inequality in distribution of resource and poverty (91% agreement); and damage to the environment by mining (85% agreement). Their responses indicated a need to include environment and sustainability issues in the intervention course on EEfS for pre-service teachers in PNG.

The participants' perceptions of the concepts of environment and sustainability content they covered in the two existing environment and sustainability courses are presented next.

5.3.1.2 Key concepts covered in EEfS

Course overviews at the teachers' college were examined to find out if environment and sustainability concepts were studied as part of EEfS. The overviews for Environmental Science and Natural and Cultural Environment included topics and concepts related to environment and sustainability education but there was no clear indication of an emphasis on key concepts of environment and sustainability (Magia, 2008; Ninzipa, 2008) When lecturers, and students in the focus groups, were asked during their interviews about the topics covered in their EEfS courses at the College, they did not mention any key concepts of environmental sustainability. However, when they were asked to state what topics or concepts they wanted included in any new EEfS course they gave the following:

- sustainability (4/5 lecturers and both focus groups);
- sustainable resource use 3/5 lecturers and both focus groups);
- sustainable development (3/5 lecturers and both focus groups);
- biodiversity (3/5 lecturers and one focus groups);

- cultural diversity (3/5 lecturers and both focus groups);
- sustainable action (4/5 lecturers and one focus group);
- resource management (3/5 lecturers and one focus group);
- future focus (3/5 lecturers and one focus group);
- lifestyle choices (3/5 lecturers and both focus groups);
- economic sustainability (5 lecturers and both focus groups);
- social sustainability (5 lecturers and both focus groups); and
- equity (3/5 lecturers and both focus groups).

In addition, the need for including the key concept of sustainability was revealed when a cohort of 100 pre-service teachers was asked in question one of Phase One questionnaire to rate support for given pairs of statements on a five point scale, where 1 indicated strong agreement with the statement on the left, 3 meant views were evenly balanced between the two statements and 5 indicated strong agreement with the statement on the right. Table 5 shows their responses.

Table 5 Environment and Sustainability

Pair	Statement	Percent Rated			Statement
		½	3	4/5	
a.	Science and technology have improved our quality of life	32	58	10	Science and technology have worsened our quality of life
b.	Modern industrial countries are seriously disturbing the natural environment	85	7	8	The natural environment is strong enough to cope with the impacts of modern industrial countries
c.	People must learn to control nature in order to survive	23	45	32	People must learn to live in harmony with nature to survive
d.	Economic growth should be given priority over environmental protection	25	42	33	Environmental protection should be given priority over economic growth
e.	Natural resources should be preserved for the benefit of future generations	77	20	3	Natural resources should be used for the benefit of the present generations
f.	The natural environment should be used to produce goods for people	41	40	19	The natural environment should be preserved for its own sake
g.	Traditional knowledge, values and skills cannot be used to solve our current environmental problems	15	23	62	Traditional and Knowledge and values are part of our lives and should be used to solve our current environmental problems

Firstly, the results in Table 5 indicate that the pre-service teachers had varied views about most environment and sustainability concepts. For example, the findings in (a) could mean either that pre-service teachers were unsure or they were aware that science and technology has both positive and negative impacts on their quality of life. Secondly, in other cases, they showed some understanding of the concepts including the understanding that local traditional knowledge and values is part of their lives and should be used to solve current environmental problems. Thirdly, the pre-service teachers showed strong support for sustainability principles. For example, in findings in (b) they strongly agreed that the activities in an underdeveloped nation were disturbing the natural environment, and in they thought that natural resources should be preserved for the benefit of future generations rather than used for present advantage. Finally, there appeared to be uncertainty about the priorities of environment and the economy, preservation of nature and control

of nature. These responses indicated a need to include the key concepts of environment and sustainability in a new EEfS course to help the pre-service teachers sustain and develop their knowledge about environment and sustainability.

The findings about existing ideas about local traditional knowledge are presented in the next section.

5.3.1.3 Traditional knowledge

The overviews of the two courses were analysed to find out if local traditional knowledge was included in college-level EEfS (Magia, 2008; Ninzipa, 2008). It was discovered that the science overview gave no evidence of utilising traditional knowledge. On the other hand, the social science overview included concepts related to culture and lifestyle but had no clear statement, link or emphasis regarding their impact on environment and sustainability. This may be an indication of lack of emphasis on these issues during the delivery of the Natural and Cultural Environment course.

On the other hand, an analysis of the environmental science assessable tasks indicated evidence of teaching and learning about local traditional knowledge. In addition, during their interviews two social science lecturers said they used traditional knowledge for teaching college-level EEfS. They said they did so because their major assessable task was on culture and their strand or department was responsible for organising the college's annual cultural show, which provided opportunities for the students to develop and use their traditional knowledge. However, there was no clear statement about a link or connection between cultural activities and learning activities for environment and sustainability concepts. Three science lecturers said they do not incorporate traditional knowledge, for a number of reasons. One of them stated, "No real opportunities were given to the students to utilise and develop their traditional or local knowledge ... We sort of just discuss what people know and did as part of their traditional sustainability practices ..."

(Environmental Science lecturer). A second Environmental Science lecturer stated:

It is not easy to fully utilise and develop traditional or local knowledge of them all... They may come from parents of two different cultural backgrounds...[In PNG] we have over 800 different culture groups and beliefs and practices ... And with this new generation lots and lots of inter-marriages have occurred so this young generation [comes from] more ... different cultural backgrounds ... This may be a hindrance because the [pre-service teachers] may have little or no knowledge of [their] culture and therefore maybe not be in a better position to relate [environment and sustainability] knowledge in cultural context and vice versa (Environmental Science lecturer).

This statement suggests that although the lecturers may have been aware of the benefits of utilising traditional knowledge about environment and sustainability in delivering EEfS, they did not do so because there were too many traditional cultures and values to include, and students were thought to possibly have little or no knowledge of their culture, which might hinder learning. This finding indicated a need to explore further the use of local traditional knowledge in teaching and learning about environment and sustainability in the new course.

5.3.2 Pedagogy used in current practice

5.3.2.1 Pedagogy in pre-service teacher education

The analysis of the course overviews for Environmental Science (Magia, 2008) and Natural and Cultural Environment (Ninzipa, 2008) to find out the pedagogy used in delivering EEfS at the college indicated that while learning activities to deliver knowledge were planned in the two courses, there was limited evidence of activities that promoted currently advocated student-centred

learning strategies, such as inquiry-based, constructivist, socio-cultural, experiential, and cooperative learning approaches (Magia, 2008; Ninzipa, 2008).

In addition to this, when the lecturers, and student focus groups, were asked about the teaching and learning strategies used to deliver EEfS at the college, they identified lecturing (5 lecturers and two focus groups) and group discussion, work, research and presentation (3/5 lecturers and both focus groups).

As one of the lecturers stated:

I have not used any direct experiences in the environment and its issues with my students because of the limited time I have. It is difficult for me to create the opportunity for them to go into the real world and study things like animals and plants (Environmental Science lecturer).

This lecturer may have known the importance of learning EEfS from direct experience but felt that they did not have time to include it. However, when the lecturers, and students in the focus group, were asked what other learning activities they wanted included in the new EEfS course they listed:

- excursion/field trip (5 lecturers and two focus group);
- role play /drama (4/5 lecturers and two focus groups);
- simulation (4/5 lecturers and one focus group);
- games (3/5 lecturers and two focus groups); and
- solving problems (5 lecturers and one focus group).

This suggested that it would be important to include in the intervention EEfS course learning activities pertinent to these learning approaches, so that the pre-service teachers could benefit by learning about the concepts and issues as well as how to create learning opportunities for their own students.

Furthermore, when the pre-service teachers were asked in question four of the Phase One questionnaire whether they considered their lecturers had taught

them how to use student-centred learning approaches, the responses were as follows:

- 83% of participants (n= 100) felt that they had been taught constructivist approaches;
- 83% of participants that they had been taught socio-cultural approaches;
- 66% of participants that they had been taught experiential approaches;
- 76% of participants that they had been taught inquiry-based approaches;
- 45% of participants that they had been taught issue-based approaches; and
- 89% of participants that they had been taught cooperative learning approaches.

These responses indicate that the pre-service teachers felt that a number of important learning strategies were being passed on to them as pedagogical knowledge through lectures, but that they were also interested in gaining more experience with specific EEfS strategies. Increased practical inclusion of these approaches in the intervention, especially the teaching about issue-based and experiential learning, was thus considered appropriate.

5.3.2.2 Pedagogy for learning in EEfS or characteristics of EEfS

The course overviews for Environmental Science (Magia, 2008). and National and Cultural Environment (Ninzipa, 2008). were analysed to investigate the pedagogy used in delivering EEfS at the college (Ninzipa, 2008). It was discovered that there was no clear indication of the use of issues or problems as contexts for learning education about, in, and for environment and sustainability. In addition, when the lecturers were asked during their interviews to state what they did to create deep understanding of the concepts of EEfS, they said:

- It was never like going into the real world and studying animals and plants (Science lecturer);

- Not enough time to go out for excursions or field trips or rarely it's done. Instead, I have given them some homework and research questions for them to find out things and report to each other and discuss in class (Science lecturer);
- At the moment we are only doing classroom activities as much as possible, and then getting the students to go out for a short while, maybe by the way of tasks or assessable tasks to collect information and research and this kind of thing. We are not really engaging ourselves with the communities (Science lecturer); and
- I encourage them to go and see the botanical gardens and wildlife conservation to study [the information] and present information on plants and animals and their environment (Science lecturer).

The lecturers seem to understand that taking students out to experience the environment and the issues related to it is important in EEfS but felt that they did not manage to do this in a way that EEfS pedagogy would suggest was important. They hoped that by setting work or assessable tasks that required their students to collect information in the field about environmental problems they might enable them to gain the required experience and practice. There was no guarantee, however, that the students would go to the sites or have the desired experiences. Thus there was a need to provide students with improved real-life experience of environmental problems to help the pre-service teachers see and feel for the environmental issues and to be engaged in solving them.

In addition, 60 out of 100 students responded when they were asked to list the courses they perceived as teaching them about EEfS at the teachers' college. Their responses are shown in Table 6.

Table 6 Courses that Provided EEfS at the Pre-service Teacher’s College

Course	Strand	Percentage (n=60)
Environmental Science	Mathematics and Science	90
Natural and Cultural Environment	Social and Spiritual Development	73
Sustainable Development	Community Development	42
Personal Development	Community Development	10

According to the information in Table 6 the pre-service teachers had some idea that EEfS was covered in more than one discipline. This was supported by one of the focus groups: “I think this subject, environment and sustainability, should be taught in any subject because it is to do with everybody” (Focus group student).

The lecturers agreed that environment and sustainability is a multidisciplinary course and aspects of it can be taught by any courses at the College. That was indicated by two lecturers when they were asked if social and economic topics could be included in the new EEfS course:

We should include some social and economic concepts and issues because I think it goes in line with the cultural context. The people cutting down trees to meet their needs and wants is also part of people’s culture and social structures and economic needs are all related. The course, how I see, should be more or less open and we should also address those types of issues within the course itself, so that our pre-service teachers [are made] aware (Science lecturer).

And:

Economic and social concepts should be included in this course if we have to write a curriculum for this environment and sustainability. It should include concepts related to all disciplines and be concerned with everyone [and include] environment, economic

and social sustainability (Social Science lecturer).

Furthermore, when they were asked to list the school subjects they could use to teach EEfS, the pre-service teachers in the questionnaire identified seven subjects, as shown in Table 7.

Table 7 Subjects that Deliver EEfS in Primary Schools

Primary School Subject	Frequency	Percentage (n=60)
Environmental Studies	35	58
Community Living	26	43
Physical Education	4	7
Health	11	18
Expressive Art	4	7
Science	24	40
Making a Living	21	35
Social Science	22	37
Personal Development	8	13
Language	5	8

The responses indicated that the pre-service teachers had some knowledge of the multidisciplinary characteristics of EEfS and where it could be included in primary subjects that were already established. Therefore, inclusion of teaching and learning activities related to the multidisciplinary nature of EEfS would seem to be appropriate in the intervention.

5.3.3 Barriers in current practices

The barriers identified by the lecturers when they were asked in their interview about the constraints they experienced while teaching the EEfS course were:

- the time factor. There was not enough time to carry out good student activities, cover enough on the topics, or carry out field trips (5/5 lecturers);
- an overcrowded curriculum. Some important issues and concepts were not covered because there were too many topics to cover in the given time (5/5 lecturers);
- lack of funds to carry out field trips, sightseeing or excursion and to purchase the needed teaching and learning materials (5/5 lecturers);

- lack of community support. Most naturally occurring sites of environmental interest/concern around the city were dangerous. There were many free areas where field studies could occur but these were usually unsafe for staff and students to visit (2/5 lecturers);
- huge classes. These made lecturer and student interaction, supervision and counselling difficult, and meant there were too many students to take out for field trips, sightseeing and excursions (5/5 lecturers); and
- lack of resources and needed curriculum materials. Some important issues and concepts were not covered (5/5 lecturers).

Potentially some of these barriers could be overcome by, for example: (1) preparing clear lesson plans with hand-outs and worksheets for the lecturers to share with pre-service teachers through appropriate approaches such as placing in the intranet for the students to read; and (2) covering as many issues and concepts as possible by introducing novel learning activities. These were modelled for the pre-service teachers so that they could learn not only the subject and content knowledge but also learn how to deliver EEFS .

5.3.4 Summary of current practice

In the examination of current practice, staff and student participants agreed that PNG is experiencing environmental problems such as deforestation, land degradation, habitat destruction, endangered species, land, water and air pollution, overfishing, population explosion and inequality in gender and resource distribution. The pre-service teachers surveyed thought that even though there was a need to teach about environmental issues experienced in PNG, they were not being taught.

Courses at the teachers' college that were EE related appeared to present many concepts, such as diversity, systems and interdependence related to natural but did not relate to the environment and sustainability. Environmental concepts in science were covered as science without being related to social and

economic activities, and concepts such as cultural diversity, while social and economic development were covered as social science concepts without being related to their effects on the natural environment.

On analysis of existing college documents and practices there seemed to be no clear evidence of the use of local traditional knowledge about the environment and sustainable practices in the delivery of EEfS in science at the college. Although the college encouraged some cultural activities, and concepts related to culture were delivered in the social science programmes, no clear connection was made with the environment and sustainability concepts and issues. Local traditional knowledge was not utilised because there was no formal statement requiring this to be done in the Teacher Education Guideline and also because the lecturers thought it was too difficult to work effectively with their students' many and varied cultural perspectives. It is also possible that the lecturers were not aware of the benefits of drawing on local traditional knowledge.

The pre-service teachers reported that the main teaching approaches used in their environment-related courses were lecturing followed by group work. There was no clear evidence of the use of other currently advocated approaches including constructivist, experiential, inquiry-based, cooperative and socio-cultural learning. However, the pre-service teachers reported being taught about these student-centred learning approaches in their courses.

Analysis of college documents and responses of participants appear to reveal that there were no evidence of the use of EEfS pedagogy or learning activities that could create deep and clear understanding of concepts and issues pertaining to environment and sustainability.

The learning activities and approaches that were expected to be used by pre-service teachers when they taught their own students were not modelled or demonstrated to them by their lecturers. Thus, there was a need to include and

model such activities and approaches in the intervention. Environmental and sustainability concepts and issues were either not delivered at all or delivered inadequately, usually due to lack of time, funds and other resources. Although the latter are often beyond the lecturers' control, these issues would need to be addressed in some way in the intervention.

The next section describes the course design for the intervention.

5.4 Intervention - a New Course Design

The review of EE policies and examination of current practice in EEfS at the teachers' college led to the design of an EEfS course to be delivered to first year pre-service teachers as an intervention. The course was designed to be relevant and appropriate for pre-service teachers of PNG in that it reflected current ideas about teaching and learning in pre-service teacher education, contemporary thinking on environment and sustainability education, and local traditional teaching and learning strategies. In addition to this, the design accorded with environment and sustainability policies and concerns of PNG.

5.4.1 Overview of the course

The course was delivered to pre-service teachers in their final trimester in a 14 week period over 28 lectures (see Appendix Twelve). The course was offered in two groups of students, one led by a lecturer and one by the researcher, both of whom are environmental science lecturers for pre-service teachers. It is important to note that all lessons were delivered using the most recommended effective pedagogical approaches.

The aim of the course was to produce beginning teachers who were competent to act in ways that contribute to environmental sustainability. This includes delivering EEfS to primary school children to help them also to become action competent. In aiming for that outcome the course included:

- a lesson (lesson 3) on currently advocated pedagogies, including constructivist, socio-cultural, inquiry-based, and cooperative learning, to set the scene for their use throughout the course. The pre-service teachers took part in this and were expected to learn about how to use the strategies in their own teaching;
- a lesson (lesson 2) on the key concepts of EEfS and characteristics of EEfS, as these were to be used throughout the course, and in the pre-service teachers' own teaching;
- two lessons (lessons 8 & 9) on key concepts of EEfS, with the expectations previously noted;
- studies of local environment and sustainability issues and pertinent traditional environmental knowledge and values (lessons 12, 14 &15);
- an opportunity for the pre-service teachers to see the environment and engage with sustainability issues by participating in field trips or excursions (lesson 5);
- providing the pre-service teachers with an opportunity to be involved in identifying local environment and sustainability issues, and to investigate and resolve them by including a problem-solving project (lesson 16, 20, 23, 24, 25);
- use of KWL charts, which allowed the students to ask and answer questions using prior knowledge, and to decide both what to learn and how to learn what they wanted to learn (lesson 13 or Appendix Fourteen);
- a simulation of a trip to different types of forest, in the course of which they lost all they had to thieves and therefore needed to depend on forest products to survive and complete their excursion. The lesson was intended to demonstrate that forests contain all that people need for survival, but that their resources must be used sustainably if future generations are also to use them (lesson 4 or Appendix Thirteen);
- a role play on discussion and decisions about building a road between two districts in Morobe in order to connect a remote district to the city (lesson 9). This activity was carried out to demonstrate that

infrastructural developments can affect the environment in numerous ways and to allow the students to see such development and its impacts from many different perspectives, not just their own;

- a lesson on the use of advanced technology, to demonstrate that it can have both positive and negative impacts on the natural environment (lesson 16);
- lessons on traditional lifestyles, to show that if many resources are taken out of the environment in small quantities by too many people, PNG's biodiversity may be depleted (lessons 14 &15);
- the use of the Follow Me game to involve all members of class in an active learning activity in which all ask and answer questions. The activity helped the class to revise key concepts (lesson 10);
- the development of a unit of work for teaching EEfS in both lower and upper primary school. This was done to demonstrate that EEfS is a multidisciplinary subject by clustering outcomes from several subjects and developing a unit of work to teach EEfS(lesson 11);
- lessons on population to show the students that population growth is a major problem in PNG and the world, and is a cause of many other environmental problems (lessons 21 & 22).

All the lesson plans were made by the researcher, who took two and half days to train a lecturer, who then took the lead for implementation of the course. The lecturer in charge prepared worksheets and hand-outs before lectures. Two classes were run, one by the lecturer in charge and the second by the researcher. Most of the lessons were delivered or presented as planned, with only a few minor changes. These included requiring the students to do some activities as homework before and after the lessons, and the delivery of longer activities after school in the afternoons and nights.

The next section presents a description of content knowledge covered in the intervention.

5.4.2 Content of the EEfS Intervention Course

Selected environmental issues in PNG were used as contexts for the holistic study of concepts related to them. The learning approaches and activities used to deliver the content knowledge were modelled by the lecturers in the course. Thus, the content knowledge, learning approaches and learning activities were developed simultaneously. Content can become out of date but knowing how to learn can help pre-service teachers to keep learning and teaching for the rest of their lives. With these points in mind, 28 lesson plans were designed for the purpose of a trial implementation of the course (see Appendix Eleven).

The pre-service teachers learnt about environmental issues by reading about, observing, discussing and reflecting on them as individuals, in pairs, groups and as a class. The issues were also studied or covered through real and simulated excursions, role plays and games. In addition, they were covered when the pre-service teachers did their project, in which they identified, investigated and resolved particular issues. Environmental problems were studied or observed using many different learning activities, to help the pre-service teachers understand them clearly.

Specific learning activities were included as follows: firstly, lesson four, for example, was a lesson on biodiversity which consisted of an imaginary excursion to the forest to see four types of forests found in PNG. This was followed by group work and class discussion on plants and their uses, and then reflection on the lesson, with students completing a reflective journal. Secondly, lesson five was a lesson on endangered species. It consisted of an excursion to a nearby sanctuary known as Rainforest Habitat, the completion of a worksheet while observing the animals and their habitat, and writing a reflective journal at the end of the lesson.

Thirdly, lesson seven was a lesson on deforestation and desertification. Learning activities included reading articles on deforestation and desertification, answering the questions on concepts and ideas raised in the

articles, pair and class discussion on those concepts and ideas, and then class discussion led by the lecturer on causes of deforestation in PNG and possible ways of reducing it.

Fourthly, lessons 18 and 19 focussed on land in PNG. Again, learning activities included reading provided articles and answering the questions raised in the articles, and participating in class discussions led by the lecturers about causes, effects and possible solutions to unwise use of land and environment, ownership conflicts and land degradation in PNG.

Fifthly, lesson 13 focused on self-study. Learning activities in the lesson included reading notes on KWL charts and making notes before class on points raised in these notes as homework, class discussion led by the lecturer on how to use KWL charts in EEFS, and then using the charts to learn about pollution and social justice issues.

Sixthly, in lesson eight the students were provided with an opportunity to participate in identifying an authentic environmental problem in their local area or workplace, investigating it to find out its causes, effects and possible solutions, and then formulating ways to reduce or stop the problem.

In an interview with the other lecturer who delivered the course, the lecturer was asked about what he thought about the course. He noted:

The course has given the students opportunity to be[come] aware of some major environmental issues such as the greenhouse effect, pollution, land shortages, population increase, industrial wastes, bad farming practices, careless attitudes in using natural resources and shortages of natural resources and [they] are able to address some of these issues at an individual level with their families, clan and communities where they come from (Lecturer interview, post-intervention)

As described above, the course was designed to teach about issues as a way to examine concepts in EEfS; the next section presents a description of the key concepts covered.

5.4.2 Key Concepts Covered in the Intervention Course

The key concepts of environment and sustainability are linked to environmental issues and these concepts were covered simultaneously with teaching about issues. Concepts including biodiversity, cultural diversity, traditional knowledge and views, interdependence, sustainable development and sustainable action were covered as shown in Table 8.

Table 8 Key Concepts of EEfS in the intervention

Key Concepts of EEfS	Lessons that addressed the concept
Biodiversity	1, 4, 5, 6, 7, 8, 9, 11
Cultural diversity or lifestyle	1, 14, 15, 16,17,18, 19
Interdependence	1, 6, 7, 8, 9, 11
Sustainable development	1, 2, 9, 11, 16, 18, 19
Traditional knowledge	1, 2, 3, 9, 11, 12, 14, 15, 16, 17
Population	1, 11, 20, 21,
Sustainable action	1, 2, 7, 8, 9, 10, 11, 20, 22, 23, 24, 25

Like environment and sustainability issues, the key concepts of environment and sustainability were read about, observed, discussed and reflected on by the students as individuals and in pairs, groups and class; and studied or covered through real and simulated excursions, role plays and games.

The most frequently addressed concept was sustainable action, in line with EEfS' advocacy of action-taking. Lesson eight was particularly focused on action and was delivered with the aim of exploring the idea that action is a fundamental part of EEfS, and providing students with some of the some skills that are required for decision-making and problem-solving as components of action-taking. The pre-service teachers were lectured on EEfS as education for

the environment (Lucas, 1979) and EEfS as issue-based and action-oriented learning, and were challenged to think of an environmental problem, its causes and its broad effects on humans and other living things. The process required the students to make plans, prepare and take actions by (1) identifying an issue in their local area; (2) investigating the issue; (3) seeking solutions to the issue; (4) carrying out actions to address the issue; and (5) evaluating the impact of the action taken to resolve the issue. They were asked to present a report on the action or action plan from week 12 onwards of the course. However, while most pre-service teachers presented their action plans, they were not able to take the actions on their plans because of time constraints placed on the course by the college.

This action-taking approach was taken to help the pre-service teachers to practise identifying, investigating and resolving environmental issues by taking appropriate actions to contribute to future sustainability. The course lecturer noted the value for the students in taking this approach when he stated that:

The course has given them the insights and made them become aware of the importance of taking care of our environment. It has enabled them to do research to find out more information about the topic[s] and issues under discussion, to be taught or addressed at clan, community, provincial and national levels (Lecturer interview, post-intervention).

Traditional knowledge was the second most frequently covered concept in the intervention because it is crucial for PNG. It is crucial because the majority of PNG's people live in rural areas and employ traditional methods of living, including gardening, hunting, fishing and cooking. Special efforts were made to cover traditional knowledge in lesson four, which had an activity which helped the students share with each other about how resources from the forests can be used for food, medicines, fuel and cooking, and eating utensils. The pre-service teachers then completed a reflection journal on the lesson. Students

also worked in groups of five to share what they knew about hunting, gathering, fishing, gardening and cooking, and about plants and animals used as food, medicine, decorations and building materials, and then to report their combined knowledge to the class.

When their lecturer was asked about what he thought about providing an opportunity for pre-service teachers to use and develop their local traditional knowledge in relation to environment and sustainability he said it helped them:

- describe [how] their ancestors led their people in practising to preserve and conserve from their natural environment. It is an advantage for the pre-service teachers because they can easily incorporate them in their own teaching;
- discuss and share their local traditional knowledge about their customs, beliefs, and values; the oral histories about their clans, tribes and communities were discussed and presented to the whole class;
- discuss and share ... how people in their societies carried out activities like gardening and hunting, at the same time taking care of their environment;
- discuss and share their ... beliefs about their certain spirits ... owning or guarding certain pieces of land, forests, mountains, rivers, lakes and sea. Therefore people have to get permission [from the chief] or perform special rituals to get their approval before they carry out activities such as fishing or gardening (Lecturer interview, post-intervention).

Through valuing the students' traditional knowledge, the lecturer was able to see that it was important to incorporate students' local traditional knowledge

when delivering EEfS because it encouraged them to share with each other their values and views about a range of things, including how their people came to be, how their people use and preserve resources and have access to the land and other resources in the environment when they want them.

The next section presents a description of the learning activities and approaches used in the intervention course.

5.4.3 The pedagogies used in the intervention course

The selection of the pedagogies used in the intervention was influenced by the literature on EEfS and the responses of participants about existing practices at the Teachers' College. These pedagogies were introduced in lesson three. This was done to set the scene for the type of learning that would be emphasised in the course. The pre-service teachers developed their knowledge about learner-centred pedagogies by reading about them from material provided, by being taught about them by their peers, and by reflecting on the lesson.

In addition, learning activities that promoted student-centred approaches were modelled by the lecturers throughout the intervention. Efforts were made to model a variety of effective pedagogies and learning activities in the hope that these experiences would benefit them both immediately and in the future with their own primary school students. These pedagogies were taught and modelled by delivering the lessons using learning activities such as lectures, reading comprehension exercises, pair, group, and class discussion, real and simulated excursions, and role plays and games. The students were also provided with an opportunity to identify local environmental issues and investigate and work towards a plan to resolve them. Table 9 shows brief details of the learning approaches taught through activities in specific lessons in the intervention.

Table 9 Learning approaches in the intervention

Learning Approaches	Lesson that promoted it	Examples of learning activity that promoted it
Lecturer centred	2, 4, 6, 8, 16, 18, 19, 22	Lectures, class discussion
Constructivist	1, 2, 4, 5, 6, 7, 9, 12, 13, 14 15, 17, 18, 20	Use of pre questionnaire, KWL
Socio-cultural learning	2, 3, 4, 5, 8, 9,10, 11, 12,13, 14, 15,16,17,18, 20, 21, 22, 23, 24, 25	Peer or elders sharing local traditional knowledge
Inquiry-based learning	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 15, 16, 17,18,19, 20, 21, 22, 23, 24, 25, 26, 27, 28	KWL, Follow Me game, resolving environmental issues
Experiential learning	2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20 ,21, 22, 23, 24, 25	Simulation, role plays and excursions
Cooperative learning	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	Pair share, group discussion

The table shows the most frequently taught learning strategy was inquiry-based learning, followed by experiential learning and then cooperative learning. Questioning which promotes inquiry-based learning occurred in most lessons, but specifically, the Follow Me game in lesson 11 was used to model very simple questioning and answering; the use of the KWL chart in lesson 13 was used to model the idea that pre-service teachers and their students can ask “What do I know about the topic or issue, what do I want to know about the topic and what did I learn about it?”; and the use of a project that focused on identifying and resolving a local environmental problem provided a model of high level inquiry-based learning.

Experiential learning was another regularly employed approach in the intervention because it is seen to work well in EEfS. All lessons in the intervention will become experiences for the pre-service teachers; however, lesson 5, the lesson with an excursion to a field centre, was specifically delivered to promote and model the experiential learning approach. This lesson modelled engaging students in developing knowledge and feelings of concern about endangered species, encouraged them to take action, and showed them how to educate their own students about EEfS outside the classroom by taking classes for a similar study in the forest.

There were also many instances of cooperative learning in the intervention, with tasks such as group work or discussions being used for many different reasons. One reason for their use is that they allow learners to benefit from one another without competing with each other. Pair share is an approach in which two-member groups were used for discussions, and was used throughout the intervention to help the pre-service teachers to share and help one another, because having only two members in the group reduces chances of having passive listeners and learners. Another particular effort made in promoting cooperative learning was in lesson 15, where the students were asked to complete a task in a group of five; the task consisted of responding to five questions each worth five points, with a further five points gained for meeting the requirements of the tasks, making the whole task worth 30 points. Each student in the group was responsible for a question whereby he or she was to investigate and report back to the group. Group work in lesson 13 was designed to promote team work and encourage all students to participate.

This idea was supported by the lecturer's response when he was asked about what he thought about learning activities used in the intervention. He said:

The learning activities used were appropriate for the students at that level and they were effective because they got the students to participate well in discussions

as well as other activities, and [this] has enabled the pre-service teachers to do research to find out more information about the concepts(s) and issues under discussion (Lecturer interview, post-intervention)

Socio-cultural learning, a learning approach that focuses on the social context of the learners, was also used frequently in the intervention course through the use of local traditional knowledge. The approach originated from the work of Vygotsky (1978), who argued that a student's growth in knowledge is very closely related to and embedded in their social activities, and is supported by Bandura's (1977) idea that learning occurs when learners are in close contact with a more knowledgeable person, whose role modelling skills can be observed by the learner. Apart from using active, learner-centred learning activities, the pre-service teachers were encouraged to critically reflect on all actions taken, concepts that were covered, learning approaches and activities that were used during the intervention and make connections with what was happening in the classroom or world. This is an important part of teaching and learning because it helps learners to learn more comprehensively and teachers to improve their practices.

The next section presents the limitations of the intervention.

5.4.4 Limitations of the intervention

Despite the intentions described above for the intervention, not all plans were implemented, for a number of reasons; as Nongkas (2007) has observed, some issues that affect research are beyond the researcher's control.

Firstly, the plan to use observation as one of the research methods in the intervention phase of the research did not eventuate because, in spite of a timely request, the current administration at the Teachers' College did not allow the researcher to offer the course as an elective, but instead wanted the

course on EEfS to be offered in place of Environmental Science. They also wanted the researcher to assist in teaching the course because they had a staffing shortage. The researcher was therefore unable to carry out observations.

Secondly, scheduling issues in teaching can often disrupt teacher planning. In this case, a significant outbreak of cholera during the semester disrupted teaching, assessment and data gathering. During the post-intervention interview, the course lecturer, observed that some content was not able to be covered because “We did not have enough time and our teaching time was affected by the disease outbreak [cholera]. When taking that into consideration, what we have covered is sufficient” (Lecturer, post-intervention interview).

Assessment was also complicated by the cholera outbreak, when the planned test had to be cancelled. This may have affected the students’ results in the course. The lecturer noted:

I think the assessment process is all right, in which students were given opportunity to do reflection, observation, recording and presentation, that also encourages students taking part in their learning. However, I think we should have given them a test as a means of controlled part of assessment, rather than all assessable tasks [being] uncontrolled, resulting in almost all students ending up with very high marks (Lecturer, post-intervention interview)

The omission of the planned test may have affected the students’ results. However, it is also possible that almost all the pre-service teachers had very high marks because they understood the concepts thoroughly because of the activities and approaches used.

Finally, data were used from only 81 out of 300 students who enrolled in the course because they were the students who returned both the pre- and post-intervention questionnaire. The remainder of the students perhaps failed to hand in their pre-intervention questionnaire because the college was closed on the day they received the questionnaire, due to a life-threatening cholera outbreak.

5.4.5 Summary of intervention

The intervention was designed to provide EEfS at teacher education level that reflected current ideas about environment and sustainability education and pedagogies for delivering EEfS as well as local PNG traditional knowledge about environment and sustainability, which was not clearly and practicably being included in the existing practice. A key aim was to develop teachers who are qualified and ready to take any action to contribute to environmental sustainability. The pre-service teachers were taught about environmental and sustainability concepts and issues through the use of problems such as biodiversity depletion, deforestation, endangered species, land degradation, population growth and poverty as contexts. The key concepts covered in the intervention course included biodiversity, cultural diversity, interdependence, sustainable development, traditional knowledge, population and sustainable action. The most intensively covered concept was sustainable action, followed by traditional knowledge.

The pedagogies used in the intervention are advocated in current literature on pre-service teacher education and EEfS as being those most appropriate to the discipline. The most commonly used approaches were inquiry-based learning and experiential and cooperative learning, followed by socio-cultural learning strategies.

Furthermore, the lessons were based around environmental issues and delivered using active, student-centred learning activities, whereby the

students were actually observing environmental issues and engaged in working towards resolving environmental issues, promote deep learning and encourage sustainable action.

5.5 Chapter Summary

Delivering EEfS in pre-service teacher education is in line with the Constitution of PNG and with the Teacher Education National Curriculum Guideline. Serious environmental issues are being experienced in PNG but were not being studied and addressed in pre-service teacher education at the Teachers' College which was the site of this research. Although there were environment and sustainability related subjects in the curriculum, the college was not delivering EEfS. Furthermore, the content knowledge was delivered through teacher-centred learning with learners typically learning passively. The teaching methods used in the existing practices were mainly lectures, with some group research and presentation. In addition, the pre-service teachers were not actively engaged in taking actions to resolve environmental issues nor gaining other environmental experiences, such as learning about biodiversity in the forest.

The intervention course as designed was relevant and appropriate to PNG pre-service teachers. It reflected current environmental issues in PNG, key concepts of environment and sustainability, current ideas about pre-service teacher education pedagogy, and advocated pedagogies for delivering EEfS, in line with the national curriculum of PNG, and the country's environment and sustainability policies and concerns. The design of the course was informed by the literature review and the Phase One Study into existing practices which was carried out at the college in 2008. EEfS was delivered using active, student-centred learning activities based around some of PNG's major environmental issues, and thus enabled the students to actually observe and engage with the challenges, to create deep learning of the concepts and promote sustainable action in the future.

The evaluation of the intervention is presented in the next three chapters, beginning with Chapter Six.

Chapter Six

6. Environmental sustainability issues and key concepts

6.1 Introduction

This chapter presents the findings from the study of pre-service teachers at the teachers' college in Papua New Guinea (PNG). The data were collected and analysed to examine if the designed intervention had impacted on pre-service teachers' knowledge and changed their perceptions about sustainability issues in PNG and the key concepts underpinning Environmental Education for Sustainability. The data were collected from 81 pre-service teachers who were in their third trimester of a six trimester Diploma in Teaching Programme. The findings are presented in two main sections: Environment and Sustainability Issues, and key concepts of Environmental Education for Sustainability (EEfS).

Section 6.2 on sustainability issues presents data that were collected using surveys and analysed to find out the pre-service teachers' perceptions of whether there are biological environment, physical environment, and developmental and social issues in PNG. These perceptions were explored through the use of a questionnaire administered to the pre-service teachers both before and after the intervention course on EEfS, reflection journals kept by the participants during the course, and an action plan produced as part of the coursework. Section 6.3 on key concepts of EEfS presents data on the pre-service teachers' understanding of these concepts of EEfS. The data were collected and analysed to explore pre-service teachers' conceptual understandings of the relationships between social, cultural and economic dimensions of sustainability and the environment. Data for this section were gathered in the same way as the data in section 6.2.

Questionnaire data for both sections were analysed using simple descriptive statistics in which the percentage, mean and standard deviation were calculated for both before and after-intervention sets of data and the difference in percentage mean and variance explored in relation to the intervention, as well as content analysis of open responses. Data from the reflective journals and action plans were used to support the data from the surveys.

The quoted data is coded as follows: PREQ for the pre-intervention questionnaire; POSQ for post-intervention questionnaire; RJ1 for reflection journal entries on the lesson on endangered species, including the excursion; RJ2 for reflection journal entries on the lesson on biodiversity with an imaginary story and group work; RJ3 for reflective journal entries on the lesson with the use of the KWL chart and Follow Me game; AP for student work in their action plans; and the numbers after the comma in the code refer to the number codes of the participants.

6.2 Environment and Sustainability Issues

The environment and sustainability issues explored in this research project were classified as: biological environment, physical environment, developmental, and social issues. The issues are generally regarded and discussed throughout PNG as national sustainability problems, and had been identified by the staff and students of the Teachers' College as sustainability problems in PNG in the preliminary survey which was conducted in 2008 (see Chapter 5). The next sections present findings based on pre-service teachers' responses when they were asked to indicate the level of their agreement to statements that depletion of biodiversity, deforestation, endangered species, land ownership and degradation, population, pollution, mining, global warming, poverty, and unequal resource distribution are problems experienced in PNG (see Appendix Six).

Responses were gathered by asking participants to circle 1, 2, 3, 4 or 5 where 1 represented Strongly Agree, 2 represented Agree, 3 represented Not Sure, 4 represented Disagree, and 5 represented Strongly Disagree. Findings on biological environmental issues are presented first.

6.2.1. Biological Environment Issues

6.2.1.1 Depletion of biodiversity

The data in Table 10 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Depletion of biodiversity is an issue in PNG" before and after the implementation of the intervention.

Table 10 Depletion of Biodiversity an issue in PNG

Issue (Pre/post intervention)	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)	Mean	Standard deviation
Depletion of Biodiversity Pre	30	17	40	2	11	2.48	1.25
	Total agree 47			Total Disagree 13			
Depletion of Biodiversity Post	48	26	22	4	0	1.81	0.90
	Total agree 74			Total Disagree 4			
Change	27 <i>Increase in agreement</i>		18 <i>Decrease in uncertainty</i>	9 <i>Decrease in disagreement</i>		0.67 <i>Change towards agreement</i>	0.34 <i>Less variance in data</i>

Prior to the intervention about half (47%, n=81) of the pre-service teachers viewed depletion of biodiversity in PNG as an issue. When explaining their views at this stage, 22% of the pre-service teachers commented on causes of depletion of biodiversity, such as mining, logging and rapid population growth, 14% of them commented on effects of depletion of biodiversity such as endangering and extinction of species and 1% of them identified education as a possible solution for depletion of biodiversity. For example, these pre-service teachers stated on their pre-intervention questionnaire: "This is the worst environmental issue happening due to mining and logging in the country" (PREQ, 7); "Biodiversity is being depleted [due to] economic and social development such as mining and logging..." (PREQ, 34); "Plants and animals are

used up by large population and now we are left [with] many endangered animals and plants..." (PREQ, 62); and

From my point of view the [resources from the] environment are dramatically disappearing as a result of human activities. People use [up resources] without understanding the effects of it, so environment and sustainability education should be [revised] and strengthen[ed] for our young generations to be made aware... (PREQ, 3).

After the intervention, 74% of pre-service teachers perceived depletion of biodiversity as an issue in PNG, which is an increase by 27%, while about a quarter (27%) of the pre-service teachers were unsure, or disagreed, that depletion of biodiversity was an issue in PNG as shown by the questionnaire data.

The variance amongst the pre-service teachers' views that depletion of biodiversity is an issue in PNG reduced after the intervention, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views in the post intervention questionnaire increased both quantitatively and qualitatively. Forty-seven percent (47%) of them commented on such causes of depletion of biodiversity as mining, logging, gardening, hunting and gathering, and bush fires. As one of the pre-service teachers stated on the post intervention questionnaire:

Most living things in the area disappeared due to high rate of commercial and industrial activities 'which destroy the ecosystems...' (POSQ, 46);

Whilst the stated that:

Depletion of biodiversity results due to 'clearing and cutting rainforests for ... gardening and building houses and...' (POSQ, 40)...activities such

as logging and mining in the environment results in depletion of biodiversity (POSQ, 33);

I agree because human activities ... burning of bushes hurts the living things [such as] ants, snakes [which] lack food and shelter because [forests] that [used to] provide them with food and shelter have been destroyed (POSQ, 17); and

[Also] because most of the people living in the rural areas are hunting wild animals, 'fishing using dynamites' (POSQ, 2) ... and gathering plants for food (POSQ, 74)

Twenty-four percent (24%) of the participants commented on effects of depletion of biodiversity such as endangering of species, and 6% of them identified education as one of the possible solutions for depletion of biodiversity, as these pre-service teachers stated:

I agree it is an issue because some rare species of plants and animals are dying out because of hunting and gardening (POSQ, 71); and

I agree [depletion of biodiversity is a problem in PNG] because most of our plants and animals are decreasing because of human activities such as cutting down of trees for building houses, clearing land for gardening, [burning bush] and economic activity such as logging and mining. Education is a solution because it will create knowledge and understanding about the issue (POSQ, 4).

These findings indicate that the effort made in lessons 4, 5 and 7 in the intervention, especially in lesson 5, which was the visit to Rainforest Habitat,

may have led the participants to become more aware of the issue of depletion of biodiversity, as these pre-service teachers wrote in their reflective journals after that visit:

Yes, I learnt [that there are great] varieties of plants and animals that live in the forest (RJ1, 4);

I have found out that some of the animals in the Rainforest Habitat are very rare animals and we need to take extra care of them... (RJ1, 63);
and

I did learn that ... there are four different types of forests in PNG...and also a lot of animals... are now endangered due to human exploits for decoration and meat (RJ2, 61).

In other words, the pre-service teachers showed evidence of having been influenced by what they learnt about the biodiversity of PNG and the causes and effects of its depletion through the intervention course.

Interestingly, about a quarter (27%) of the pre-service teachers were unsure, or disagreed, that depletion of biodiversity is an issue in PNG after the intervention. It is possible that some of those responses may be based on misunderstanding of concepts and misinterpretation of the provided information, which may be able to be corrected by further work on the course, as these pre-service teachers stated: "Biodiversity is too general, I have no idea what it really means and nothing is really decreasing in numbers... (POSQ, 20) and so further work on this in the course could be useful to help these students to clarify their views. It could also be possible that for some pre-service teachers concern for preservation of biodiversity of PNG in itself is not a priority. The next section examines pre-service teachers' views of deforestation in PNG.

6.2.1.2 Deforestation

The data in Table 11 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Deforestation is an issue in PNG" before and after the implementation of the intervention.

Table 11 Deforestation an issue in PNG

Issue (Pre/post intervention)	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)	Mean	Standard deviation
Deforestation (Pre)	49	19	16	5	11	2.12	1.39
	Total agree 68			Total Disagree 17			
Deforestation (Post)	56	32	2	6	4	1.70	1.04
	Total agree 88			Total Disagree 10			
Change	20 <i>Increase in agreement</i>		14 <i>Decrease in uncertainty</i>	7 <i>Decrease in disagreement</i>		0.42 <i>Change towards agreement</i>	0.35 <i>Less variance in data</i>

Prior to the intervention, more than two-thirds (68%, n=81) of the pre-service teachers viewed deforestation in PNG as an issue. When explaining their views at this stage, 45% (n=81) of the pre-service teachers commented on the causes of deforestation and identified mining and logging activities as the main causes. As one of them stated on the pre-intervention questionnaire: "Many parts of PNG are experiencing deforestation because of logging and mining activities" (PREQ, 21)

A further 24% of participants commented on effects of deforestation such as "some areas where there used to be trees have turned into grassland..." (PREQ, 27); and 8% of them identified reforestation as a possible solution of deforestation. For example, "this is happening in some parts of PNG [because] trees are cut down for logs and no one is replanting or replacing them with the young plants" (PREQ, 62). Forests in some parts of PNG are turning into grassland because logging and mining activities are carried out without subsequent reforestation activities.

After the intervention, the proportion of pre-service teachers perceiving that deforestation was an issue in PNG increased by 20%, as shown by the questionnaire data after the intervention, and the variance amongst the participants' views that deforestation is a problem in PNG reduced after the intervention, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, as follows:

- Fifty-two percent (52%) of those in agreement commented on the causes and root causes of deforestation, as these pre-service teachers wrote on their post intervention questionnaire:

Deforestation is caused by cutting down trees without replacing them with the young plants (POSQ, 59);

Activities like logging, mining, gardening, cutting trees for building houses [and fences], all these contribute to deforestation (POSQ, 16); and

As the population increases, more and more people are engaged in activities such as gardening and so large areas of land are cleared for agricultural purposes (POSQ, 69).

- Thirty-four percent (34%) of the respondents commented on effects of deforestation, including:

Some of these forests are no longer there; instead they have been replaced by grasslands (POSQ, 16); and

PNG has already lost a great quantity of species of plants [and animals] from the forest as a result of deforestation..."(POSQ, 9) .

- Twelve percent (12%) of them identified reforestation and education as possible solutions to deforestation. These pre-service teachers stated on their post-intervention questionnaire:

It is caused by too many logs being cut without any reforestation programme (POSQ, 30);

Because there is not enough awareness [about the effects] of cutting down trees and [not] replacing [them] with young ones (POSQ, 51);

Awareness about the need to care for the forests is needed by the people who own the land” (POSQ, 79); and

Because there is not enough awareness against clearing forest and cutting trees and on reforestation (POSQ, 51).

These findings indicate that efforts made in lessons 5 and 7 in the intervention to teach the pre-service teachers about forests, their resources and their possible depletion, may have led them to become more aware of the issue. These pre-service teachers stated in their reflection journals:

The new thing I learnt is we can get all we need from the forest but we need to take them out with consideration for others who will come after us [the future generation] (RJ1, 37); and

I learnt that the forest is very important habitat for different types of animal species. Animals need the environment [forest as their home] to survive so we must look after the environments [the forests] (RJ1, 2).

In other words, these statements show understanding that people in PNG can obtain all they need from the environment but they should do so sustainably without compromising the ability of future generations of people or animals to meet their needs and wants from the environment.

After the intervention 10% of pre-service teachers were unsure, or disagreed, that deforestation is an issue in PNG. This could indicate that further work on this in the course would be useful, or that for some pre-service teachers, preservation of forests in itself is not a priority for them. The findings on pre-service teachers’ views of endangered species in PNG are presented next.

6.2.1.3 Endangered Species

The data in Table 12 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Endangered species is an issue in PNG".

Table 12 Endangered species is an issue in PNG

Issue (Pre/post intervention)	Strongly disagree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)	Mean	Standard deviation
Endangered Species (Pre)	41	20	23	2	14	2.2	1.24
	Total agree 61			Total Disagree 16			
Endangered Species (Post)	67	24	1	2	6	1.58	1.08
	Total agree 91			Total Disagree 8			
Change	30 <i>Increase in agreement</i>		22 <i>Decrease in uncertainty</i>	8 <i>Decrease in disagreement</i>		0.62 <i>Change towards agreement</i>	0.16 <i>Less variance in data</i>

Prior to the intervention, more than half (61%, n=81) of the pre-service teachers viewed environmental threats to endangered species in PNG as an issue. When explaining their views at this stage, 24% of the pre-service teachers commented on the perceived causes of this situation. These pre-service teachers stated:

Today PNG is losing lots of its species of plants and animals because of deforestation which are caused by logging and mining activities (PREQ, 75); and

Some species of living things are all gone [extinct] because of logging and mining (PREQ, 48).

One percent (1%) of the participants identified education as a possible solution for protecting endangered species. One of them stated:

We have to educate people on how to preserve animals and plants for future generations (PREQ, 47).

The proportion of pre-service teachers perceiving negative impacts on endangered species as an issue in PNG increased by 30% after the intervention, as shown by the questionnaire data after the intervention, and the variance amongst the pre-service teachers' views that this is a problem in PNG reduced after the intervention, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, with more people commenting on the causes and effects of the problem. Thirty-three percent (33%) of the pre-service teachers commented on the causes, including mining and logging. They also identified hunting and gathering and deforestation from clearing and burning of bushes for gardening as other threats to endangered species. These were seen as linked to rapid growth in the population, as these participants stated:

Due to mining, logging, gardening and bush fires, many animal [and plant] species are endangered (POSQ, 9);

Many people in the village are killing and eating the animals, (POSQ, 41); and:

Growing population in the country means more is needed to feed the growing population [and so the] natural environment and resources are being greatly used, destroying the home for other living things (POSQ, 10).

These views indicated that participants considered that species of animals and plants are endangered because people are hunting and gathering the plants and animals for food and because the forests are being destroyed through human activities such as logging, mining and farming. Sixteen percent (16%) of them commented on effects on endangered species such as extinction of species, as these pre-service teachers stated:

Most species of animals [that] we used to see have disappeared because human beings were hunting them for food (POSQ, 27); and:

I strongly agree [endangered species is an issue in PNG] because there are lots of endangered animals in our country, of which most are already extinct and only few are remaining, [the problem] is caused by deforestation because forest is their home and when forests are destroyed, some of these animals cannot survive therefore they die while the others run away to other places where they can survive (POSQ, 4).

Five percent of participants identified education as one possible solution for endangered species, as these examples show:

Most of animals and plants are extinct and so educating them now can reduce or stop [the problem] (POSQ, 65);

[We] have to educate [the] people on how to preserve animals and plants for our future generation” (POSQ, 78); and

Educating the people about it can reduce the problem in future (POSQ, 65).

Educating the people can help them take appropriate sustainable action which can benefit future generations.

These findings indicate that efforts made in lessons 4 and 5 in the intervention to teach the pre-service teachers about PNG flora and fauna and their possible extinction may have led the pre-service teachers to become more aware of the issue. These pre-service teachers wrote in their reflective journals after seeing endangered species in Rainforest Habitat:

I have found out that some of the animals in the Rainforest Habitat are very rare and [so] we need to take extra care and protect them (RJ1, 63); and

Yes, I learnt about many different animals of PNG which I did not know before. I also learnt about endangered species. It was a good experience for my friends and I because with this kind of experience we can really understand the problem of endangering species (RJ1, 4).

After the intervention 9% of participants were unsure, or disagreed, that threat to endangered species is an issue in PNG, which could indicate that either further work on this in the course would be useful, or that for some pre-service teachers, endangered species are not a priority for them. Findings on physical environmental issues are presented next, beginning with findings on pre-service teachers' views of land disputes and degradation in PNG.

6.2.2. Physical Environment Issues

6.2.2.1 Land

The data in Table 13 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Land dispute and degradation are issues in PNG".

Table 13 Land dispute and degradation in PNG

Issue (Pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Land Dispute and Degradation (Pre)	28	25	35	5	7	2.38	1.16
	Total agree 53			Total Disagree 12			
Land Dispute and Degradation (Post)	50	29	11	10	0	1.81	0.98
	Total agree 79			Total Disagree 10			
Change	26 <i>Increase in agreement</i>		24 <i>Decrease in uncertainty</i>	2 <i>Decrease in disagreement</i>		0.57 <i>Change towards agreement</i>	0.18 <i>Less variance in data</i>

Prior to the intervention, about half (53%, n=81) of the pre-service teachers viewed land dispute and degradation as issues in PNG. When explaining their views at this stage, the pre-service teachers who agreed with the statement commented on the causes (25%) and effects (16%) of land ownership dispute and degradation. Comments included:

Population growth in PNG has brought conflicts in land-ownership. Due to population growth the land has been degraded and the result is plants are not growing well (PREQ, 42);

Population is growing in PNG rapidly. In 1990, it was only 3 million but now it is 6.5 million (PREQ, 25); and

Increase in population has resulted in land shortage and land shortage is becoming the main cause of tribal fights experienced right across the country (PREQ, 78).

After the intervention, the proportion of pre-service teachers perceiving that land ownership dispute and degradation were issues in PNG increased by 26%, as shown by the questionnaire data after the intervention, and the variance amongst the pre-service teachers that agreed with the statement reduced after the intervention, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, with participants identifying many issues associated with land problems. Fifty-seven percent (57%) of the pre-service teachers commented on the causes and 26% of them commented on the effects of land dispute and degradation land related problems. They said:

The land ownership disputes and land degradation are becoming major issues in PNG because of rapid population increase (POSQ, 3);

People argue over a particular piece of land to find out who the real owner is. This often leads to fights in some part of country... and land degradation occurs [because of] farming or agricultural activities which take place continuously (POSQ, 32);

Land can be easily destroyed by the land owners (POSQ, 79); and

Because these people think they own the land so they can do anything they want [to it], this leads to land degradation (POSQ, 51).

Because 97% of land in PNG is customarily owned collectively by the members of the clans who live on the land, these observations are substantive. In this customary land ownership system, people living on the land or in the clan decide how the land is used and descriptions, land-marks and history and paths of land inheritance are passed on verbally without written records. The system used to work well when:

- all clan members were living on the land,

- all clan members valued their traditional system of keeping and passing information,
- all clan members valued their traditional values and beliefs; and
- the population was small enough for the carrying capacity of the land (the environment).

Lots of people in PNG are confused by the fact that while most of the population still employs traditional methods of hunting, gathering, gardening and cooking, people are also influenced by Western ideas. This includes a move away from holding traditional beliefs and values, which impinges on the integrity of traditional education and information keeping systems. In addition to that, the nation's rapid population growth is resulting in people competing for land space as well as environmental resources.

Thirty-five percent (35%) of participants identified education as possibly providing solutions for land dispute and degradation. For example:

As teachers we need to create awareness on the issue so that people can know and take sustainable action (POSQ, 79); and

Educating the people now can benefit our future generations. The actions they take now can preserve the land and its resources so that people in future generations can [also] use the land and its resources to satisfy themselves (POSQ, 51).

The pre-service teachers indicated an understanding that education can help people understand how to use land and its resources sustainably.

These findings indicate that efforts made in reading about land ownership, policies and uses and answering questions on points from the notes, and having group and class discussion on issues in PNG may have led the pre-service teachers to increased awareness of the issue.

Interestingly, after the intervention 21% of participants were unsure, or disagreed, with the statement that landownership dispute and degradation are issues. This could indicate that either further work on this in the course would be useful, or that for some pre-service teachers the problem is too complicated and they may not know what to think. The findings on pre-service teachers' views of pollution in PNG are presented next.

6.2.2.2 Pollution

The data in Table 14 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Water, land and air pollution are issues in PNG".

Table 14 Pollution is an issue in PNG

Issue (Pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Water, land and Air Pollution (Pre)	59	17	11	5	8	1.85	1.23
	Total agree 76			Total Disagree 13			
Water, land and Air Pollution (Post)	65	22	3	5	5	1.69	1.20
	Total agree 87			Total Disagree 10			
Change	11 <i>Increase in agreement</i>		8 <i>Decrease in uncertainty</i>	3 <i>Decrease in disagreement</i>		0.16 <i>Change towards agreement</i>	0.03 <i>Less variance in data</i>

Prior to the intervention, about three-quarters (76%, n=81) of the pre-service teachers viewed water, land and air pollution in PNG as issues. When explaining their views at this stage, 52% of those in agreement commented on the causes of pollution. As one of them stated:

[Water, land and air pollution is occurring] in PNG due to the economic development activities [that are carried out] every day such as factories, mining and logging activities (PREQ, 7).

The intervention may have contributed to an increase by 11% in the proportion of pre-service teachers who perceived pollution as an issue in PNG, as shown

by the questionnaire data after the intervention. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, with more participants commenting on more causes and effects of pollution. Sixty-seven percent (67%) of the participants identified human activities such as mining, logging industries, rubbish disposal and gardening as causes of pollution:

I strongly agree because there is pollution of water, land and air through mining, logging, burning of bushes, making of fire, smoke from the factories etc. (POSQ, 4);

[Pollution is an issue in PNG] because people's social,[cultural] and economic activities like mining, industries, burning bushes for gardening, and logging are polluting the air, land and water (POSQ, 49); and

Waste from the factories and household, burning of tyres and plastics ... cause pollution (POSQ, 5).

Thirty-six percent (36%) of participants commented on effects including the pollution and destruction of the environment and organisms, and 7% commented on possible solutions to pollution which emphasised mainly education or awareness. As these pre-service teachers stated on their post intervention questionnaire:

Mining, logging, industries, farming are affecting the plants and animals are depleting them. Land for gardening is polluted; drinking and washing water is [also] polluted ... (POSQ, 67);

... polluting our water, land and air [which in turn] causes global warming, sickness and other problems (POSQ, 49); and

If we educate the children now, we can help them to take sustainable action in future (POSQ, 65).

These findings indicate that efforts made during the intervention to discuss land use and settlements and the effects of different types of industries the environment in lessons 8 and 23 may have led the pre-service teachers to become more aware of the issue.

After the intervention, eight percent (8%) of the pre-service teachers were unsure, or disagreed with the statement that pollution is an issue in PNG. This could indicate either that further work on this in the course would be useful, or that for some pre-service teachers their experiences with pollution have not created concern. The next section presents pre-service teachers' views of global warming in PNG.

6.2.2.3 Global Warming

The data in Table 15 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Global warming is an issue in PNG" before and after the implementation of intervention.

Table 15 Global Warming an Issue in PNG

Issue	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Mean	Standard Deviation
Global Warming and climate change Pre Implementation (n=81)	51%	20%	17%	5%	7%	1.24	1.99
	Total agree 71%			Total Disagree 12%			
Global Warming and climate change Post Implementation (n=81)	62%	28%	6%	1%	3%	0.89	1.56
	Total agree 90 %			Total Disagree 4%			
Change	19% <i>Increase in agreement</i>		11% <i>Decrease in uncertainty</i>	8% <i>Decrease in disagreement</i>		0.35 <i>Increase towards agreement</i>	0.43 <i>Less variance in data</i>

Prior to the intervention, about three-quarters (71%, n=81) of the pre-service teachers viewed global warming in PNG as an issue. When explaining their views at this stage, 22% of the pre-service teachers commented on the causes of global warming. One of the pre-service teachers stated:

Smoke from the factories and mining change the climate by warming the globe (PREQ, 9).

Twenty-nine percent (29%) of them commented on effects of global warming such as sea level rise and temperature and climate change; for example:

Sea level is rising and small islands are covered or the land mass of the island getting smaller (PREQ, 8); and

Extinction of animals [which could] not adapt to climate change (PREQ, 60).

The pre-service teachers identified temperature and climate change, sea level rise and species extinction as major effects of global warming.

After the intervention, the proportion of pre-service teachers perceiving global warming as an issue in PNG increased by 19%, as shown by the questionnaire data, and the variance amongst the pre-service teachers' views reduced after the intervention, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, as follows:

- Seventy-four percent (74%) of the pre-service teachers commented on the causes of global warming saying, for example:

It is caused by burning bushes [and] tyres and [waste gases from the] factories which contribute such as carbon dioxide into the air ... (POSQ, 30);

Burning fuel excessively and increasing carbon dioxide ... contributes to global warming (POSQ, 74);

[It is] caused by waste from vehicles and mining (POSQ, 81).

- Sixty-one percent (61%) of the participants commented on effects such as a rise in sea level, climate change and sicknesses. For example, they stated:

The level of sea is rising and covering some [small] islands in PNG resulting in unusual weather patterns... (POSQ, 20); and

Because the climate is becoming so hot that it can cause sickness like headache and skin rash (POSQ, 9).

- Thirty-three (33%) commented on possible solutions for global warming. Comments included:

[I agree] global warming is [a problem in PNG] caused by [waste gases] such as carbon dioxide from the burning bushes, tyres and factories [emitted] into the air (POSQ, 30); and

We are experiencing this because of too many human activities [within a short period of time but education can help solve the problem] (POSQ, 2).

The pre-service teachers identified waste gas from factories, vehicles and mining and from burning of fuel, bush and rubbish such as tyres as causes of global warming. They continued to see climate changes, rising sea levels and extinction of species as effects of global warming.

These findings indicate that discussions about global warming and its effects on PNG and the world as one of the environmental issues during the intervention may have led the pre-service teachers to become more aware of the issue, and indeed 12% of them stated that they were planning to take action to address global warming in their action plans. As one of them stated:

I will tell people and students about its causes, [and the] effects of global warming and how they can contribute in addressing the issue (AP, 73).

After the intervention, 10% of participants were unsure, or disagreed, that global warming and climate change were issues. This could indicate that either further work on this in the course would be useful, or that for some pre-service teachers global warming and climate change are not priorities. Findings on pre-service teachers' views of mining are presented next.

6.2.3. Developmental Issues

6.2.3.1 Mining

The data in Table 16 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Mining is an issue in PNG" before and after the implementation of intervention.

Table 16 Mining is an issue in PNG

Issue (Pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Mining (Pre)	65	13	12	6	4	1.85	1.23
	Total agree 78			Total Disagree 10			
Mining (Post)	68	21	4	5	2	1.51	0.94
	Total agree 89			Total Disagree 7			
Change	11 <i>Increase in agreement</i>		8 <i>Decrease in uncertainty</i>	3 <i>Decrease in disagreement</i>		0.34 <i>Change towards agreement</i>	0.29 <i>Less variance in data</i>

Prior to the intervention, more than three quarters (78%, n=81) of the pre-service teachers viewed mining in PNG as an issue. When explaining their views at this stage, 12% of them commented on effects of mining such as land problems and pollution. As these participants stated:

I strongly agree [mining is an environmental issue in PNG because] so many hectares of land is damaged leaving some people running short of land spaces as in Southern Highland and Enga Provinces (PREQ, 16); and

Mining destroys environment and causes [air, land and] water pollution (POSQ, 78).

After the intervention, the number of pre-service teachers perceiving that mining is an issue in PNG increased slightly, by 11%, as shown by the questionnaire data after the intervention, and the variance amongst the pre-service teachers' views reduced slightly after the course, as shown by the lower standard deviation in the findings. The pre-service teachers' explanations of their views about mining in the post- intervention questionnaire increased both

quantitatively and qualitatively. Nineteen percent (19%) of them commented on mining and its effects as an issue. As these pre-service teachers stated:

It destroys the living things in that particular area where mining is taking place (POSQ,38); and

[This happens because mining wastes are frequently dumped into the rivers] causing water pollution and destroying marine life (POSQ, 43).

Furthermore, 4% of participants stated that education was a possible solution to reduce the effects of mining; one of them stated:

People need education [and awareness] to take correct actions (POSQ, 49).

This is supported by the fact that some (9%) of the pre-service teachers had made plans to address mining in their action planning. These findings indicate that efforts made in learning about mining and its possible effects in PNG in the intervention may have made the pre-service teachers more aware of the issue.

After the intervention 8% of the pre-service teachers were unsure, or disagreed, that mining is an issue and this could indicate that either further work on this in the course would be useful, or that for some pre-service teachers concern for mining activities and their effects is not a priority for them, or that the benefits they saw from mining over-rode any such concerns. Findings on social issues are presented next, beginning with findings on pre-service teachers' views of population growth in PNG.

6.2.4. Social Issues

6.2.4.1 Population Growth

The data in Table 17 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Population growth is a problem in PNG".

Table 17 Population growth issue in PNG

Issue (Pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Population Growth (Pre)	51	17	21	6	5	2.00	1.19
	Total agree 68			Total Disagree 11			
Population Growth (Post)	69	24	0	6	1	1.47	0.88
	Total agree 93			Total Disagree 7			
Change	25 <i>Increase in agreement</i>		21 <i>Decrease in uncertainty</i>	4 <i>Decrease in disagreement</i>		0.53 <i>Change towards agreement</i>	0.31 <i>Less variance in data</i>

Prior to the intervention, more than half (68%, n=81) of the pre-service teachers viewed population growth in PNG as an issue. When explaining their views at this stage, 20% of the pre-service teachers commented on the causes, 20% of them commented on effects and 3% of them commented on possible solutions of population growth. Comments included:

[Strongly agree because] the rate of population growth in PNG is very high because there is no proper family planning and leads to land space shortage and disputes (PREQ, 7); and

Rapid population growth results in shortage of resources, more resources from the environment are being used up, more bushes are cleared for farming and not long all the forest will become [infertile] grassland and people will starve (PREQ, 3);

Population is growing rapidly caused by ...teenage unplanned pregnancy and longer life span (PREQ, 51); and

Ignorance or lack of knowledge has contributed to huge increase in population ... (PREQ, 34).

These pre-service teachers identified lack of family planning and ignorance of family planning methods as the causes of rapid growth in population, and effects of large population, and said uncontrolled population growth was connected to other problems such as shortage of land and resources and land degradation.

After the intervention, 93% of pre-service teachers perceived population growth as an issue in PNG, which was an increase of 25%. Only 7% of them were unsure, or disagreed with the statement that population growth is an issue in PNG. The pre-service teachers' explanations of their views in the post-intervention questionnaire increased both quantitatively and qualitatively as follows:

- Twenty percent (20%) of the pre-service teachers commented on the causes of population growth such as lack of education and family planning. For example, they stated:

Rapid population growth is experienced in PNG because of no proper family planning (POSQ, 7);

[It] is also because of unplanned pregnancy and families having more ... children (POSQ, 20); and

Due to introduction of better health services and people are producing as many children as they want because there is no Government policy against it (POSQ, 56).

- However, a significantly increased fifty-seven percent (57%) of participants commented on the negative effects of population growth, as these statements show:

Rapid increase in population results in more pollution, land shortage, unemployment, criminal activities, and environmental destruction such as depleting of rainforests (POSQ,30);

Increasing number of people is putting more pressure on the environment through farming and other developmental activities (POSQ, 36); and

...a high percent of unemployment [and] illiteracy... POSQ,21).

- Twelve percent (12%) of the participants commented on possible solutions to population growth, as these pre-service teachers stated:

There is a high rate of unemployment, limited spaces in schools to cater for all children and there is no proper awareness to address these issues (POSQ, 21); and

Educational awareness on it [population growth and its effects] will help control birth and address other [associated] issues (POSQ, 14).

These pre-service teachers considered that lack of education is a key cause of “rapid population growth [which] is causing all other kinds of problems that we are experiencing today” (POSQ, 66), and so argued that providing education and awareness would be the best solution at this stage. This idea of creating awareness was further supported by the extra written comments provided by one participant on their post-intervention questionnaire:

I will take action to reduce or stop these environmental problems in my community ... As an educated person and future teacher I will encourage my educated brothers and cousins to take initiatives to make awareness [campaign] on family planning [among our people] (POSQ, 14).

These findings indicate that learning about population growth in PNG and its causes and effects and possible solutions in lessons 20 and 21 may have led the pre-service teachers to become more aware of the issues. They saw rapid population growth as an issue and a root cause for other environmental issues, including poverty.

6.2.4.2 Poverty

The data in Table 18 show pre-service teachers' responses when they were asked to show their level of agreement with the statement "Poverty is a problem in PNG".

Table 18 Poverty an issue in PNG

Issue (Pre/post intervention)	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)	Mean	Standard deviation
Poverty (Pre)	12	21	25	21	21	3.28	1.34
	Total agree 33			Total Disagree 42			
Poverty (Post)	18	27	15	20	20	2.95	1.41
	Total agree 45			Total Disagree 40			
Change	12 <i>Increase in agreement</i>	10 <i>Decrease in uncertainty</i>	2 <i>Decrease in not sure</i>	0.2 <i>Change towards agreement</i>	0.07 <i>more variance in data</i>		

Prior to the intervention, the pre-service teachers had varied views about poverty in PNG. Thirty three percent (33%, n=81) of the pre-service teachers who perceived poverty as an issue in PNG made comments such as:

Most people in both urban and rural area of PNG do not have enough resources and are poor (PREQ, 69); and

There is lack of job opportunities [for people] so [they] become beggars on the streets (PREQ, 54).

These pre-service teachers thought that poverty was indicated by people lacking money and other goods, and by unemployment and criminal activities.

On the other hand 42% of the pre-service teachers did not perceive poverty as an issue in PNG, and made comments such as:

[I] disagree because we have enough resources and cash crops in our areas (PREQ, 41);

PNG people ... are blessed with resources and fertile land and they generally have good life (PREQ, 25);

PNG is ... blessed by God with everything that its people need to survive including food and drink [and so] nobody is poor (PREQ, 15); and

Most of the people are Christian and know how to share with each other [all have equal right over things' (PREQ, 28)], so really there is no one poor (PREQ, 47).

These pre-service teachers think people in PNG are not poor because the country and its people have been blessed with all that the people need. The people:

- have resources from their environment as food and for fund raising;
- have crops from their subsistence gardens as food and for fund raising;
- own fertile land on which they can produce all they need; and
- have other people to share with them.

The proportion of pre-service teachers perceiving that poverty is an issue in PNG increased by 11% after the intervention, as shown by the post-intervention questionnaire data. Although there were some different responses, the pre-service teachers continued to have varied views about poverty in PNG. Forty percent (40%) of the pre-service teachers who agreed that poverty was a problem commented on signs, causes, effects and possible solutions of poverty.

- Indications of poverty:

[I strongly agree poverty is a problem in PNG because] we are very poor in terms of wealth and cash. We cannot afford to buy everything we want. We always struggle to live (POSQ, 34);

PNG is poor in terms of people's living standard ... (POSQ, 14);

Services such as health, education and infrastructure ... (POSQ, 69);

Too many unemployed people ... [and] some people without money at all (POSQ, 78);

People go out stealing from other people (POSQ, 21);

More people living in squatter settlements and without better jobs to improve their living standard ... (POSQ, 41); and

Some people do not have land so they cannot make a garden or grow cash crops (POSQ, 28).

- Causes of poverty:

The resources are not distributed equally ... (POSQ, 16);

Laziness and attitude problems are causing poverty in the country (POSQ, 15);

High rate of population and land degradation (POSQ, 17);

Lacking education and skills for improvising and utilizing resources (POSQ, 9; and

People who live where there is no road connection and who do not receive government service live in poverty (POSQ, 71).

- The effects of poverty:

Increase in poverty [...poor getting poorer] leads to increase in environmental destruction (POSQ, 11).

These pre-service teachers identified lack of wealth, inability to buy things they need with money, low standard of living, unemployment, lack of services and infrastructures and land shortage and degradation as indications of poverty.

And they identified laziness, attitude problems, lack of education and skills and rapid population growth as causes of poverty leading to the poor getting poorer and an increase in environmental destruction.

Twenty-seven (27) of the pre-service teachers who disagreed that poverty was a problem explained their view as follows:

We are not poor because we do not rely on money but on natural resources from the environment (POSQ, 63);

We are rich in natural resources and we have our customary land to cultivate ... (POSQ, 49);

People [can] earn money [they need] from their resources and cash crops (POSQ, 3); and

We have all we need including food and shelter to sustain our family's living and we share with others as Christians (POSQ, 28).

These pre-service teachers considered that they were not poor because they had all they needed such as food, water and shelter and they did not rely on money to buy food, medicine, fuel and building materials but could get them from the environment and from subsistence farming. If they need money they get resources from the environment or cash crops, and then sell them to make money. In addition to that, their cultural traditions meant that people shared with each other the little they had. The finding that after the intervention more than half the participants were unsure, or disagreed with the statement that poverty is an issue in PNG could indicate that their perception of poverty was different from commonly-held perceptions about PNG. Their perception of poor people is people without food, shelter, land, relatives or friends. Since they had food, shelter, land, friends and relatives they did not regard themselves as poor.

6.2.4.3 Unequal distribution of resources

The data in Table 19 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Unequal distribution of resources is an issue in PNG".

Table 19 Unequal resource distribution an issue in PNG

Issue (Pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Unequal Resource Distribution (Pre)	31	26	23	10	10	2.47	1.31
	Total agree 57			Total Disagree 20			
Unequal Resource Distribution (Post)	41	31	12	12	4	2.07	1.16
	Total agree 72			Total Disagree 16			
Change	15 <i>Increase in agreement</i>		11 <i>Decrease in uncertainty</i>	4 <i>Decrease in disagreement</i>		0.47 <i>Change towards agreement</i>	0.15 <i>Less variance in data</i>

Prior to the intervention more than half (57%, n=81) of the pre-service teachers viewed unequal distribution of resources as a problem in PNG. The comments by the pre-service teachers to support their responses on unequal resource distribution in PNG included:

- Twenty-four percent (24%) of the pre-service teachers commented on it as a problem caused by the government's inability to provide service for everyone in the country, as these pre-service teachers stated:

This is an issue that is experienced in PNG [because]the services provided by the Government are only distributed between urban areas (PREQ, 14);

While [the] rural areas lack Government and business services (PREQ, 56); and

Most people living in the remote places in PNG do not receive Government services because the leaders are corrupted and carry out corrupt deals (PREQ, 65).

- Five percent (5%) of the pre-service teachers commented on the effects of unequal resource distribution. One of them stated:

Resources are not being distributed equally and so rich are getting richer while the poor are getting poorer (PREQ, 16).

- Another five percent (5%) of the pre-service teachers commented on possible solutions for unequal resource distribution. One of them stated:

Both problems [unequal resource distribution and poverty] can be reduced with education (PREQ, 16).

Most of these pre-service teachers thought unequal resource distribution was caused by the government and its representatives such as the members of parliament allocating resources, mainly to urban areas.

The intervention may have increased by 15% the proportion of pre-service teachers perceiving unequal resource distribution is an issue in PNG, as shown by the questionnaire data, and the variance amongst the participants' views that unequal resource distribution is an issue in PNG reduced after the intervention, as shown by the lower standard deviation in the findings. The explanations of pre-service teachers about their responses increased quantitatively and qualitatively. Some comments by the pre-service teachers to support their responses on unequal resource distribution in PNG were as follows:

- Thirty-eight percent (38%) of the pre-service teachers commented on it as a problem caused by the government's inability to provide services for everyone in the country; as these pre-service teachers stated:

It is a big problem most people in rural areas of PNG do not receive basic services from the Government. [It] seems like most benefits [are] for the urban people (POSQ, 32);

All resources are falling into the wrong hands, corrupted leaders who misappropriate them (POSQ, 17); and

Members of parliament usually distribute resources only to their supporters' areas (POSQ, 61).

- The other 28% of pre-service teachers noted that some individuals or groups wanted more resources, so the others did not have enough:

I strongly agree because nowadays people want to have more resources for themselves and so they do not share them equally with other clan members (POSQ, 48);

Some people only think of themselves so they sell resources like land leaving the rest of the people in the clan using small pieces of land over and over again leading to land degradation (POSQ, 8);

Most of these resources are being used by people without thinking about future generations to meet their own needs and wants (POSQ, 7);

Often people in the rural areas use resources as if they own everything without thinking about other clan members who are working and living away from their clan land. For example, when cutting down trees for building houses, they cut more trees than what they needed (POSQ, 4); and

Villagers never distribute resources equally. [They] are greedy and so men [working in] urban [areas] will never own pieces land like those who are in rural areas (POSQ, 50).

- Twenty-two percent (22%) of the pre-service teachers commented on the perceived effects of unequal resource distribution, as these pre-service teachers stated on their post questionnaire:

[This] is leading towards high rate of criminal activities and poverty in the country (POSQ, 1);

The clan land owners fight against each other because the royalty payment is too low for the population of the clan or tribe (POSQ, 63); and

Other people only use the same land over and over which results in land degradation and other problems such as hunger and sicknesses (POSQ, 8).

- Thirteen percent (13%) of the pre-service teachers commented on possible solutions for reducing unequal resource distribution. Comments included the following:

Education is one thing that can help solve [the problem] one day (POSQ, 29);

We need to encourage the good side of the wantok system so that we as people from PNG can share with each other (POSQ, 34); and

We need to encourage traditional and Christian ways of sharing with each other (POSQ, 10).

The pre-service teachers identified main causes of unequal resources distribution as government's inability to provide for all rural and urban people the service they need. They said that at the moment the resources are mainly allocated for the urban people and not the rural people. Other causes of unequal resource distribution they identified included the few greedy individuals who wanted the land and its resources without thinking of others in the clan. These people often sold some portion of the land or resources or use more than their share. Unequal resource distribution has resulted in urban people increasingly little better off than the rural majority, who lack many goods and services and therefore fight over land and payment for land and resources, and the rich get richer while the poor get poorer. These findings indicate that the efforts made in involving the pre-service teachers in discussions about the use and distribution of resources in PNG in lessons 6-8 and involving them in reading, answering written questions and discussing about land policy, land tenure, land uses and issues related to the land and its owners in lessons 18 and 19 may have led the pre-service teachers to become more aware of the associated problems. One of them wrote in their reflective journal:

I also learnt that biodiversity is depleted at a very fast rate because some people are greedy, and want more and more so they take more out of the environment, leaving very little for others and so few people are rich while many are poor (RJ2, 77).

Interestingly, 28% of the pre-service teachers were unsure, or disagreed, that unequal resource distribution is an issue in PNG after the intervention. This could indicate the need for further work on this in the course, or that these pre-service teachers had not experienced any examples of unequal resource distribution in PNG.

6.2.5 Summary

The analysis of the data on the pre-service teachers' perceptions about environmental issues seems to indicate some general patterns and a number of diverse views, as shown in Table 20 and noted in the next few paragraphs.

Table 20 Summary of findings on issues

Issue	Agreed an issue prior to intervention (%)	Agreed an issue post intervention (%)	Change in agreement (%)
Depletion of biodiversity	47	75	28
Endangered species	61	91	30
Deforestation	68	90	22
Land ownership and degradation	53	82	38
Population	68	92	24
Pollution	75	89	14
Mining	78	92	19
Global warming	71	90	19
Poverty	35	42	7
Unequal resources distribution	57	79	23

In general: (1) Prior to the intervention pre-service teachers perceived that biodiversity depletion, deforestation, endangered species, land dispute and degradation, pollution, global warming, mining, population, and unequal resource distribution were problems in PNG. In particular, mining, pollution, global warming and deforestation were seen as issues of concern whilst poverty, biodiversity depletion and land were not seen as issues of concern at that stage. These findings are not unexpected as these problems had already been identified by the baseline survey as prominent issues for PNG. At the same time, it is possible that some of those responses may have been based on misunderstanding of concepts and misinterpretation of the provided information which were perhaps corrected during the intervention. One possible indicator of potential uncertainty amongst the pre-service teachers

about their own conceptual understanding was that most of the respondents failed to explain their espoused views further in the pre-intervention questionnaire.

(2) Prior to the intervention the pre-service teachers identified mining and logging and other industries as the main environmental issues and some went on to connect these activities to all other biological and physical environment problems. However, their perceptions seemed to have changed after the intervention, when a number of participants instead identified deforestation by people's living activities as one of the main causes of biodiversity depletion, deforestation, endangerment of threatened species, land degradation, pollution and global warming, and that, for some, these in turn were seen as caused by rapid population growth.

(3) The intervention may have contributed to an increase in the number of pre-service teachers who perceived that biodiversity depletion, deforestation, threats to endangered species, land dispute and degradation, pollution, global warming, mining, population growth, and unequal resource distribution are issues in PNG, particularly biodiversity depletion, endangered species, land dispute and degradation, population growth and unequal resource distribution.

(4) The explanations that the pre-service teachers gave of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, with more explaining their views and identifying more different causes and effects of the environmental issues. In particular, there were large increases in the number of pre-service teachers who commented on endangered species, depletion of biodiversity, land dispute and degradation, and population growth.

(5) After the intervention, the pre-service teachers seemed more ready to acknowledge that people, including themselves, are causing environmental problems and so people need to take part in solving these problems. They also identified education as a solution which they can be involved in, to address

these environmental issues indirectly by providing education and awareness to their students and their families and communities. Thus, the intervention may have contributed to all these changes in their perceptions about environmental issues in PNG.

Interestingly, the pre-service teachers had varied views about poverty in PNG, which did not change much after the intervention. This may be possibly due to their view of poverty and the cultural social support system, known as the wantok system, that is practised in almost all societies in PNG. Under this system, no one in PNG is expected to be poor, because every person is part of a clan and all clans or tribes have pieces of land to which all the members have access, and are expected to use. In the wantok system, people in the family and clan are expected to share what they have or earn with other people in the family or clan, especially the poor and needy and so no one is supposed to be rated poor. In more traditional settings, people are expected to share what they get from fishing and hunting and from what they have from their subsistence farming. Apart from that, every person in PNG is allowed by informal law to trade, and so when people need money they get materials from the environment or their subsistence farm and sell them in order to pay school or other fees. However, today people cannot depend on guaranteed access to clan land because of land space shortage, tribal fights and land degradation, which are an increasing problem because rapid population growth means there are too many family and clan members trying to use the same few pieces of land. In modern settings such as the cities, or where money is involved, poor people can get the help they need from the wealthy members of the family or clan simply by helping them in some other ways, such as providing congenial escort, security and cleaning services for rich people. However, the wantok system is failing because some people have been abusing it. For example, some wealthy people are not happy supporting people who are poor because they view them as lazy and not deserving to be supported. Correct practice of wantok system may be a way forward to poverty reduction and equality of resource distribution.

The greatest change observed in the pre-service teachers' perceptions was in their thinking about biological environment issues, especially endangered species. This may have resulted from the kind of learning activities they were engaged in, which included an excursion to a wildlife habitat, the completion of a worksheet during the excursion and the completion of reflective journal after the excursion lesson on endangered species. This change in perception may have occurred because the lesson promoted:

- an authentic learning experience where the pre-service teachers read about and then saw the animals which were endangered;
- direct contact with the environment;
- experiential learning, an experience which can promote sustainable action in both the present and the future;
- constructivist and enquiry-based learning where the students studied the species and completed the worksheet by themselves using the questions on the worksheet as their guide; and
- critical, reflective learning where the student critically reflected on anything new they learnt during the lesson.

The least change observed in the participants' views was in their perceptions of mining in PNG. The percentage of pre-service teachers that had considered before the intervention that mining was an issue in PNG was very high, and so there was only a small increase in agreement with the statement after the intervention. The pre-service teachers' comments showed that they viewed mining as the main cause of other environmental issues in PNG and they maintained those views after the intervention. Those participants whose views did not change may have held perspectives on the social and economic benefits of mining that were important to them.

If the issues investigated through the intervention are thought to be important in environmental education for sustainability for school children, then the finding that there were participants who were unsure or who disagreed that these are concerns for PNG after the intervention indicates that further work

on these issues in the course would be useful, especially in the area of social environment issues. The next section presents pre-service teachers' perceptions of concepts of EEfS.

6.3 Findings on Key Concepts of Environmental Education for Sustainability

The data in this section were collected and analysed to find out about pre-service teachers' perceptions of key concepts of environmental education for sustainability prior to the intervention, and to find out if these perceptions had been modified after the intervention. The key concepts explored in this study were interdependence, sustainable development, and connectedness between people and their environment.

The pre-service teachers' perceptions were probed using semantic differential questions in the pre- and post-intervention questionnaires, and through analysis of their reflective journals and action plans. The semantic differential questions asked the student teachers to indicate their level of agreement to a pair of opposing statements on the concepts of environmental education for sustainability by circling a number between 1 and 5, where: 1 means Strongly Agree with the statement on the left; 2 means Agree with the statement on the left; 3 means the participant's views are evenly balanced between the two statements, or they are unsure; 4 means Agree with the statement on the right; and 5 means Strongly Agree with the statement on the right. Findings on interdependence are presented first.

6.3.1 Interdependence

People are an inseparable part of the environment. They are part of a system that links individuals, cultures and values, and the bio-physical world of nature with social and development activities. For example, as part of one system, social and economic developments affect other components of the system, which include the natural environment.

6.3.1.1 Social and economic development effects on the natural environment

The pre-service teachers' responses when they were asked to indicate whether they thought that social and economic development activities were affecting the natural environment in PNG are shown in Table 21 (see 1B Appendix Six). (Note: the Agree percentages incorporate both those who responded Agree and Strongly Agree, and similarly for the Disagree cohort).

Table 21 Social and Economic Development and Natural Environment

	<i>Agree that social and economic development activities are affecting the natural environment in PNG (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that social and economic development activities are not affecting the natural environment in PNG (%)</i>
Pre-Intervention n =81	57	15	28
Post-Intervention n =81	91	4	5
% Change	34 <i>Increase in agreement that natural environment is being affected</i>	11 <i>Decrease in uncertainty or neutral stance</i>	23 <i>Decrease in agreement that natural environment is not being affected</i>

Prior to the intervention, more than half (57%, n=81) of the pre-service teachers believed that social and economic development activities were affecting the natural environment in PNG. This finding is supported by the pre-service teachers' comments on deforestation and pollution in question three of the pre-intervention questionnaire; 31% of respondents identified social and economic development activities as one of the causes of deforestation and pollution, saying, for example:

I agree [deforestation is a problem] caused by of social and economic development activities such as mining and logging (PREQ, 20); and

It [mining] has impact on the environment but it provides job opportunities and development to our country (PREQ,68).

After the intervention, 91% of the pre-service teachers perceived that social and economic development activities were affecting the natural environment in PNG, whilst only 9% of them were unsure or disagreed that social and economic development activities were affecting the natural environment in PNG. The intervention may have contributed to an increase by 34% in the proportion of the pre-service teachers who agreed with the initial statement. This finding is supported by a number of the responses to question three of the post-intervention questionnaire:

Pollution is one of the problems experienced by PNG today because of social and economic development (POSQ, 6); and

Every industrial and economic activity that is taking place in the country contributes to pollution of land, water and air and [destroys] the living things in it (POSQ, 39).

Furthermore, 67% of respondents stated that social and economic development activities constituted one cause of deforestation, with one of them stating on their post-intervention questionnaire:

Deforestation is taking place in PNG because of the economic and social development (POSQ, 28).

These findings indicate that the efforts made in the intervention to guide the pre-service teachers to consider that social and economic development activities are interdependent and can have an impact on the natural environment, and about how land is used in relation to industries in PNG, may have led them to become more aware that social and economic development activities can affect the natural environment.

Findings on the interdependence of people's socio-cultural background and their behaviour towards the environment are presented next.

6.3.1.2 Social cultural background and behaviour towards the environment

Participants' responses when they were asked to indicate whether they thought that people's social and cultural background were affecting their

behaviour towards the environment in PNG are shown in Table 22 (see 2B Appendix Six).

Table 22 Social cultural background and behaviour towards environment

	<i>Agree that people's social and cultural backgrounds affect their behaviour towards the environment (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that people's social and cultural backgrounds do not affect their behaviour towards the environment (%)</i>
Pre-Intervention n =81	53	17	30
Post-Intervention n =81	75	10	15
% Change	22 <i>Increase in agreement with statement</i>	7 <i>Decrease in uncertainty or neutral stance</i>	15 <i>Decrease in agreement with statement</i>

Prior to the intervention, approximately half (53%, n=81) of the pre-service teachers considered that people's behaviour towards the environment is dependent on and is influenced by their social and cultural background. This finding may possibly reflect the fact that 90% of people in PNG live in close connection with their land and sea environment, and maintain traditional beliefs and values regarding hunting, fishing, and gathering, gardening and cooking practices. When they were asked about traditional environment and sustainability education, these pre-service teachers stated:

Traditional knowledge is part of our life, it is about how we are expected to live, make gardens and look after livestock such as pigs, dress for different occasions... (PREQ, 4);

our grandparents and parents teach us how to extract materials from the forest or environment for building house, medicine, food and clothing to satisfy our needs and wants ... and how to make wise decisions when taking the resources... (PREQ, 26); and

It is usually taught as part of village activities such as initiations, wedding ceremonies, planting and harvesting ceremonies... (PREQ, 58).

Increasingly, however, people in PNG are becoming less connected with these environments and more reliant on urban services.

After the intervention, 75% of the pre-service teachers considered that people's social and cultural backgrounds affected their behaviour towards the environment; this was an increase of 22%. The findings indicate that efforts made in the intervention to discuss beliefs and values related to different social and cultural activities may have contributed to this change. This finding is supported by some pre-service teachers' comments on the post-intervention questionnaire when they were asked about traditional environment and sustainability knowledge:

The special knowledge and values about environment and sustainability are passed from the elders and parents within the clans such as keeping and looking after land, forests and special plants... (POSQ, 38); and

Skills such as for...hunting are demonstrated to the children...by their parents and grandparents and the children learn by practising them. The parents usually give offering to God and the spirits when the children begin their practice...(POSQ, 58).

In these statements the participants are saying that the actions people take and how they behave towards the environment are affected by the cultural background which includes the influence of the Christian God and ancestral and elementary spirits. These findings indicate that efforts made to ask the pre-service teachers to identify and discuss their traditional and local knowledge and beliefs about forests, land use, hunting, gathering, fishing, gardening and cooking in lesson 15 in the intervention may have led them to become more aware that people's behaviour towards the environment is influenced by their

socio-cultural background, which includes belief in the spirits of ancestors, elementary spirits and God's Spirit influencing and controlling them.

Interestingly, after the intervention quarter (25%) of the pre-service teachers were uncertain or neutral, or considered that people's social and cultural backgrounds did not affect their behaviour towards the environment. This could indicate that either further emphasis on this in a revised course would be useful, or perhaps that some pre-service teachers are city dwellers and have little knowledge of and connection to their cultural values and beliefs about the environment.

People who live in the rural parts of PNG are also affecting the natural environment, and this is discussed next.

6.3.1.3 Rural lifestyle and environment

The information in table 23 show responses of pre-service teachers' when asked whether they thought that people living in rural areas in PNG cause environmental problems (see 1D Appendix Six).

Table 23 Rural lifestyle and environment

	<i>Agree that people living in rural areas in PNG do not cause environmental problems (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that people living in rural areas in PNG cause environmental problems (%)</i>
Pre-Intervention n =81	23	43	34
Post-Intervention n =81	3	40	57
% Change	20 <i>Decrease in agreement with statement</i>	3 <i>Decrease in neutral stance or uncertainty</i>	23 <i>Increase in agreement with statement</i>

Prior to the intervention, there were diverse views about whether people living in the rural areas caused environmental problems. Thirty-four percent (34%, n=81) of the pre-service teachers considered that people living in rural areas in PNG were causing environmental problems while 43% were unsure and 23% did not think people living in the rural area were causing environmental problems. Their stance was indicated when they commented that environmental issues such as pollution, deforestation and threats to endangered species were caused by economic development activities such as mining, logging and factories; these pre-service teachers wrote in response to question three on the pre-intervention questionnaire:

Mining and logging along with other industrial activities cause land, water and air pollution (PREQ, 26);

Deforestation is mostly caused by logging and mining companies (PREQ, 50); and

Species are endangered and even extinct because of logging and mining business (PREQ, 48).

At that stage ordinary people and their survival activities were not seen as contributing factors to environmental destruction.

After the intervention, 57% of the pre-service teachers perceived that people living in rural areas of PNG were causing environmental problems, which is an increase by 23% in the proportion of the pre-service teachers who believed that, and a 20% decrease in the proportion of pre-service teachers who thought that people living in rural areas of PNG did not cause environmental problems. This finding is supported by pre-service teacher comments made on the post questionnaire, when 17% of the pre-service teachers said that people in the rural areas live off the environment and need to be educated about sustainability. One of them said:

In our rural areas, people get their basic needs such as food, water, and shelter mainly from the environment ... We as student teachers are ... responsible for educating our brothers, sisters and parents, who often cause destruction to the environment ... (POSQ, 63).

The pre-service teachers realised that ordinary people like themselves and their clan and family members are causing environment problems while trying to meet their basic needs, and that as teachers and educated people they were responsible for educating their family and clan members. Furthermore, this finding is supported by action plans the pre-service teachers made: 27% of them planned to create awareness about endangered species, burning the forest and agricultural practices among their people and students in primary schools. This seems appropriate because the majority of the people are rural people who live by subsistence farming, and the students believed this practice may be impacting too severely on the environment. These findings indicate that the efforts made in lessons 15, 16 and 17 in the intervention to emphasise that the majority of PNG people live in rural areas, and are continuously cultivating the land and using resources from the environment, may have enabled the pre-service teachers to become aware of the fact that apart from

subsistence farming, many other resources from the forest are being taken out as food, for building temporary houses, for decoration and as fuel for cooking.

After the intervention implementation almost half (40%) of the pre-service teachers remained either unsure of or had a neutral stance to the proposition that people living in rural areas in PNG cause environmental problems. This may reflect the significant number of people who rely on the natural environment for their subsistence, or the increasing urbanisation of the people isolating them from knowledge of a rural lifestyle. Further work on the relationship between rural people and the environment in the course may be useful. Findings on pre-service teachers' perceptions of sustainable development are presented next.

6.3.2 Sustainable development

6.3.2.1 Economic Growth and Environmental Protection

Pre-service teachers' responses when they were asked whether they thought that economic growth should be given priority over environmental protection in PNG are shown in Table 24 (see 1F Appendix Six).

Table 24 Economic growth and environment

	<i>Agree that economic growth should be given priority over environmental protection (%)</i>	<i>Agree that both economic growth and environmental protection should be given equal priority or uncertain where priority should be placed (%)</i>	<i>Agree that environmental protection should be given priority over economic growth (%)</i>
Pre-Intervention n =81	17	34	49
Post-Intervention n =81	19	37	44
% Change	2 <i>Increase in agreement with the statement</i>	3 <i>Increase in uncertainty or neutral stance</i>	5 <i>Decrease in agreement with statement</i>

Prior to the intervention, almost half (49%) of the pre-service teachers agreed that environmental protection should be given priority over economic growth, whilst 34% of them thought that the environment and economic growth should be given equal priority, or were uncertain. This latter group often seemed to view both environment and economic growth as equally important, as is further shown by their responses to question three of the pre-intervention questionnaire. Some explained that although mining provides wealth for the country, it has a destructive impact on environment. For example:

Mining can improve our country’s economic standard but its effect has much more destruction on the environment (PREQ, 63); and

It has impact on the environment but it provides job opportunities and development to our country (PREQ, 68).

The intervention may have contributed to a decrease by 5% in the proportion of those who considered that environmental protection should be given priority over economic growth, and an increase of 4% in the proportion of the pre-service teachers perceiving economic growth and environmental protection as equally important and requiring equal priority. Although there had not been much change in their perceptions, it may be noted that in their

responses to question three of the post-intervention questionnaire, a number of students (9%, n=81) again stressed that although mining improves the economy of the country, it also has a destructive impact on the environment, as this respondent stated:

It has impact on the environment, however it provides job opportunities and development to our country (POSQ, 2).

There was also evidence of understanding of the need for a more sustainable approach to mining in PNG:

The benefit of mining is very vital but the consequences are very bad so we need to teach the students to take sustainable action [towards] disposal of waste (POSQ, 1).

The aim of the intervention was to help the pre-service teachers develop knowledge and attitudes that would lead them to take sustainable action towards economic growth; however, there was only a slight change in the responses indicating that environment protection and economy growth were equally important, whilst a large number of the participants (44%) still considered that environmental protection should be given priority over economic growth. The participants' responses in this case may have been influenced by regular reports in the daily newspapers of complaints about the pollution and environmental destruction caused by mining and logging activities in different parts of Papua New Guinea. These reports always sound as if land owners are not benefiting in any way and that their normal, local ways of living have been destroyed, leaving them with badly polluted water and land. The study's findings show that this is a complex issue for PNG and more exploration of attitudes and values around the balance of economic growth and environmental protection might be useful in a revised course.

All economic development occurs in the environment and so necessarily affects the quality of life in the environment.

6.3.2.2 Development and quality of life in the environment

Participants' responses when they were asked whether they thought that developments in transport and communication have diminished or improved the quality of life in PNG are shown in Table 25 (see 1A Appendix Six).

Table 25 Development and Quality of Life

	<i>Agree that development in communication and transport have worsened the quality of life in PNG (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that development in communication and transport have improved the quality of life in PNG (%)</i>
Pre-intervention n =81	0	27	73
Post-Intervention n =81	7	35	58
% Change	7 <i>Increase in agreement with the statement</i>	8 <i>Agreement with both statements or neutral stance</i>	15 <i>Decrease in agreement with the statement</i>

Firstly, prior to the intervention, about three-quarters (73%) of the pre-service teachers believed that developments in transport and communication have improved the quality of people's lives in PNG. This finding is supported by the extra comments written by one of the pre-service teachers on the pre-implementation questionnaire:

Transportation helps to bring mothers from the rural areas to ... market in town to sell farm produce and earn mone ... [C]ommunication and life are made easier with the introduction of cell phones into PNG (PREQ, 65).

Secondly, the intervention may have contributed to a 15% decrease in the proportion of participants who believed that developments in transport and communication have improved the quality of people's lives and a shift to either uncertainty or belief that such developments have worsened the quality of life in PNG, as shown by the questionnaire data after the intervention. This apparent shift was supported by comments about causes of air pollution in

question three of the post- intervention questionnaire, where a number of students highlighted waste gas from vehicles (5%) and burning of tyres (8%) as two out of many causes of air pollution:

Burning of waste tyres ... are polluting the air. In addition to that, vehicles... are releasing waste gases (POSQ, 20).

These pre-service teachers had identified air pollution from burning of fuel by vehicles and burning of waste tyres, which may have led them to change their minds about developments in transport and communication. In addition, the respondents had lengthy discussion during the intervention about the advantages and disadvantages of having mobile phones with advanced features readily available. On the other hand, it was argued that people can organise criminal activities such as holding up rich people and vehicles carrying goods. These findings indicate that the participants' exposure to the ideas discussed during the intervention may have led them to modify their thinking on these points.

Thirdly, after the intervention 42% of the pre-service teachers considered that developments in transport and communication had either not improved the quality of life in or worsened it. This perhaps indicates that further exploration of this in the revised course would be useful, or that for some of the participants developments in transport and communication and their possible effects on natural and social environment are simply not of significant interest. Use of advanced technologies may also affect the environment and student views on this are presented next.

6.3.2.3 Use of advanced technology and the environment

Pre-service teachers' responses when asked whether they thought that use of advanced technology in PNG cities is solving or causing environmental problems are shown in Table 26 (see 1C Appendix Six).

Table 26 Advanced Technology and Environment

	<i>Agree that the use of advanced technology is causing environmental problems (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that the use of advanced technology is solving environmental problems (%)</i>
Pre-Intervention n =81	41	28	31
Post-Intervention n=81	72	25	3
% Change	31 <i>Increase in agreement with statement</i>	3 <i>Decrease in agreement with both statement or uncertainty</i>	28 <i>Decrease in agreement with statement</i>

Prior to the intervention there was great variation in the pre-service teachers' views about the use of advanced technology and its impact on the environment. There was only a small difference between the number of those who thought that the use of advanced technology was causing environmental problems and those who considered it was solving them. One aim of the intervention was to help the pre-service teachers to understand the advantages and disadvantages of using advanced technology, so this was extensively discussed in lesson 16 of the intervention.

After the intervention, 72% of the respondents considered that the use of advanced technology was causing environmental problems; this was an increase of 31%.

This data is supported by pre-service teacher comments on pollution in question three of the post intervention questionnaire; they stated use of advanced technology was one of the causes of pollution (6%) and endangered species (5%), as these pre-service teachers stated, "... pollution is caused by ...cars, burning of tyres ... and the use of advance technology ..." (POSQ, 70) and "People carelessly wipe out these animals by killing them using advance modern weapons... (POSQ, 12).

These findings indicate that the efforts made in the intervention may have led the pre-service teachers to become more aware that use of advanced technology can contribute to environmental problems. Lesson 16 stressed that the use of more sophisticated machines increases production and improves living standards but also affects natural and social environments, through the emission of greenhouse gases into the atmosphere, and because more animals can be killed when modern weapons are used for hunting and fishing.

Interestingly, after the intervention 28% of the participants were unsure about or definitely considered that use of advanced technology in cities was solving environmental problems. This could mean further exploration of the topic in the course would be useful to further understand the diverse views that students hold. The next section presents the findings on rural lifestyle and its effects on the environment.

6.3.4. Connectedness

6.3.4.1 People and Natural Environment

Table 27 shows the pre-service teachers' responses when they were asked to indicate whether they thought that people must learn to manage the environment to improve the quality of lives or learn to be connected to their environment and to live with it in harmony (see 1E Appendix Six).

Table 27 People and Natural Environment

	<i>Agree that people in PNG must learn to manage and use the environment to improve the quality of lives (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that people in PNG must learn to be connected to their environment, to live with it in harmony (%)</i>
Pre-Intervention n =81	24	54	22
Post-Intervention n =81	11	80	9
Change	13 <i>Decrease in agreeing with statement on left</i>	36 <i>Increase in agreeing with both statements or uncertainty</i>	13 <i>Decrease in agreeing with statement on right</i>

Firstly, prior to the intervention 54% of the pre-service teachers circled 3 from the scale, indicating that they agreed with both statements and thought that people in PNG must learn to be connected to their environment, to live with it in harmony and also learn how to manage and use the environment to improve quality of life. However, that response may also mean they agree with neither of the statements or are uncertain of how to answer.

Secondly, the intervention may have contributed to a 36% increase in the proportion of participants who thought that people in PNG must learn to be connected to their environment, to live with it in harmony and also that they need to learn to manage the environment sustainably to improve quality of life, or who agreed with neither of the statements or are uncertain, as shown by the questionnaire data after the intervention. This finding is supported by a number of post-intervention comments:

Most of the things Papua New Guineians use are found in their environment, so they need to collect and use them sustainably. For example, traditionally my people use a dry tree to build a house instead of cutting down a living tree (POSQ, 9); and

[The] environment is very important to us, we need to know how to use its resources sustainably and leave some for the future generation. For

instance, people should not [be] hunting every day... because it will lead to species extinction (POSQ, 15).

These pre-service teachers understood that people must be connected to their environment so that they can take and use resources from the environment with care and concern. Their understanding on the matter may have caused them to make plans to teach primary school children to feel connected to their environment; as one of them stated in their reflective journal:

I will teach my students about animals [and plants]... [and] take the children for excursions to the forest or a place like Rainforest Habitat...[to] help them ... to feel connected to their environment, [and to] appreciate and care for their environment (RJ1, 41).

It seems that some of the pre-service teachers may have understood the need for taking sustainable action when using resources from the environment. These findings indicate that the efforts made in the intervention to guide the participants to identify and share with each other about the use of resources from the environment may have led them to become more aware of the importance of being connected to the environment and living within it in harmony.

Thirdly, the finding that after the intervention, 11% of the pre-service teachers thought that people in PNG must learn to manage and use the environment to improve the quality of their lives only, whilst 9% of them thought that people in PNG must learn to be connected to their environment, to live with it in harmony only after the intervention could indicate that further work on this in the course would be useful, as this conception is evidently a complex one.

6.3.4 Summary of pre-service teachers' perceptions of key concepts of EEfS

Firstly, prior to the intervention a number of the respondents considered social and economic development activities were affecting the natural environment, and that people's social and cultural backgrounds affected their attitude to the environment. The proportion who thought this clearly increased after the intervention.

Secondly, prior to the intervention, there was a diverse range of beliefs in response to the statements "The use of advanced technology in cities is causing environmental problems" and "People living in rural areas in PNG are causing environmental problems". However, after the intervention there was a clear increase in the number of responses which agreed with these statements.

Thirdly, prior to the intervention, a majority of the participants said that development in transport and communication had improved the quality of life in PNG. After the intervention, the proportion of pre-service teachers who supported these statements decreased slightly; however, the majority maintained their view.

Lastly, prior to the intervention the pre-service teachers were largely uncertain whether they should learn to live in harmony with their environment or that people in PNG should learn how to manage the environment so as to improve quality of life. After the intervention, the number of pre-service teachers who appeared to be uncertain increased, indicating the complexity of this viewpoint.

These findings indicate changes which may have been caused by the intervention and unexpected results which may have been caused by background of the pre-service teachers. Thus, further work on these in the course would be useful to understand what EEfS means for PNG, especially in the area of sustainable economic development.

6.4 Summary of findings on pre-service teachers' perception of environmental issues and key concepts

The intervention may have changed the participants' perceptions of environment and sustainability issues and increased the proportion of pre-service teachers who perceived biodiversity depletion, deforestation, and threats to endangered species, pollution, population growth, and land ownership dispute and degradation as major challenges in PNG.

The greatest change observed in their perceptions of environmental issues in PNG was in their thinking about biological environment issues, specifically with regard to endangered species. This may have been because the pre-service teachers were exposed to a number of such species during an excursion to Rainforest Habitat Sanctuary. There they were enabled to learn a lot about endangered species through the use of a worksheet which they completed in the field, and then after the lesson they critically reflected on new things they had learnt. It can be inferred that for learners to clearly understand environmental issues, feel concern about them and take action to address them, they must be exposed to the issues firsthand and allowed to learn about them through experience, inquiry and critical reflection in order to make necessary connections.

The pre-service teachers' knowledge about key concepts of sustainability was increased after the intervention. The greatest changes observed were in the participants' perception that social and economic development activities are causing environmental problems, followed by the view that people living in rural areas in PNG are causing environmental problems and that people's social and cultural backgrounds affect their attitude to the environment. This may have resulted from the pre-service teachers having studied and discussed and then completed a task related to the concept in a number of lessons, including those on biodiversity, land ownership, land tenure and use, deforestation and

traditional life style. They were encouraged to discuss uses of resources in activities and relate them to the beliefs and values their people held about different objects and activities.

It can be said that for knowledge, values and attitude to be more effectively developed the learners need to be allowed to learn about one concept through several subjects and lessons through the use of pedagogy which not only encourages learners to become more knowledgeable and interested in the topic (in this case, the environment), but which can also enable them to become actively involved in the resolution and prevention of problems (in this case, complex environmental challenges) both individually and as part of a group.

Chapter Seven

7. Findings on Pedagogy

7.1 Introduction

This chapter presents some findings of an evaluation of the implementation of a course specifically designed to address environmental education for sustainability (EEfS) with pre-service teachers in PNG. The data were collected from 81 pre-service teachers who were in their third trimester of a six trimester Diploma in Teaching programme at a teachers' college. The findings are presented in two sections, which focus on participants' perceptions in delivering EEfS of: (1) currently advocated pedagogies; (2) the pedagogy for environment and sustainability education. These perceptions were explored through the use of a questionnaire administered to the pre-service teachers before and after the intervention on EEfS, reflection journals kept by the participants during the course and an action plan produced as part of the coursework.

Section 7.2 on pedagogy presents data on the pre-service teachers' perceptions of currently advocated pedagogies, which were collected and analysed to explore the participants' perceptions of whether student-centred learning approaches such as constructivist, experiential, enquiry-based and cooperative learning, as well as socio-cultural views of learning and traditional PNG teaching and learning methods should be used for effective teaching and learning in EEfS. Section 7.3 on the characteristics of environment and sustainability education presents participants' perceptions of: the importance and benefits of making EEfS relevant to learners' needs, culture and the national curriculum; treating EEfS as a multidisciplinary subject which is studied holistically; utilising students' experiences and values; critically reflecting on all actions and learning; and the quality of future life being dependent on the

quality of current EEFS. The data in this chapter are analysed and reported as described in Section 6.1.

7.2 Findings on participants’ perceptions about pedagogy

The data in this section was collected and analysed to find out about pre-service teachers’ perceptions about pedagogies, and to find out if their perceptions of these pedagogies had changed after the intervention. The pedagogies explored in this study were constructivist learning, experiential learning, enquiry-based learning, cooperative learning, socio-cultural learning, and traditional PNG teaching and learning methods. Findings on the perception of the pre-service teachers about these pedagogies are presented next.

7.2.1 Constructivist Learning

The data in table 28 show pre-service teachers’ responses when they were asked to show their level of agreement to the statement “Learners need to forget what they already know to learn new things” (see 4A Appendix Six).

Table 28 Prior knowledge and learning

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Learners need to forget what they already know to learn new things (Pre)	10	10	10	21	49	3.9	1.37
	20			70			
Learners need to forget what they already know to learn new things (Post)	2	5	3	23	67	4.47	0.94
	7			90			
Change	13 <i>Decrease in agreement</i>		7 <i>Decrease in uncertainty</i>	20 <i>increase in disagreement</i>		0.57 <i>Increase towards disagreement</i>	0.43 <i>Less variance in data</i>

Firstly, there was evidence that most pre-service teachers believed before the intervention that prior knowledge and experience were needed for development of new knowledge. This was indicated when 70 % (n=81) of the pre-service teachers disagreed with the statement that “Learners need to forget what they already know to learn new things”, prior to the intervention.

When explaining their views, the pre-service teachers wrote comments such as:

I strongly disagree because learners need prior knowledge because it becomes foundation for their learning... (PREQ, 79); and

People have to use the knowledge they already have in order to learn new things (PREQ, 10).

The pre-service teachers had in theory been exposed to constructivist learning as part of the reform which is currently being introduced in the PNG teacher education system.

Secondly, the intervention may have contributed to an increase by 20% in the proportion of pre-service teachers who disagreed with the statement that “Learners need to forget what they already know to learn new things”, as shown by the questionnaire data after the intervention. When explaining their view, the respondents wrote comments such as:

I strongly agree because some learners [need to] remember and use what they learnt and known from the past [which will] facilitate the new knowledge, skills and values (POSQ, 48).

In addition, the variance amongst the participants’ views on the statement had reduced after the intervention, as shown by the lower standard deviation in the findings. Furthermore, when reflecting on the learning activities used in the intervention, 38% of the pre-service teachers said they would use the KWL chart when they teach because it will help them utilise students’ prior knowledge to develop new knowledge. One of them stated:

I will apply this method [KWL] when I teach because it will help the children to use their prior knowledge and experience to learn new things [knowledge] (RJ3, 52).

These findings indicate that the efforts made in lesson 3 in the intervention where the pre-service teachers read and shared with each other about the characteristics and benefits of constructivist learning may have made them more aware of the use of prior knowledge in developing new knowledge, as these pre-service teachers reported:

The new thing I learnt during the lesson is the use of the KWL chart [the learning activity which] utilises knowledge and uses enquiry-based learning strategies” (RJ3, 55);

Yes, this course influenced me to teach about environment and sustainability. I will teach it and [I will] use the KWL chart to teach because it allows the learners to use their prior knowledge (RJ3, 8); and

I learnt that telling imaginary stories is a good way of utilising students’ prior knowledge and experience and then add onto the current (RJ2, 54).

Almost all the pre-service teachers (90%, n=81) disagreed with the statement “Learners need to forget what they already know to learn new things” after the intervention. The remaining 10% of participants who disagreed or were unsure may still be uncertain of the value of constructivist learning so early in their teaching career.

7.2.2 Socio-cultural Learning

The data in table 29 show participants’ responses when they were asked to show their level of agreement to the statement “Learning is dependent on or affected by the learner’s social and cultural background” (see 4B Appendix Six).

Table 29 Effects of social and cultural background on learning

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Learning is dependent on or affected by the learner's social and cultural background (Pre)	26	32	32	5	5	2.31	1.06
	58			10			
Learning is dependent on or affected by the learner's social and cultural background (Post)	31	40	17	4	2	1.95	0.95
	71			6			
Change	13 <i>Increase in agreement</i>		15 <i>Decrease in uncertainty</i>	4 <i>Decrease in disagreement</i>		0.36 <i>Change towards agreement</i>	0.11 <i>Less variance in data</i>

The data presented above indicate the following:

Firstly, prior to the intervention more than half (58%, n=81) of the pre-service teachers perceived that student learning can be affected by the learner's social and cultural background. When explaining their views, the respondents wrote comments such as:

I agree, because the learner's social and cultural background will help [the learner] to relate [what he/she already knows] to new knowledge [that is] being learnt (PREQ, 41); and

I strongly agree, learners learn better when the lesson is suitable [for] the social and cultural context of Papua New Guinea (PREQ, 67).

These pre-service teachers indicated an understanding that social and cultural background of the learners could affect their learning.

Secondly, the intervention appears to have increased by 13% the pre-service teachers who considered that learning is dependent on or affected by the learner's social and cultural background, as shown by the questionnaire data

after the intervention. When making comments to support their responses, those in agreement with the statement made comments such as these:

Yes, I strongly agree because everyone has a culture which can either hinder or facilitate learning (POSQ, 64); and

I strongly agree because where a student lives and comes to school, the type of family, the type of village or community, their customs or traditions, their way of living, talking etc. will greatly affect that student's learning (POSQ, 72).

In addition, the variance amongst the participants' views on the statement was reduced after the intervention, as shown by the lower standard deviation in the findings. These findings indicate that the efforts made in lesson 3, when the pre-service teachers read and shared with each other about the characteristics and benefits of sociocultural learning, may have led them to become more aware of the importance for effective learning of recognising the learner's social and cultural background and, for example, utilising the learner's values and beliefs, as one of them wrote in their reflective journal:

I will apply the same method [as the] KWL chart in my future [teaching and that] will activate students' values, beliefs and prior knowledge of the topic to be studied... It influenced me when I was discussing the causes and effects of environment and sustainability issues ... with other students and the lecturer (RJ1, 74).

Thirdly, the finding that after the intervention about a quarter (23%) of participants were unsure, or considered that learning is not dependent on or affected by the learner's social and cultural background could indicate that either further work on this in the revised course would be useful, or that for some pre-service teachers utilising socio-cultural knowledge in learning is not something they value.

7.2.3 Experiential Learning

The data in table 30 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Students can use their current and past experiences to develop new knowledge" (see 4C Appendix Six).

Table 30 Knowledge development, and past knowledge and experiences

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Students can use their current and past experiences to develop new knowledge (Pre)	63	17	16	0	4	1.64	1.0
	80			4			
Students can use their current and past experiences to develop new knowledge (Post)	67	23	4	4	2	1.52	0.92
	90			6			
Change	10 <i>Increase in agreement</i>		12 <i>Decrease in uncertainty</i>	2 <i>increase in disagreement</i>		0.12 <i>Change towards agreement</i>	0.08 <i>Less variance in data</i>

The data presented above indicate the following:

Firstly, prior to the intervention more than three-quarters (80%, n=81) of the pre-service teachers considered that people's experiences were important for developing new knowledge. A large number seemed to have held this view prior to the intervention this could be due to the current practices and emphasis on student centred learning which is consistent with learning approach used in PNG's local traditional education system. When explaining their viewpoint, the respondents wrote comments such as:

Having experience and fair idea about the concepts makes learning easier, interesting and enjoyable (PREQ, 35); and

Students understand better when the ideas they are learning are connected to their experience so it is necessary to build on and develop ideas from past [knowledge and] experiences (PREQ, 67).

These pre-service teachers appear to understand that prior experiences of the learners can affect their learning. They are exposed to experiential learning as part of the reform which is currently being introduced in the PNG education system.

Secondly, the intervention appears to have increased by 10% the number of pre-service teachers perceiving that students can use their current and past experiences to develop new knowledge, as shown by the questionnaire data after the intervention. They gave some of the following reasons:

I strongly agree because new knowledge is developed as we compare and contrast with past and current knowledge and experiences (POSQ, 49);

Experience in real life is better than [learning] from the text books ... (POSQ, 40); and

Students can use their... experiences to develop new knowledge by recalling and modifying old experience and knowledge (POSQ, 15).

These findings indicate that the effort made in lesson 3 when the pre-service teachers read and shared with each other about the characteristics and benefits of experiential learning and lesson 5 when they had their own experiences may have enabled them to become more aware of the use of experience in developing new knowledge, as these pre-service teachers stated in their reflective journals:

I learnt [that] excursion makes the learners experience their environment as well as feel connected to their environment... (RJ1, 17); and

Taking students for [an] excursion [and] teaching them ... helps them to see, feel and know as we did [during] our excursion ... (RJ1, 72).

Thirdly, the finding after the intervention that 6% of the pre-service teachers disagreed that students can use their current and past experiences to develop new knowledge indicates that a small number of participants either remained unconvinced of the value of experience in learning or that they were unclear about the question being asked.

7.2.4 Enquiry-based Learning

The data in table 31 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Learners develop knowledge by questioning and answering questions" (see 4D Appendix Six).

Table 31 Questioning and answering in knowledge development

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Learners develop knowledge by questioning and answering questions (Pre)	65	19	12	3	1	1.56	0.89
	84			4			
Learners develop knowledge by questioning and answering questions (Post)	74	22		1	0		
	96		3	1		1.31	0.58
Change	12 <i>Increase in agreement</i>		9 <i>Decrease in uncertainty</i>	3 <i>Decrease in disagreement</i>		0.25 <i>Change towards agreement</i>	0.31 <i>Less variance in data</i>

Firstly, prior to the intervention more than three-quarters (84%, n=81) of the pre-service teachers believed that learning is effective when it is based around students' questions and answers. A high number of respondents perceived

enquiry-based learning as appropriate for developing knowledge prior to the intervention because it is one of the most common approaches currently used in PNG. The method was discussed in lesson 3, when the characteristics of enquiry-based learning were described, along with other approaches. Apart from that, the different levels of enquiry-based learning were modelled through the intervention.

Secondly, the intervention appears to have increased by 12% the proportion of pre-service teachers who believed that learners develop knowledge by questioning and answering questions, as shown by the questionnaire data after the intervention. In addition, the variance amongst the participants' views had reduced after the course, as shown by the lower standard deviation in the findings. Furthermore, when reflecting on the lessons related to learning activities the pre-service teachers said they had learnt a lot through learning activities including Follow Me, the KWL chart (47% of participants mentioned this in their reflection journals) and the excursion, and would use them in teaching their students, as these pre-service teachers stated:

I learnt how to organise the lesson with [the Follow Me game] and have the students play it so that they can learn by asking and answering questions. I will use the game to teach environment and sustainability... (RJ3, 68);

The use of the KWL chart is new to me. It is good for learning in environment and sustainability because it ...allows learners to choose what they want to learn by asking and answering questions (JR3, 19); and

The new thing I learnt is to have a set of questions for the students to answer while they are on the excursion. Having questions for them to answer will promote some serious learning to occur (RJ1, 27).

These findings indicate that the efforts made in lesson 3 when the pre-service teachers read and shared with each other about the characteristics and benefits of enquiry-based learning may have made them more aware of the importance of learners questioning and answering questions in learning. One of them stated in their reflection journal:

I will prepare questions like my lecturer prepared, and use [them] to teach my students. The game is good and will keep the whole class busy because I will prepare a question and an answer for all students so each one can answer someone's question and ask someone else a question. This will keep them all busy, alert to respond, at the same time learn (RJ3, 71).

7.2.5 Cooperative Learning

The data in table 32 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Learners learn better when they work and learn in small groups"(see 4F Appendix Six).

Table 32 Learning in small groups

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Learners learn better when they work and learn in small groups (Pre)	43	35	12	2	5	1.88	1.05
	78			7			
Learners learn better when they work and learn in small groups. (Post)	60	33	2	4	1	1.49	0.72
	93			5			
Change	15 <i>Increase in agreement</i>		10 <i>Decrease in uncertainty</i>	2 <i>Decrease in disagreement</i>		0.39 <i>Change towards agreement</i>	0.33 <i>Less variance in data</i>

The data presented above indicate the following:

First, prior to the intervention about three-quarters (78%, n=81) of the participants believed that learners work and learn better in small groups. A large number of them seemed to know about group work because it is one of the common methods of student-centred learning used in PNG. When explaining their views, the pre-service teachers said:

Learners contribute and learn more in small groups than in the whole class (PREQ, 67);

In small groups students learn to share ideas and feel free to talk to each other (PREQ, 27); and

Because there are different types of learners in class, some learners learn best in small groups ... (PREQ, 75).

These pre-service teachers appeared to understand the importance of group work in teaching and learning. They had been exposed to cooperative learning as part of PNG's ongoing education reform.

Secondly, the intervention appears to have increased by 15% the proportion of pre-service teachers who considered that learners learn better when they work and learn in small groups, as shown by the questionnaire data after the intervention. When making comments to support their responses, those in agreement with the statement made comments such as:

[I strongly agree because] by working in groups students share ideas, talk freely to each other, listen to each other's views and learn from each other (POSQ, 58); and

[I strongly agree because] working in groups makes students express opinions and learn better through peer discussions (POSQ, 71).

In addition, the variance amongst the participants' views on this statement reduced after the intervention, as shown by the lower standard deviation in the findings. These findings indicate that the efforts made in lesson 3, when the respondents had read about and discussed the characteristics and benefits of cooperative learning, may have raised their awareness of the benefits of learning in small groups. One stated:

I learnt a lot because we worked in a group that had people from many different cultural backgrounds and they use different things for different purposes. Yes, working in groups is good and it can help learners learn from each other as well as from the main points stressed by the lecturer (RJ2, 77).

7.2.5 Student-centred learning

The data in table 33 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Learners learn best when given information by the teacher" (see 4E Appendix Six).

Table 33 Teacher centred learning

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Learners learn best when given information by the teacher (Pre)	22	33	12	26	7	2.62	1.28
	55			33			
Learners learn best when given information by the teacher (Post)	20	25	9	36	10	2.91	1.33
	45			46			
Change	10		3	13		0.29	0.05
	<i>Decrease in agreement</i>		<i>Decrease in uncertainty</i>	<i>Increase in disagreement</i>		<i>Change towards not sure</i>	<i>more variance in data</i>

The data presented above indicate the following:

Firstly, prior to the intervention more than half (55%, n=81) of the pre-service teachers perceived that “Learners learn best when given information by the teacher”. When explaining their views, pre-service teachers wrote comments such as:

Most of the time children learn from the teachers and only few times children learn by themselves (PREQ, 67); and

I think that is true because people learn better from superiors (PREQ, 47).

Secondly, after the intervention a change was observed: the proportion of pre-service teachers who thought that “Learners learn best when given information by the teacher” decreased by 5%, while the proportion of pre-service teachers who disagreed changed by 15%. When explaining their view, the pre-service teachers wrote comments such as:

I agree [because the] learners learn [better] when given information by the teachers because the teachers teach about the facts and experiences they had (POSQ, 68);

[Also] children learn best when they follow teacher’s instruction (POSQ, 28); and

Explanation of the teachers [can help the] students work out and learn better (POSQ, 12).

These pre-service teachers appeared to understand the job of the teacher as a facilitator who will provide information, instruction and explanation where and whenever necessary. These findings indicate that the efforts made in the intervention by modelling different approaches may have led the pre-service teachers to become slightly more aware of the benefits of a student-centred learning approach and the importance of having the teacher alongside the

students learning. However, the finding that the mean was about 3 before and after the intervention and 9% of participants were unsure about the statement that “Learners learn best when given information by the teacher”, after the intervention could indicate that further work on this may be necessary to clarify the pre-service teachers’ thinking about student-centred learning.

7.2.6 Traditional teaching and learning method

The data in table 34 show pre-service teachers’ responses when they were asked to show their level of agreement to the statement “Traditional teaching methods from the village are useful for teaching in schools” (see 4G Appendix Six).

Table 34 Utilizing traditional teaching and learning methods in schools

Pedagogy (pre/post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Traditional teaching methods from the village are useful for teaching in schools (pre)	20	31	28	11	10	2.6	1.2
	51			21			
Traditional teaching methods from the village are useful for teaching in schools (Post)	19	48	22	6	5	2.3	1
	67			11			
	16 <i>Increase in agreement</i>		6 <i>Decrease in uncertainty</i>	10 <i>Decrease in disagreement</i>		0.3 <i>Change towards agreement</i>	0.2 <i>Less variance in data</i>

Prior to the intervention about half (51%, n=81) of the pre-service teachers believed that traditional teaching methods from the village were useful for teaching in schools. Efforts were made during the intervention in lesson 4 and 8, where using resources from the environment for different purposes was discussed and in lesson 9, where role play of a discussion about why the indigenous people refused to accept road development on their land, to demonstrate to the pre-service teachers that traditional teaching methods could be useful for helping the majority of people in PNG to understand their environment and issues related to it.

After the intervention the proportion of participants who thought that traditional teaching methods from the village could be useful for teaching in schools increased by 16% and the variance in pre-service teachers' views reduced, as shown by the lower standard deviation in the findings. When explaining their views, the pre-service teachers said traditional pedagogies were important for use in schools because: they were relevant to the majority of people in PNG (17%); they could easily be integrated with currently advocated pedagogies (10%); they were effective for delivering EEfS (14%); they were in line with Outcome Based Education (12%) which was currently introduced in PNG; and they facilitate effective learning (7%). Comments on the post questionnaire included:

Most people in PNG use the traditional subsistence way of living so to encourage sustainability the educators such as teacher educators and primary school teachers should recognise and use traditional knowledge and methods of learning(POSQ, 38) [because] ... a traditional education system is contextual and learnt by learners participating and imitating the older people who are usually more knowledgeable and skilled... (POSQ, 6); and

Utilising traditional knowledge, teaching and learning methods is useful and relevant because it will not only help the students learn better about their environment and its sustainability but it is also in line with what is emphasised in outcome based education (POSQ, 81).

These findings indicate that the intervention may have made the respondents more aware of the importance of utilising traditional knowledge when teaching about the environment and sustainability. One of them stated in their post-intervention questionnaire:

I will utilise traditional teaching and learning methods to deliver EEfS to help the children learn better about their environment and its resources because traditional learning occurs in authentic context or in the actual environment or activity. I think it is closely in line with education in and for the environment (POSQ, 43).

Thirdly, the finding that 33% of the participants were unsure or disagreed that traditional teaching methods from the village are useful for teaching in schools after the intervention could indicate that either further work on this in the intervention course would be useful, or that some of those responses may be based on different beliefs about school-based learning, or misinterpretation of the information provided on the questionnaire.

7.2.7 Summary of the findings on pedagogies

Prior to the intervention the pre-service teachers perceived that pedagogies such as constructivist, experiential, enquiry-based cooperative and socio-cultural learning were appropriate for teaching environment and sustainability. A high number of respondents identified experiential, enquiry-based and cooperative learning as appropriate for teaching EEFS, perhaps because they had already met these approaches as part of PNG's educational reform. Apart from that, experiential learning is also used in the traditional education system where important survival information, skills and knowledge are passed from one generation to another.

After the intervention there was an increase in the number of participants who considered that student-centred learning strategies such as constructivist, experiential, enquiry-based cooperative and socio-cultural learning were appropriate for teaching environment and sustainability. The greatest increase in the pre-service teachers' perceptions was observed in their views about traditional teaching methods but the total number of pre-service teachers who perceived traditional teaching method was appropriate for teaching in schools was still lower than the number that identified the other pedagogies as appropriate for teaching in schools. It can be inferred that the efforts made in the intervention had made them more aware of the suitability of using the traditional methods in PNG schools.

Prior to the intervention, the pre-service teachers had the view that 'Learners learn best when given information by the teacher'. Their views are varied after the intervention. The result is not surprising because the pre-service teachers are in theory taught and encouraged to use a student centred learning approach as part of current educational reform in PNG, but they know in reality teachers in PNG teach more teacher centred lessons than student centred lessons, possibly because they lack enough training in student centred learning approaches, or because many schools in PNG lack resources to enable teachers to teach in this way.

7.3 The pedagogy for EEfS

A key aim of the intervention was to demonstrate to the pre-service teachers that:

- environmental education for sustainability could be taught in a range of subject areas;
- learning in environmental and sustainability education is holistic;
- experiences in the environment are important in teaching environmental and sustainability education;
- values are important in environmental and sustainability education;
- critical reflection is important in learning in environmental and sustainability education; and
- EEfS should be related to the culture of PNG and be in line with PNG curriculum.

These were demonstrated to the pre-service teachers by role modelling the concepts and by engaging them in activities that promoted each of the characteristics of environment and sustainability education. An evaluation was carried out after the intervention to see if respondents' thinking on environmental education for sustainability had changed. Data from this evaluation is now presented.

7.3.1 Multidisciplinary Issues

One aim of the intervention was to demonstrate to the pre-service teachers that environment and sustainability education could be taught in a range of subject areas. This was done by engaging the pre-service teachers to cluster learning outcomes from health, language, community living and expressive art which are related to the selected themes and prepare the unit of work to demonstrate that environment and sustainability education could be included in any subject or learning area.

The intervention course was offered in place of a traditional environmental science course at the College which had been delivered by science lecturers. It was of interest then to see if the pre-service teachers' perceptions about where environmental and sustainability education could fit in the curriculum could be influenced in the intervention.

The data in Table 35 show pre-service teachers' responses when they were asked to show their level of agreement to the statement "Environmental and sustainability issues should be taught through science subjects in school" before and after the implementation of intervention (see 5A Appendix Six).

Table 35 Environmental issues as multidisciplinary issues

Characteristics of EEFS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Environmental and sustainability issues should be taught through science subject in school (pre)	33	23	19	22	3	2.37	1.23
	56			25			
Environmental and sustainability issues should be taught through science subject in school (Post)	25	23	4	23	25	3.1	1.52
	48			48			
Change	8		15	23		0.83	0.29
	<i>Decrease in agreement</i>		<i>Decrease in uncertainty</i>	<i>Increase in disagreement</i>		<i>Change towards disagreement</i>	<i>more variance in data</i>

Prior to the intervention there was evidence that the participants considered that environmental and sustainability issues were part of science education. This was indicated by about half (56%, n=81) of the pre-service teachers agreeing with the statement “Environmental and sustainability issues should be taught through science subjects in schools” whilst only about a quarter of them disagreed with the statement. As one of them stated when commenting on their views in pre-intervention questionnaire:

Yes, [I strongly agree because] environmental issues are part of science (POSQ, 65).

When they were asked in question seven of the pre-intervention questionnaire, which subjects in primary school they think could include environment and sustainability education, participants identified four subjects in primary schools that could include environment and sustainability education: Environmental Studies, Making a Living, Science and Social Science. This suggests that they had varied views about the subjects that can include environment and sustainability.

After the intervention there was an increase by 24% in the proportion of pre-service teachers who disagreed with the statement “Environmental and sustainability issues should be taught through science subject in schools”. Also after the intervention, when they were asked in question seven, which subjects in primary school they think could include environment and sustainability education, the pre-service teachers identified several more than they had previously: Environmental Studies, Community Living, and Health, Making a Living, Science, Language, Expressive Arts, Social Science and Personal Development. In lessons 10 and 11 of the intervention respondents engaged in clustering learning outcomes from four subjects and developing units of work with themes related to environmental issues. This may have helped them see that environment and sustainability issues are multidisciplinary issues and can be taught holistically across a range of subjects.

7.3.2 Holism

During the intervention the holistic nature of learning in environmental and sustainability education was demonstrated by engaging the pre-service teachers in identifying:

- environmental issues or problems from their local area;
- the causes of the identified issue or problem;
- the effects of the identified issue or problem;
- possible solutions for the problem, and plans for action.

Table 36 shows respondents’ responses to the statement “People can deal with the effects of environmental problems without knowing the causes of environmental problems” before and after the implementation of intervention(see 5B Appendix Six).

Table 36 Holistic study of environmental issues

Characteristics of EEFS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
People can deal with the effects of environmental problems without knowing the causes of environmental problems (pre)	4	1	27	9	59	4.19	1.01
	5			68			
People can deal with the effects of environmental problems without knowing the causes of environmental problems (Post)	4	4	7	15	70	4.44	1.03
	8			85			
Change	3 increase in agreement		20 Decrease in uncertainty	17 Increase in disagreement		0.25 Change towards disagree ment	0.02 more variance in data ment

Prior to the intervention 68% (n=81) of the pre-service teachers disagreed with that statement. Ten made additional comments to illustrate their understanding of the importance of knowing the causes of environmental problems when dealing with the effects, as these participants stated:

I strongly disagree because people cannot solve the effects of the environmental [problems] without knowing their causes. They have to know the causes before seeking [solutions for] the problems (PREQ, 40); and

People have to know the causes of the problems before they can deal with the problem [and] ... solve the problem in a more effective way (PREQ, 20).

After the intervention, the proportion of pre-service teachers who did not agree that people can deal with the effects of environmental problems without

knowing the causes of environmental problems increased by 17% whilst the proportion who were uncertain decreased by 20%. Comments included:

I disagree, because it is impossible for one to deal with the effects of environmental problems (POSQ, 61);

People must know the causes of environmental issues first before going into seeking solutions to the problem (POSQ, 66); and

Identifying the cause of the problem is vital as people can concentrate on the identified area to get the problem fixed (POSQ, 36).

These findings indicate that the efforts made in lesson 2 in the intervention to emphasise key concepts of environment and sustainability education, characteristics of EEfS, the multi-faceted nature of environmental issues and to involve the respondents in identifying and solving environmental problems may have contributed to the shift in their thinking. At the same time, all the activities they were engaged in during the intervention were becoming part of their learning experience.

7.3.3 Experience

Firsthand experience is important in environmental and sustainability education. This was demonstrated throughout the intervention by engaging the pre-service teachers in:

- sharing with each other their experiences of the forest and the use of resources from it;
- discussing and writing reports about why different resources from the environment are used for different purposes and how these activities are connected to cultural activities, beliefs and values; and
- a field trip on which they made observations which they recorded and then reflected on.

The data in Table 37 show pre-service teachers' responses to the statement "Experience in the environment is not necessary for learning about environmental issues" before and after the implementation of intervention(see 5C Appendix Six).

Table 37 Experiences in Environmental Education for Sustainability

Characteristics of EEFS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Experiences in environment are not necessary for learning about environmental issues (Pre)	4	1	21	31	43	4.09	1.01
	5			74			
Experiences in environment are not necessary for learning about environmental issues (Post)	0	3	2	31	64	4.57	0.67
	3			95			
Change	2 <i>decrease in agreement</i>		19 <i>Decrease in uncertainty</i>	21 <i>Increase in disagreement</i>		0.48 <i>Change towards disagreement</i>	0.34 <i>Less variance in data</i>

Prior to the intervention, there was evidence that the pre-service teachers perceived that firsthand experience was necessary for learning about environmental issues. This was indicated when about three-quarters (74%, n=81) of the pre-service teachers disagreed with the statement that ‘Experience in the environment is not necessary for learning about environmental issues’. Supporting comments included:

Experiences are necessary for learning [because] it will provide more useful ideas about environmental issues (PREQ, 20); and

[For example,] when the people do not have experience in environments they will not know the causes and effects of environmental problems (PREQ, 12).

After the intervention, the proportion of pre-service teachers who disagreed with the statement increased by 22%, as shown by the questionnaire data after the intervention. The variance amongst participants’ views had also reduced after the intervention, as shown by the lower standard deviation in the

findings. When commenting on their views on the post-intervention questionnaire, those in disagreement statement made comments such as:

I strongly disagree that because experiencing reminds the [learners] of what they learn. Experience in learning about environmental issues [are] very important because once they practice what they learnt then it will become their experience (POSQ, 72);

Because through experiencing in the environment it is possible for one to identify and learn about environmental problems (POSQ, 61); and
It is the experiences about the condition in the environment that will help learners to identify [and solve] the problems (POSQ, 67).

The pre-service teachers understood the benefits of experience in developing knowledge and so some of them planned to provide opportunity for their students to have such experience, as these pre- service teachers stated in their reflection journals:

Now I believe experience makes learning of concepts better (RJ1, 4);
and

I also learnt that seeing actual things increases learning or makes learning effective ... I will organise and take the students out on excursions (RJ1, 8).

The number of pre-service teachers that considered experience in the environment was necessary for learning about environmental issues was quite high prior to the intervention and increased further to almost 100% after the intervention. This may have been encouraged by the notion that in PNG's traditional education system experience is one of the valued components of effective learning.

7.3.4 Values

In the intervention the importance of values in learning in environmental and sustainability education was demonstrated to the pre-service teachers by engaging them in a role play about why and why not a road from Kabwum to Lae should be developed through a sacred virgin forest between Kabwum and Nawaeb Districts. They also required discussing why different resources from the environment were used by their people for different purposes, which emphasised for them the extent to which actions and behaviours of people in PNG are influenced by their cultural values.

Table 38 presents respondents' responses to the statement "Understanding environment and sustainability issues needs thinking of values" before and after the implementation of the intervention (see 5D Appendix Six).

Table 38 Values in environmental education for sustainability

Characteristics of EEFS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Understanding environment and sustainability issues needs thinking of values (Pre)	32	28	31	3	6	2	0.89
	60			9			
Understanding environment and sustainability issues needs thinking of values. (Post)	42	34	20	1	3	1.81	0.79
	76			4			
Change	16 <i>Increase in agreement</i>		11 <i>Decrease in uncertainty</i>		5 <i>Decrease in disagreement</i>	0.19 <i>Change towards agreement</i>	0.1 <i>Less variance in data</i>

Prior to the intervention more than half (60%, n=81) of the pre-service teachers perceived that understanding environment and sustainability issues involved thinking about values. When explaining their views the pre-service teachers made comments such as:

I strongly agree that understanding environment and sustainability issues needs thinking of values [because]without understanding and valuing something no one would bother to care about it (PREQ, 59).

After the intervention, the proportion of pre-service teachers who agreed with the statement increased by 16%, as shown by the post-intervention questionnaire data. The variance amongst the participants' views had also reduced slightly, as shown by the lower standard deviation in the findings. When explaining their views, respondents made comments such as:

It is people's values about something that will help them to care for it (POSQ, 23); and

[B]ecause their cultural beliefs and values about environment and sustainability influences their actions (POSQ, 38).

The latter comment contains the idea that people's decision to use or care for the environment and its resources is dependent on what they value. These findings indicate that the efforts made in the intervention in lessons 9, 14 and 15 to help the pre-service teachers understand how the ways in which PNG people hunt, fish, gather or collect food and building materials, make garden, prepare or cook food are very much connected to their cultural values may have led them to become more aware of the need for understanding values when teaching about environment and sustainability issues. This is why critical reflection is important when learning about environment and sustainability.

7.3.5 Critical reflection

The importance of critical reflection in learning in EEfS was illustrated by engaging the pre-service teachers in reflecting on what they had learned from the lessons throughout the intervention, including the three sets of reflections that were collected and analysed as part of the data.

The data in Table 39 show pre-service teachers' responses to the statement "Critical reflection about environment and sustainability learning is necessary" before and after the implementation of intervention (see 5E Appendix Six).

Table 39 Critical reflection about environment and sustainability learning

Characteristics of EEFS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Critical reflection about environment and sustainability learning is necessary (Pre)	46	21	26	2	5	2	1.12
	67			7			
Critical reflection about environment and sustainability learning is necessary (Post)	69	28	1	0	2	1.41	0.56
	97			2			
Change	30 <i>Increase in agreement</i>		25 <i>Decrease in uncertainty</i>	5 <i>Decrease in disagreement</i>		0.59 <i>Change towards agreement</i>	0.56 <i>Less variance in data</i>

Prior to the intervention more than two-thirds (67%, n=81) of the pre-service teachers perceived that critical reflection about environment and sustainability learning was necessary. Only four pre-service teachers wrote clear comments on their pre-intervention questionnaires to support their views; one said:

Yes, you must think critically about the environment [and] think [about] sustaining it for future (PREQ, 79).

After the intervention, the proportion who thought that critical reflection about environment and sustainability learning was necessary increased by 30%, as shown by the post-intervention questionnaire data, and the variance among the pre-service teachers' views reduced after the intervention, as shown by the lower standard deviation in the findings. When explaining their views, the pre-service teachers made comments such as:

I strongly agree [that] critical reflection about environment and sustainability learning is necessary because we must critically reflect on

the actions we take on the environment so that we can be careful (POSQ, 25); and

I strongly agree, because when you critically reflect about the environment and sustainability, it will help you to discover more new [knowledge] or ideas to solve the issue (POSQ, 61).

These findings indicate that efforts made in lesson 2, when the students read and talked about critical reflective learning as one of the pedagogies of learning EEfS; and efforts made during the intervention to encourage them to always critically reflect on their learning may have contributed to their understanding of the importance of critical reflection in environment and sustainability education.

The next section presents the students' perceptions of relevance in environmental education.

7.3.6 Relevance

The concepts and issues discussed or learnt about in EEfS should be relevant to the student's needs, experiences, culture and curriculum. Having EEfS in PNG teacher education program is relevant because PNG is already experiencing environmental issues both in rural and urban areas. At the same time the need for teaching about and learning about it has been emphasised in the National Curriculum Statement for PNG. The NCS of PNG identifies environmental issues in PNG and emphasises the need for addressing it through education (PNGNDoE, 2003a).

The data in Table 40 show the pre-service teachers' responses to the statement "Environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum" before and after the implementation of the intervention(see 5G Appendix Six).

Table 40 Relevance in environment and sustainability education

Characteristics of EEfS (Pre/Post intervention)	Strongly Agree (%)	Agree (%)	Not Sure (%)	Disagree (%)	Strongly Disagree (%)	Mean	Standard Deviation
Environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum (Pre)	40	25	28	5	2	2.06	1.05
	65			7			
Environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum (Post)	47	35	14	4	0	1.77	0.86
	82			4			
Change	17 <i>Increase in agreement</i>		14 <i>Decrease in uncertainty</i>	3 <i>Decrease in disagreement</i>		0.29 <i>Change towards agreement</i>	0.19 <i>Less variance in data</i>

Prior to the intervention more than half (65%, n=81) of the pre-service teachers perceived that environment and sustainability education should be related to the culture of PNG and be in line with PNG curriculum. Only five of those in agreement with this notion wrote clear comments on their pre-intervention questionnaires to support their views; for instance:

[The] environmental problem is a big issue in the world including PNG which has small land mass [with a] beautiful environment to live and survive in ... (PREQ, 26); and

It is true that learning about environment and sustainability should be related to [our] culture and curriculum so that people can be aware of their cultural [environment] and curriculum...[and] make connections... (PREQ, 68).

After the intervention, the proportion of pre-service teachers perceiving that environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum increased by 15%, as shown by the questionnaire data after the intervention. The variance amongst the pre-service teachers' views reduced after the intervention, as shown by the lower standard deviation in the findings. When explaining their views, those who agreed that environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum made comments such as:

I strongly agree because we are Papua New Guineans and therefore we should base our teaching relating to our cultures by integrating with the PNG curriculum for the students to fully understand and participate effectively in the learning (POSQ, 17); and

I agree environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum because when it is [related to] PNG culture and in line with PNG curriculum the learners will learn well because they are brought up in the culture and they know it is related to their curriculum (POSQ, 20).

These findings indicate that the focus in lesson 2 of the intervention on relevance as one of the pedagogies suited to EEfS may have made the participants aware that environment and sustainability education is relevant to PNG.

7.3.7 Summary of findings on EEfS pedagogies

Firstly, there is evidence of change in the perceptions of the pre-service teachers after the intervention. Prior to the intervention more than half of the participants considered that: knowing the cause of environmental problems is important for solving those problems; experience is necessary for learning environmental and sustainability; understanding environmental and sustainability involves thinking of values; and critical reflection about environment and sustainability learning is necessary. This proportion increased

after the intervention. This finding may have been because the course was designed not only to develop participants' content knowledge about the environment and sustainability but also to impart appropriate teaching and learning approaches by modelling them.

Secondly, prior to the intervention the students perceived that environmental and sustainability issues should be taught through science subjects in schools. After the intervention the number who disagreed with the statement "Environmental and sustainability issues should be taught through the science subjects in schools" increased, which is consistent with their response when, asked to identify the subjects in primary school that could include environment and sustainability, they identified nine subjects, five more than in the pre-intervention questionnaire. However, about half of the pre-service teachers were unsure or agreed with the statement "Environmental and sustainability issues should be taught through the science subjects in schools". This may have been because the intervention was offered in place of a science course at the college and was delivered by science lecturers. It may also be because the statement is not clear, in that it does not say environment and sustainability issues should be taught only through science subjects in schools, which would have been a clearer question.

Thirdly, the greatest change was observed in the number of participants who agreed with the statement "Critical reflection about environment and sustainability learning is necessary". This may have been because the pre-service teachers were taught and encouraged to reflect on all their lessons and actions throughout the intervention.

7.4 The Traditional Education System

This section presents data on the pre-service teachers' perceptions of: traditional knowledge, skills and values; facilitators of traditional knowledge, skills and

values; venues for traditional knowledge, skills and values; and pedagogies for delivering traditional knowledge, skills and values.

7.4.1 Traditional knowledge, skills and values

The pre-service teachers were asked semantic differential questions to indicate their level of agreement to a pair of opposing statements on the use of traditional knowledge for solving environmental problems in PNG. This strategy required them to circle a number between 1 and 5, where: 1 means Strongly Agree with the statement on the left; 2 means Agree with the statement on the left; 3 means the participant's views are evenly balanced between the two statements, or they are unsure; 4 means Agree with the statement on the right; and 5 means Strongly Agree with the statement on the right. Table 41 presents the students' responses (see question 2D Appendix Six).

Table 41 Traditional knowledge about environmental problems

	<i>Agree that traditional /local knowledge, values and skills are useful for solving environmental problems in PNG (%)</i>	<i>Agree with neither or both statements or uncertain (%)</i>	<i>Agree that traditional /local knowledge, values and skills are not useful for solving environmental problems in PNG (%)</i>
Pre-intervention	61	25	14
Post-Intervention	71	19	10
% Change	10 <i>increase in agreement to statement on the left</i>	6 <i>Decrease in agree with neither or both statements or uncertain</i>	4 <i>decrease in agreement to statement on the right</i>

The table shows that prior to the intervention 61% (n=81) of the pre-service teachers responded that they thought traditional or local knowledge, values and skills were useful for solving environmental problems in PNG. After the intervention, the proportion of pre-service teachers who thought that increased by 10%. These findings indicate that the intervention may have led the participants to become more aware of the benefit of utilising traditional

knowledge and teaching methods when solving problems and teaching environment and sustainability education. The finding that 19% of the participants circled 3 from the scale after the intervention could mean they were unsure or agreed with neither or both statements. It could also indicate either that further work on the topic in the course would be useful or that some of these responses may have been based on a misunderstanding of concepts and/or misinterpretation of the information provided in the questionnaires.

7.4.2 Facilitator of traditional knowledge, skills and values

Analysis of the pre-service teachers' response to question eight: "Describe what you know about how traditional knowledge about environment and sustainability is passed on. Who teaches it, where it is taught and how it is taught?" are presented in sections 7.4.2 Facilitator of traditional knowledge, skills and values; 7.4.3 Venue for delivering traditional knowledge, skills and values; and 7.4.4 Pedagogy for delivering traditional knowledge, skills and values.

When the pre-service teachers were asked to describe how traditional knowledge about environment and sustainability was passed on, fewer than half of them (42 %, n=81) responded to the question on the pre-intervention questionnaire, while about three-quarters (74%) responded to the question on the post-intervention questionnaire.

Table 42 shows respondents' perceptions of the people who facilitate environment and sustainability education traditionally. The data was coded from the responses to question 8. Some identified more than one facilitator.

Table 42 Facilitator of local traditional environment and sustainability knowledge and skills

Educator/Facilitator	% Pre-intervention	% Post- intervention
Parents (n=81)	40	52
Grandparents (n=81)	31	45
Elder Brother/Sister (n=81)	30	43
Clan leaders/Elders (n=81)	25	31
Uncles & Aunties (n=81)	9	12

Prior to the intervention the pre-service teachers identified parents, grandparents and older brothers and sisters as facilitators for traditional environment and sustainability education. The parents were the main facilitators of traditional environment and sustainability education, followed by the grandparents and then the older brothers and sisters. As one of the respondents stated on their pre-intervention questionnaire:

The traditional knowledge about environment and sustainability is passed through young people observing and listening to grandparents and parents and other older people in the family or community (PREQ, 55).

After the intervention, the number of pre-service teachers that identified parents, grandparents and older brothers and sisters as teachers for traditional environment and sustainability knowledge, skills and values increased. As one of the respondents commented on their post-intervention questionnaire:

The traditional knowledge about environment and sustainability is ... taught by our grandparents, parents, clan leaders and other older people such as bothers and sisters ... (POSQ, 15).

The facilitators most commonly identified by the pre-service teachers were the parents, as one of the pre-service teachers stated on the post-intervention questionnaire:

Most of this traditional environment and sustainability knowledge is taught by [the] parents while working with their children in the garden or children going into the bush for hunting, gathering food and collecting materials for building houses. Children get told about the knowledge and values and shown the skills. The venue for the lessons in traditional education system varies depending on the knowledge, skills and values learnt (POSQ, 40)

7.4.3 Venue for Traditional Knowledge, Skills and Values

Table 43 shows pre-services teachers' perceptions of where environment and sustainability education is traditionally delivered. The data was coded from their responses to question eight in the questionnaire. Some pre-service teachers identified more than one venue for learning.

Table 43 Venue for delivering traditional knowledge and skill and values

Venue for Learning	% Pre-intervention (n=81)	% Post-intervention (n=81)
Family house (n=81)	18	26
Village meeting house (n=81)	20	23
Men & women house (n=81)	18	45
Specific context (n=81)	27	46
Not mentioned (n=81)	26	5

The respondents identified the family house, the village meeting house, the men and women house and the actual outdoor environment (Specific context) as the venue in which teaching and learning about the environment and sustainability occurred. They reported that the most common venue for delivering traditional knowledge, skills and values about the environment and sustainability was the environment itself. As one of them stated on the pre-intervention questionnaire:

Older people teach the learners in the actual place such as sea, forest and by demonstrating the skills. For example, young boys are taught how to use fishing net by using the fishing net carefully without damaging both the net and the corals (PREQ, 6).

After the intervention the number of respondents who identified the family house, the village meeting house, the men and women house and the actual environment as the venue in which they considered that teaching and learning occurred increased. The most common venue for teaching and learning of EEFS were identified as the men and women house and the actual environment:

The traditional knowledge about environment and sustainability ... is told to the younger people as stories and advice by older people in the family house, the men and women house, and clan and tribe meetings ... (POSQ, 15); and

[M]ost of the othe ... knowledge and skills are taught by [the] parents when working with their children in the garden or bush when hunting, gathering, making gardens and collecting materials for building houses (POSQ, 40).

The men and women houses are special houses where knowledge, beliefs and values that men and women need to successfully live in their environment are taught to them secretly and carefully. The other common venue for learning about the environment that the respondents identified was the environment itself. Learning about environment and sustainability in the actual environment is important because it can easily facilitate sustainable action. Both teacher- and learner-centered approaches are used for the transmission of traditional knowledge and skills.

7.4.4 Pedagogy for delivering traditional knowledge, skills and values

Table 44 shows the pre-service teachers' perceptions of how young people are traditionally taught about the environment and sustainability. The data was coded from their responses to question eight. Some identified more than one method of learning.

Table 44 Pedagogies for delivering traditional knowledge and skills

Pedagogy	% Pre-intervention	% Post- intervention
Listening to the facilitator (n=81)	26	51
Observing activities, events and demonstration (n=81)	25	22
Imitating or participating in events and activities (n=81)	28	48
Others (n=81)	20	2

The approaches the pre-service teachers identified as those used by learners to learn traditional knowledge were: learning by listening to facilitator, observing activities, events and demonstration, and imitating or participating in events and activities. They said:

Traditional knowledge about environment and sustainability is passed on by telling history, stories and legends by older people such as grandparents ... and the young people learn by listening (PREQ, 59); and

The young people develop the traditional knowledge and skills by involving or participating in activities such as community work like making garden, building a house, and dancing in traditional dances and imitating the older more knowledgeable and skilled (PREQ, 68).

The number of participants who commented on different traditional ways of passing on knowledge and skills increased after the intervention. These pre-service teachers wrote:

The traditional knowledge about environment and sustainability ... is taught by grandparents, parents, clan leaders or other older people demonstrating to ... the young ones [and they] learn by listening, observing, and following instruction and taking actions (POSQ, 15); and

It is learning them through activities such as gardening, hunting, fishing, making a fence and building a house ... (POSQ, 37).

The most common method of learning identified by pre-service teachers after the intervention was imitating or participating in real-life events and activities and listening to the facilitators. This is consistent with Lucas' ideas of education in and for the environment (Lucas, 1979), and Tilbury's idea that EEfS should be relevant, and action-oriented (Tilbury, 1995).

7.4.5 Summary of Pedagogies

Traditional knowledge, beliefs and values, including knowledge about the environment and sustainability, are taught by older people speaking to the young people and the learners learn by listening. In most cultures of PNG, younger people listen to the leaders and other older people without saying anything and this indicates respect for elders. This is viewed as teacher-centred learning and rejected by current advocates of student centred learning approaches. However, it is the most used approach for teaching and learning in PNG because learners who listen to the teachers without asking questions are viewed as good and respectful students.

When the older person demonstrates skills and processes to the young person or people, they in turn learn by observing and imitating and by participating. This type of learning is viewed as socio-cultural learning. Learning about something by doing it is known as experiential learning. All these approaches to learning are

important for teaching and learning of environment and sustainability in pre-service teacher institutions in PNG.

7.5 Summary of Chapter Seven

The major goal of the intervention course on EEfS was to develop pre-service teachers who are competent to teach EEfS, that is, action competent. Thus, the intervention tried to accommodate current ideas about environment and sustainability education and teaching and learning. After the intervention, the pre-service teachers' perceptions of currently advocated environment and sustainability education and pedagogies had changed.

Prior to the intervention, the pre-service teachers perceived that student-centred learning strategies such as constructivist, experiential, enquiry-based cooperative and socio-cultural learning were appropriate for teaching environment and sustainability, especially experiential, enquiry-based and cooperative learning, while traditional teaching methods were perceived as the most inappropriate method for teaching about the environment and sustainability. After the intervention, the numbers of respondents supporting the use of these pedagogies rose in all categories, particularly with regard to traditional teaching methods.

Although there was significant change in the pre-service teachers' perception of traditional teaching methods, the total percentage of participants who saw it as appropriate was about two-thirds, which was the lowest compared to their evaluation of other approaches. Thus, more work focused on giving value to traditional teaching methods in the unit would be useful.

Prior to the intervention a number of the pre-service teachers had perceived that an EEfS course should: be relevant to learners' needs, culture and the national curriculum; treat EEfS as a multidisciplinary subject; be studied holistically; utilise students' experiences and values; based on critically reflecting on all actions and learning, especially holism and critical reflection. This number rose after the

intervention, especially in relation to critical reflection. Although there was a change in the participants' thinking about environmental issues as multidisciplinary issues, the total percentage of those who saw environmental issues as being multidisciplinary issues was less than half, which was the lowest percentage, compared to their views on other characteristics. Thus, more work focused on emphasising environmental issues as multidisciplinary issues in the unit would be useful.

Chapter Eight

8. Action competence

8.1 Introduction

This chapter focuses on action competence and presents data on pre-service teachers' perceptions about their experience in the intervention and their own perceived competence for teaching EEfS in primary schools. The chapter presents data that were collected and analysed to examine the development of competence by the student participants during the intervention.

The data presented in this section are from the:

- open-ended questions on the questionnaires which were administered to the pre-service teachers before and after the intervention on EEfS;
- action plans produced as part of the coursework by the participants; and
- reflection journals kept by the participants during the course.

The aspects of action competence examined are action, knowledge, attitudes, commitment to action and reflection.

8.2 Action Experience

During the intervention the pre-service teachers were provided opportunities to participate in some activities. These activities became experiences from which they can take actions in future. At the same time they were used to help the participants to understand that for their own students to be action competent they must be provided with opportunities to experience taking action which is aimed at addressing the causes and effects of environment and sustainability issues; and they must feel connected to their environment. This was encouraged and demonstrated by involving the pre-service teachers in planning and taking sustainable action, which included identifying environmental or sustainability problems in their local areas. Local areas in this sense included their clan land,

village, or wherever they lived most of the time and the schools in which they would teach. These interactions could provide students with experiences and understanding of the issues, and involve them in achievable actions that will contribute to a more sustainable future.

The environmental issues discussed in section 6.2 of Chapter 6 are those that are experienced in PNG while those discussed in this section are experienced in the local areas of the pre-service teachers, where they could easily involve themselves in sustainable action. The data in table 45 were drawn from students' action plans which were done as one of the compulsory activities. All participants had completed an action plan.

Table 45 Environmental issues pre-service teachers proposed to address

Issue pre-service teachers want to address	Percent of participants who want to address the issue
Land shortage and degradation	36
Pollution (air & water)	23
Endangered species	16
Bad agriculture practice	12
Logging	5
Mining	5
Rapid population growth	3

All (100%, n=81) participants were engaged in the process of identifying environmental issues, and investigating and identifying causes, effects and possible solutions. The highest proportion of pre-service teachers (36%) identified and wanted to address land-related problems. These pre-service teachers were planning to take action in their own time, as one of them wrote on their action plan:

I [will] create awareness during Christmas about the causes and effects of land shortage [and other land-related problems] ... (AP, 17).

As noted in 6.2.2.1, the majority of the pre-service teachers identified land-related problems as the major issue of concern in their local area. This is not surprising because land in PNG is owned, used, managed and passed by the people from one generation to the next without the use of written records, and many current problems have been linked to disputes over land ownership and usage.

The next two most common environmental problems the pre-service teachers identified and planned to address were pollution (23%) and endangered species (17%). These pre-service teachers stated in their action plans:

I [will] create awareness about water pollution because it is [a] major problem in the country and most of my people in my area are suffering ... because their river water ... is badly polluted (AP, 32); and

I will create awareness in my area on how to manage our environment in order to preserve plants and animals and [stop people] from using traditional poisonous vines and chemicals used for killing wild animals (AP, 7).

It is important that both threats to endangered species and pollution are addressed because they are issues that are caused by economic activities as well as people's social and cultural activities. For example, 15% of the participants who described pollution as their focus earlier (see Table 42) mentioned air pollution caused by rural people through burning of bush and grasslands.

The fourth most common environmental problem the pre-service teachers identified and wanted to address was bad agricultural practices. One of them stated in their action plan:

I will teach my students [to use a] crop rotation method so that it will help minimise the issue (AP, 62).

The majority of people in PNG are rural people who use subsistence farming methods to survive. By working with their own students the pre-service teachers could be able to help minimise the problems associated with it, such as land shortage, biodiversity depletion and land degradation.

The next two most common problems the participants identified and wanted to address were issues related to mining and logging, as these pre-service teachers wrote in their action plans:

I will go home and educate my people about bad effects of mining, create awareness and teach the upcoming generation about the uncontrollable damage done to the environments and [encourage] them to take [appropriate action] ... in order to sustain our environment (AP, 5); and

I will influence my clan members so they will not allow any logging companies to our [clan] rainforests [and] when I become a teacher I will influence my students to do the same (AP, 47).

The last problem the pre-service teachers identified and planned to address was rapid population growth. Although only a few pre-service teachers said they wanted to address this topic, a careful analysis of the causes of environmental problems shows that 56% of the participants identified rapid population growth as the most common root cause of the other environmental issues, especially land-related problems, and so it is likely that more than the 3% of students who reported planning to take action on this would make some effort to address it.

Only 20% of the participants made plans that indicated they were planning to take action beyond the course they were taking. This is despite many more participants stating that they learnt about environmental and sustainability issues as reported in Section 7.4.2 above. This is consistent with reports in the literature which have found that often people may know about environmental

issues, their causes, effects, and possible solutions, but do not take any action to address them (Barker & Rogers 2006; Tilbury, 1997).

Most of the participants had good action plans but were not able to take action as part of the course because of time constraints in the course. Others chose authentic environmental issues but were not able to commit themselves to take action because the problems they identified seemed too difficult for them to address; for example, many identified land-related problems and also identified rapid population growth as the root cause for land disputes and land degradation, but not many planned to address this challenge. This could be because topics to do with sex, growth and reproduction are taboo in PNG culture and people do not talk about them openly.

However, action competence can be understood as an educational ideal which is associated with democracy such as human rights, free expression and use of cultural values and beliefs, and developmental activities, and is characterised by direct and indirect addressing of environmental issues (Morgensen & Schnack 2006). This being the case, it is hoped that all pre-service teachers who participated in the intervention will take some form of actions in their own way and time in harmony with their values and beliefs because of the experience gained in the process of identifying and solving problems. Any actions taken by the students, whether complete or incomplete, direct or indirect, would eventually become experiences which the learners can use to plan and take further actions.

8. 3 Knowledge

As part of the intervention, the pre-service teachers were given the opportunity to develop knowledge, skills and values that would make them competent to teach EEfS effectively. At the same time they came to understand that development of action competence for their students required the students to have some knowledge about the environment and environmental problems,

from which they could draw to make informed decisions and take sustainable action.

This was done by focusing on environmental issues during the discussions and by encouraging knowledge development in the intervention in the following ways:

- reading and talking about the environment, environmental issues, key concepts and the pedagogy of environmental education for sustainability throughout the intervention;
- considering social and cultural views and alternative ways of addressing issues;
- discussing the causes of deforestation and land tenure and uses in PNG;
- taking them out on an excursion to the Rainforest Habitat Sanctuary; and
- helping them to identify problems in their local area and take steps to solve them. This included understanding of the underlying causes and the effects of the issues being addressed, the need for an integrated approach, and examining scientific information.

The participants responded to these aspects of the intervention by commenting on the excursion and the use of other learning activities about the value of knowledge for their own learning and indicated they would provide opportunities for their students to develop their knowledge about environment and sustainability.

Table 46 presents an analysis of the respondents' views about what they had learnt from lesson 5, the excursion to the Rainforest Habitat Sanctuary, and how they might apply it in the future. The data in the table was thematically analysed from their responses when they were asked if they learnt anything new from the lesson. Some pre-service teachers learnt more than one concept, and this was recorded.

Table 46 Pre-service teachers' perceptions of things learnt in the intervention

Concepts/Things Learnt	Examples	Percent of participants (n=81)
Environmental knowledge	Plants, animals, forest, sanctuary	75
Environmental issues	Endangered species, depletion of biodiversity	61
Need for action	Community awareness, teaching	48
Key Concepts of EEfS	Interdependence, future focused	41
Pedagogical Tools	Excursion, use of questionnaire	30

The pre-service teachers claimed they learnt some new things about the components of the environment (75%, n=81), environmental issues (61%) and the need for action (48%), such as teaching primary school students and creating awareness for the community members. In response to being asked whether they had learnt something during the excursion these respondents wrote in their reflection journals:

I learnt so many new things about the environment. This includes seeing different species of cockatoo, the trip itself, [and]how animals are kept (RJ1, 61);

[I learnt] how the living things interact with each other and their environment and how [the] environment is important to us (RJ1, 72).

The students also reported that they had learnt some new things about using an excursion as a pedagogical tool (30%). As these participants stated in their reflection journals after lesson 5:

I also learnt about ... how to organize an excursion and make the learners experience their environment and feel connected to their environment (RJ1, 17); and

Experience in seeing environmental problems can help people act and address the issues (RJ1, 59).

These pre-service teachers reported experiencing and learning the importance of using pedagogical tools such as an excursion in delivering environment and sustainability education, and this promotes experiential learning and connectedness.

Apart from identifying the excursion as a useful learning tool and wanting to use it to deliver environment and sustainability education, the pre-service teachers also reported identifying other learning approaches that would encourage their students to be active learners. Table 47 shows their replies when they were asked if they had learnt anything about the activities used in the intervention. The data in the table were drawn from reflection journal three.

Table 47 Learning activities for delivering EEfS learnt from the intervention

Identified learning activities from the intervention	Percent (% , n = 81)
Use of KWL Chart	47
Follow Me Game	33
Simulation of field trip	20

Firstly, about fifty percent (47%, n=81) of the participants said they had learnt about the KWL chart. One wrote as part of their reflection:

The new thing I learnt is the use of [the] KWL chart ... The learning activity promotes learning by utilising prior knowledge and use of asking and answering questions to develop further knowledge and the students learn what they want to learn (RJ3, 8).

This pre-service teachers identified the benefits of using the KWL chart as being the promotion of constructivist, experiential and inquiry-based learning,

all of which are important for delivering EEfS. The KWL Chart and activity in it helps learners remember what they already know about a topic, interpret what they read, decide on things they want to learn more about and helps to revise what has been learnt (see Appendix Fourteen).

Secondly, about a third (33%, n=81) of the student teachers said the new thing they learnt was about the 'Follow Me Game'. One of them wrote as part of their reflection:

I learnt that by playing games like Follow Me many questions can be answered and all the students in the class are [encouraged] to participate by giving everybody a question, and an answer to a question (RJ3, 59).

This respondent had recognized the benefits of using the Follow Me game, which include covering more content, active student participation and use of questioning and answering. Covering content knowledge is important for pre-service teachers in PNG because many of them will teach in rural schools with few resources, and will often resort to knowledge and experiences they gained during their pre-service training.

Thirdly, a fifth of the pre-service teachers said they had learnt about 'Simulation'. One wrote in their reflection journal:

I learnt that telling an imaginary story [about a situation] is a good way of utilizing students' prior knowledge and experience [to develop] new knowledge (RJ3, 54).

This respondent recognized the benefit of using simulation in EEfS, and planned to use it when teaching in the future. Gaining knowledge about the environment and sustainability and EEfS can influence and change the attitude of learners.

The findings seem to indicate that the efforts made during the intervention may have led the pre-service teachers to understand that knowledge and

understanding about the environment and sustainability are essential to make well-informed decisions on issues. This finding is in line with one of the aims of the intervention, which was for the pre-service teachers to develop both the content and pedagogical knowledge that were necessary for them to teach EEfS. Traditional knowledge and education about the environment are important in PNG and need to be utilised in EEfS.

8.5 Attitude

The development of knowledge about environment and sustainability education was to change the attitudes of the pre-service teachers towards teaching this subject. Eighty-nine percent (89%, n=81) of them said in the reflection journal that the lessons they learnt had influenced their thinking about teaching environment and sustainability, and they were planning to teach it. These participants wrote in their reflection journals:

The lesson has influenced me to teach about environment and sustainability and so I am planning to teach it (RJ1, 70);

I realised ... people have to change and take sustainable actions to change the situation ... I am convinced to teach environment and sustainability because if we do not, we will lose all the valuable plants and animals we have today ... (RJ1, 67); and

It has influenced my thinking and motivated me to teach about environment and sustainability (RJ1, 10).

Only 11% of the participants said the lessons about teaching environment and sustainability had influenced them they were unable to explain clearly how they had been influenced and what they would do about the conviction they had. The efforts made in the intervention appeared to have influenced most of the pre-service teachers and developed their attitudes towards the environment and teaching about sustainability.

8.5.1 Attitudes towards teaching environment and sustainability

One of the aims of the intervention was to influence the pre-service teachers to teach and influence their students to take sustainable action. A range of content was delivered through a variety of learning activities to help the pre-service teachers to understand that for their students to have positive attitudes to environment and sustainability, they need to receive knowledge about environment and sustainability issues.

Table 48 presents an analysis of respondents' views in their reflection journals about how their thinking about teaching environment and sustainability was influenced by the intervention.

Table 48 Factors that influenced pre-service teachers' thinking about teaching EEfS

Factor that influenced	Examples	Percent influenced (n=81)
Knowledge about environment	Environmental issues, Cause and effect of environmental problems, key concepts, forest, Sanctuary	89
Experience with environmental issues	Endangered species, Depletion of biodiversity	81
Knowledge how (Pedagogical tools)	Excursion, worksheet, experiential learning	60

Firstly, most (89%, n=81) of the participants reported they were influenced by the knowledge they gained during the intervention, as these pre-service teachers wrote in their reflection journal about lesson 5:

The lessons I learnt so far have influenced me to teach about environment and sustainability to the students in my class. Not just to teach but to make efforts to influence them so that they can take sustainable actions (RJ1, 31);

I realized that our environment is very important. It helps human beings in many [different] ways therefore we need to as much as possible sustain it (RJ1. 35); and

I realized that ... people have to change and take sustainable actions to change the situation.... I am convinced to teach environment and sustainability because if we do not [do anything about it] we will lose all the valuable plants and animals we have today (RJ1, 67).

These student teachers had developed and assimilated knowledge and understanding about the components of the environment, their interdependence and the issues related to them, and the urgency for taking action would include teaching primary school children and encouraging them to take sustainable action.

Secondly, more than three-quarters (81%) of the participants said they were influenced to teach environment and sustainability by the environmental problems they observed and experienced. These participants wrote in their reflection on lesson 5:

My experience in seeing biodiversity depletion, especially the endangered species, is influencing me to take action [and]... teach the students in my class seriously, making all efforts to convince them so that they can take sustainable action (RJ1, 59); and

This lesson has influenced my thinking about teaching environment and sustainability because our natural environment, which includes plants and animals, is under threat due to human activities and most of [the] animals are becoming endangered (RJ1, 33).

These participants were clearly affected and influenced to teach environment and sustainability by environmental issues they were exposed to during the lesson.

Lastly, more than half (60%) of participants said they were influenced to teach about the environment and sustainability by the learning activities and approaches they were exposed to during the intervention. For example, they wrote:

I learnt about how to organise an excursion and make the learners experience their environment [and] feel connected to [it]. The lesson influenced me to teach environment and sustainability and take the children for an excursion to the forest (RJ1, 17);

[T]eaching at the same time [helped] the students to see, feel and know about the environment and the problems associated with it as we did in our excursion (RJ1, 72); and

[To] make them feel connected to their environment so that they can appreciate and care for it (RJ1, 29).

These pre-service teachers were influenced by the approaches such as the excursion which were used as pedagogical tools for teaching environment and sustainability concepts. They wanted to use the excursion because it promotes experiential, connectedness and deep learning. The other learning activities they wanted to use are described in the next few paragraphs.

Table 49 presents the analysis of pre-service teachers' views about how their thinking about learning activities for teaching environment and sustainability were influenced. The data in the table were thematically analysed from participants' responses from their reflection journals when they were asked if

and how they were influenced to use the modelled learning activities to teach about environment and sustainability.

Table 49 Factors that influenced pre-service teachers to use the learning activities

Learning activity	Factors that influenced participants about the learning activities (Percent)
KWL Chart (n=38)	Promoted enquiry-based learning activity (42)
	Utilised prior knowledge (38)
	Gaining knowledge required/desired by learner (43)
Follow Me Game (n=27)	Promoted enquiry-based learning (38)
	Promoted active student participation(35)
	Covers more content in a lesson (27)
Simulation (n=16)	Promoted prior knowledge (46)
	Facilitated deep learning (21)
	Connected learners to environment (17)

The pre-service teachers reported that they found using the KWL Chart a useful approach to include in environment and sustainability lessons because it promotes use of enquiry-based learning and prior knowledge, and allows students to learn what they need or want to learn. One respondent wrote in their reflection journal on learning activities:

The use of KWL chart ... is good for learning in environment and sustainability because it utilizes prior knowledge of students and allows children to choose what they want to learn by asking and answering questions.... I [have been] influenced to teach environment and sustainability and I am planning to use KWL chart to help my students to develop knowledge, skills and attitudes that are required for sustaining the environment (RJ3, 19).

This pre-service teacher was planning to use KWL because he or she understood that it would promote constructivist and enquiry-based learning in the delivery of environment and sustainability education.

Another learning activity the pre-service teachers found useful to include in environment and sustainability lessons was the Follow Me Game, because they noted that it promotes enquiry-based learning and active student participation learning. One wrote:

I am influenced to teach environment and sustainability and I will use [learning] activities such as [the] follow me game to promote enquiry-based learning, active [student participation and] at the same time I can cover more concepts (RJ1, 44).

This respondent reported the importance of using an active student-centred learning approach such as enquiry-based learning, which is currently recommended for delivering environment and sustainability education. They also noted that learning activities like the Follow Me game can facilitate active enquiry-based learning.

Another learning approach the pre-service teachers found useful was the use of simulation, as they noted it promotes enquiry-based learning, utilizes prior knowledge, and connects the learner with the environment, as one of the pre-service teachers wrote in their reflection journal:

The use of simulation of the trip...made us think deeply and made us feel connected to the environment.... It is a good method because it helps to retrieve and utilize prior knowledge of the students...I am also influenced to use the approach in ...teaching environment and sustainability (RJ3, 66).

The participants reflected on the importance of the learner's connection to the environment and the use of prior knowledge and enquiry-based learning in

delivering environment and sustainability education, which is in line with the aim of the intervention. They also discussed that it was important for them as teachers in PNG to gain the basic knowledge they would need for teaching their students, because they might be employed in under-resourced rural schools where they would need the knowledge and experience they had gained from their pre-service teacher training.

The student teachers also understood the importance of utilizing traditional knowledge and methods for teaching and learning to deliver environment and sustainability education. When they were asked for any other comments they had about environment and sustainability education, 33% (n=81) of them said they would utilize traditional knowledge when teaching environment and sustainability, as one of them stated on their post-intervention questionnaire:

I will utilize traditional knowledge to deliver about environment and sustainability education (POSQ, 26).

The knowledge and experience the pre-service teachers gained during the intervention appeared to have developed their attitude, not only to teaching environment and sustainability in primary schools, but also to using approaches which they thought would be important for learning, such as the learning activities that were modelled during the intervention.

8.6 Commitment to Action

Table 50 presents the analysis of the participants' views about the action they would take after the lessons about teaching environment and sustainability. The data in the table were thematically analysed from the responses of the pre-service teachers on the reflection journals when they were asked about how they might apply what they had learnt.

Table 50 Pre-service teachers' action plans based on knowledge and experience gained in the intervention

Action plan	Percent
Teach about environment and sustainability in primary schools	67
Create awareness for family and community members	24
Other actions (e.g. conserve the animals)	9

The majority (67%, n=81) of the participants reported being committed to teaching environment and sustainability in primary schools; these pre-service teachers wrote in their reflection journals about lesson 5:

I will teach my students about animals, especially the endangered species (RJ1, 17); and

[I will] teach them how to look after the environment in their local areas... and take sustainable action whenever necessary (RJ1, 24).

Another action that the pre-service teachers wanted to take was to create awareness of environmental issues for their family and community members.

Two respondents stated:

I must teach my own family and community members to [care for and] preserve some of the species that are endemic and endangered (RJ1, 75); and

I would like [to] encourage the community to look after the flora and fauna because it makes up the beauty of [PNG and the] world (RJ1, 3).

The most common action the pre-service teachers planned to take was to help other people become aware of the issues, especially by teaching the students in primary schools and creating awareness for family and community members, which was in line with the aim of the intervention. However, a few of the participants planned to take other actions to contribute to sustainable future of

PNG. Although there is no guarantee that these pre-service teachers will teach EEfS as they planned, it is evident that these pre-service teachers clearly indicated the importance of teaching primary school students about environment and sustainability at this time.

This was also evident when pre-service teachers were asked in the pre- and post-intervention questionnaires to describe their beliefs about the importance of teaching primary school students about environment and sustainability. In the pre-intervention questionnaire, 79% of participants responded that it was important that primary school students were taught about environment and sustainability, and 63% of them gave reasons why they believed this. In the post-intervention questionnaire, all (100%, n=81) of the participants responded that it was important that primary school students were taught about environment and sustainability, and 78% of them gave reasons why they believed this. Table 51 shows their reasons for teaching environment and sustainability. The data were thematically analysed from responses when they were asked if they thought teaching primary school students about environment and sustainability was important.

Table 51 Reasons for Teaching EEfS in Primary schools

Reasons for teaching EEfS in primary school is to develop the needed:				
	Environmental and sustainability knowledge (%)	Skills for sustainable action (%)	Environmental attitudes and behaviours (%)	Competence for sustainable action (%)
Pre-intervention (n=81)	63	14	11	43
Post- intervention (n=81)	76	46	58	69
Change	13	32	47	26

From Table 51, it can be seen that prior to the intervention a significant number of pre-service teachers believed it was important that primary school students were taught about environment and sustainability to help them develop the

needed knowledge (63%) and competence to take sustainable action (43%).

These pre-service teachers wrote on the pre-intervention questionnaire:

Yes, it is important for them to learn about environment and sustainability because it is a growing issue that needs greater consideration (PREQ, 41); and

It is important because the children have to be made aware of these issues so that in the future they will [participate] in decision-making or whatever action taken to fight against these problems (PREQ, 34).

However, few of the respondents saw as important the development in their students of skills which would prepare them for action in the environment.

After the intervention, the proportion of participants who thought it was important that primary school students were taught about environment and sustainability had increased. This seems to indicate that they had come to consider that children should be empowered so that they could contribute to the sustainable future of PNG.

The greatest increase was observed in their perception about attitude and behaviour (increased by 47%) and skills and process (increased by 32%). These findings may have resulted from the active and reflective learning activities which the pre-service teachers were engaged in during the intervention because the critical reflection they were required to practise may have encouraged deep learning and developed a feeling of responsibility for sustainable action.

8.7 Reflection

During the intervention the pre-service teachers were taught that development of action competence requires that learners are reflecting and making connections between current knowledge, and how they might base future action on prior and current knowledge and experience. Thus, as teachers it was

important for them to learn how to reflect critically on past and present knowledge and experiences in order to develop strategies for future actions and experiences.

This was emphasised to the participants during the intervention by engaging them in reading and discussing about the benefits of reflection of lessons and actions and by encouraging them to reflect on their lessons throughout the intervention. Their reflection was guided by questions: What was the lesson about? Did you learn anything new? If so, what? How might you apply this learning in future? Has this lesson influenced your thinking about teaching environment and sustainability? If so, how? Is there anything more you would like to know about the idea raised in this lesson? There is evidence that the pre-service teachers were reflecting on the lessons they learnt in the intervention. This was indicated by the fact that all (100%) participants reflected on the lessons 4 and 6, and 83% of the participants reflected on pedagogies that were used during the intervention. Further, as part of their reflective writing they wrote about their thoughts and feelings about the lesson or course. For example:

When I think deeper, I realize that the animals and plants are endangered because more and more people are taking them and using them for many different purposes. People have to change and take sustainable actions to change the situation.... I am convinced to teach environment and sustainability because if we do not [do anything about it] we will lose all the valuable plants and animals we have today (RJ1, 67).

The participants also understood that critical reflection is necessary in EEFs; as was reported in 7.3.5, after the intervention 97% of pre-service teachers considered that critical reflection about environment and sustainability learning was necessary. In addition to that, the pre-service teachers were asked to write any other relevant comments they might have on their post-intervention questionnaire. Seven percent of them said they would provide opportunity for

their students to critically reflect on their actions and lessons, as these respondents stated:

I will make them think critically about their actions and how these actions will affect others (POSQ, 79); and

I will make the children think critically about the actions they take and lessons they learn in class so that they can learn from the experiences they have and the lessons they learn (POSQ, 10).

The pre-service teachers were able to think critically about the things they learnt during different lessons in the intervention, their feelings about the things they learnt and then commit to act on them in the near future. Critical reflection on actions taken and lessons learnt can lead to deeper learning and well-informed decisions and actions.

8.8 Summary on action competence

The pre-service teachers gained knowledge, experience, skills and values required by participating in the process of identifying issues and investigating causes, effects and solutions for issues and planning to take informed action. This is indicated by the commitment they made to contribute to sustainable future in their:

- action plans;
- reflection journals; and
- post-intervention questionnaire.

Generally, the pre-service teachers said they had gained knowledge and experience by participating in activities, learning things about environment and sustainability concepts and issues, and by reflecting on the lessons learnt and actions taken and planned.

The three most commonly identified environmental issues identified in this section and in section 6.2 are threats to endangered species, pollution, and land-related problems. Endangered species were one of the three main issues identified by the pre-service teachers in the research. This may have been because the issue of endangered species was thoroughly studied in the intervention, including the excursion, where the pre-service teachers actually saw the endangered species and after seeing them and learning about them, reflected on their learning lessons.

Land-related problems are of concern in PNG because 97% of the land is owned by the customary land owners. They are owned collectively by members of the clans or by the people who live on the land. These people collectively manage the land use, and transfer, according to their beliefs and values. The right to use the land for different purposes such as building houses, fishing, gathering plants for food or other needs, or collecting firewood are handed down from generation to generation without written record. It is usually through inheritance from father to sons, except in a few cases where daughters inherit from their mothers. The system worked well when all the clan members were living on the land, when the clan population was small enough for the land to cater for all the clan members and when everyone on the land belonged to the clan. However, this is no longer the case; not all clan members stay on the clan land because of education and employment, the numbers of people in the clans are rapidly increasing, and intermarriage means not everyone on the land is a full clan owner. Disputes over land are complex because no written records of ownership or land boundaries were kept. The issue requires a holistic change in people's beliefs, values and behaviour at the personal and group level.

The experience the participants had in identifying environmental issues, their causes and effects and possible solutions persuaded them to commit to taking both direct and indirect action, including teaching EEfS.

The participants who reflected on the learning activities said they were planning not only to teach environment and sustainability but also to use the methods they had identified as effective learning activities. Thus, about half of the pre-service teachers said they wanted to use the KWL chart and the excursion whilst about a third of them said they wanted to use simulation and the Follow Me Game as learning activities to deliver EEfS. They also planned to utilise traditional knowledge in their teaching.

This commitment based on the change in the participants' perceptions of environmental issues was in accordance with the aim of the intervention. Thus, there is evidence that the implementation of the intervention course may have achieved its aims.

The pre-service teachers reported they had gained knowledge, experience and skills through the learning activities in which they had participated; and this had included identifying and solving problems and developing units of work for teaching EEfS in primary schools.

The student teachers had appeared to come to see that for people to be willing and qualified to address problems they need to be knowledgeable, experienced in reflecting and taking action, and committed to a vision for sustainable action. It is difficult to know at this stage if they will actually carry out their plans. However, it is possible to say that all learning experiences and taken actions will soon become experience that will facilitate future actions. Thus, it can be said that the pre-service teachers who had learnt and had experiences in environment and sustainability issues as part of their EEfS lessons had developed some action competence

Chapter Nine

9. Discussion, Conclusion and Recommendation

9.1 Chapter Overview

This chapter presents the discussion of the findings and the conclusions in this research. The discussion of the findings is presented in three sections as: (1) Existing Practice, which focuses on the findings in Phase One of the study that informed the intervention; (2) The intervention, which discusses the design and implementation of the intervention; and (3) Impact of the Intervention, which discusses the findings in Phase Two of the study. Conclusions are then drawn, followed by implications for EEfS in teacher education in PNG, and the chapter and the thesis finishes with some thoughts about further research.

9.2 Existing Practice

This is the discussion of findings on practices prior to the intervention in response to research question one: What are the existing practices of EEfS in PNG pre-service teacher education prior to the intervention course? The section examines existing policies, student knowledge and teacher pedagogy.

9.2.1 Policies in place

The Government of PNG expects all its citizens, including teacher educators and primary school teachers, to take action to contribute to the future sustainability of PNG's environment and resources. The Government's concern for environment and sustainability, and the expectation for its citizens to take sustainable action, is clearly stated in the PNG Constitution within the Five National Goal Directive Principles (Chalmers & Pliwala,1984; PNG Government, 1975).

The Government of PNG expects all its citizens, including teacher educators and primary school teachers, to take action to contribute to the future sustainability

of PNG's environment and resources. The Government's concern for environment and sustainability, and the expectation for its citizens to take sustainable action, is clearly stated in the PNG Constitution within the Five National Goal Directive Principles (Chalmers & Pliwala, 1984; PNG Government, 1975). These National Goal Directive Principles are acknowledged and emphasised in a number of Departmental and divisional policies including the Teacher Education National Curriculum Guideline (TENCG) and National Curriculum Statement (NCS). The TENCG is responsible for guiding the training of primary school teachers (PNGNDoE, 2004a) and the NCS is the policy responsible for guiding the training of primary and secondary school children (PNGNDoE, 2003d).

The Teacher Education Division of PNG expects teacher educators and teachers to take action to contribute to the future sustainability of PNG's environment and resources. A careful analysis of the TENCG revealed that, although there are no clear statements about the specific delivery of EEfS in the TENCG, there are indications that the teacher educators are expected to deliver EEfS (PNGNDoE, 2004a). This expectation is emphasised by the inclusion of modules that contain environmental and sustainability concepts and issues in the teacher education curriculum. Thus, the teacher educators are expected to deliver EEfS at the teachers' colleges and help the pre-service teachers to develop their knowledge, skills and values towards sustainable living and teaching of EEfS in primary schools.

The PNG Department of Education appears to expect teachers to deliver EEfS in schools, including primary schools. In analysing the NCS, it was discovered that the Department of Education is expecting the teachers not only to deliver EEfS to primary school children, but also to deliver it using appropriate pedagogies (PNGNDoE, 2003d). This expectation is emphasised by the relatively recent development of EEfS-related subjects in primary school, namely 'Environmental Studies' (PNGNDoE, 2003c) and 'Making a Living' (PNGNDoE, 2003b). The

Department's expectation for the delivery of EEfS through at least these subjects in primary schools is therefore spelt out clearly in both the NCS and the related school syllabi (PNGNDoE, 2003 a, c, d).

However, this study has found that there is a gap between the expectations of the TENCG and the NCS, and both the training modules for training the pre-service teachers at the Teachers College that were in existence at the start of this study. Prior to the intervention, there were no clear statements guiding teacher educators to deliver EEfS at the College and no clear statements linking development of EEfS in the College to the delivery of EEfS in primary schools. In addition, the Social Science Department has modules for delivering aspects of environmental and sustainability learning in the College but it is not responsible for preparing pre-service teachers to deliver EEfS in primary schools. These findings seem to indicate that the pre-service teachers at the College were not being supported to deliver EEfS in schools. This finding indicated that there is a gap that needs to be bridged between the political expectations of the TENCG and NCS and the support for delivery of EEfS in the teacher's colleges.

The next section presents the discussion on existing practice in delivering content knowledge about environment and sustainability at the College.

9.2.2 Content Knowledge

The knowledge linked to EEfS that the pre-service teachers were learning at the College was investigated, along with what they and the College staff felt was important knowledge to learn in order for the pre-service teachers to be ready to deliver EEfS in schools. Findings related to teaching and learning of environmental issues in PNG, the key concepts of EEfS, and the value of local traditional knowledge of PNG prior to the intervention are discussed in this section.

9.2.2.1 Environmental Issues

The staff and students in the Teachers College were aware of environmental issues experienced in PNG but there appeared to be a lack of teaching and learning about these issues at the College. In examining participants' perceptions about environmental issues, it was discovered that both staff and student participants of this study were aware of some environmental issues currently being experienced in PNG. This awareness was indicated in their responses especially regarding issues of global warming, deforestation, mining, population growth and pollution, that have previously been reported in PNG by Aka (2001) and Cammack (2009). Global warming was the issue most frequently identified by the participants, perhaps because it is the most frequently discussed and reported issue in PNG (Aung, Kaluwin & Lennon, 1998; Eroro, 2004). Mining was the second most frequently identified issue by the participants, and this issue has often been discussed as a root cause of many other social, economic and environmental issues (Esonu, 2009; Gibson et al., 2004). The participants were aware not only of the existence of environment and sustainability issues but also of the need for pre-service teachers to learn about them (Fien & Tilbury, 1996). This was indicated by the analysis of their responses which showed that, although they felt there was a need for the pre-service teachers to learn about environmental issues experienced in PNG, they felt the pre-service teachers were not learning about them adequately. This could be due to a lack of clear statements of instruction in the TENCG instructing the teacher educators to teach about environmental issues in PNG and to help pre-service teachers link them to subjects in primary schools (PNGNDoE, 2004a). There was also some evidence that the teacher educators felt that they could not deliver as much content knowledge as they wanted to deliver because of limited time and funds, which are barriers to delivering EEfS that have previously been identified by Cowie and Eames (2004) in their discussion of outcomes of the evaluation of environmental education practices in New Zealand Schools. Therefore, it would seem important to include discussion of environmental issues in an intervention to better prepare the pre-service teachers to teach EEfS in schools.

The next section presents discussion of the findings related to teaching and learning the key concepts of EEfS.

9.2.2.2 Key Concepts of EEfS

Analysis of the College's course documents prior to the intervention showed that the existing EEfS-related science course aimed to deliver concepts such as biodiversity, systems thinking and interdependence related to the natural environment, but did not relate them to cultural, social and economic sustainability, nor explicitly relate them to their importance in the natural environment (Chapman & Eames, 2007). On the other hand, the existing EEfS related social science course at the College aimed to deliver concepts such as cultural diversity and lifestyle, but did not appear to have linked them to their possible environmental impact.

Equally, analysis of the responses of student and staff participants in Phase One of the study illustrated a lack of emphasis on teaching and learning of key concepts of EEfS, including the relationship between natural, social, cultural and economic systems during the delivery of EEfS at the College. This could be due to the fact that there were no clear statements of instruction in the TENCG instructing the teacher educators to teach about key concepts of EEfS (PNGDoE, 2004a). It could also mean that the teacher educators were unaware of the key concepts of EEfS (Chapman & Eames, 2007; PCE, 2004). It would seem important for the pre-service teachers to develop an understanding of the key concepts during their EEfS training so that they would feel confident in designing their teaching for EEfS in schools. Therefore, inclusion of explicit teaching of key concepts in the intervention was required.

The next section presents the discussion on use of traditional knowledge.

9.2.2.3 Local Traditional Knowledge

A lack of emphasis on the use of local traditional knowledge at the College was indicated from a careful analysis of existing college documents and practices. There seemed to be no clear evidence of the use of local traditional knowledge about environment and sustainability in the delivery of EEfS in science at the College. On the other hand, although there were College cultural activities and delivery of concepts related to culture in the social science curriculum, there appeared to be no clear connections in this curriculum with environment and sustainability concepts and issues. The teaching staff did indicate that they thought it was too difficult to utilize the wide variety of cultures present in PNG, thought to number over 800, and this may be one reason for this lack of emphasis. It could also be due to the fact that there was no clear statement in the TENCG guiding the teacher educators to utilize local traditional knowledge about environment and sustainability. Or it could also mean the teaching staff were unaware of the benefits of utilising local traditional knowledge.

Despite these problems, it was considered to be important to include local traditional knowledge in the intervention. This is because local traditional knowledge, like Western scientific knowledge, is thought to be a powerful and legitimate source of knowledge, derived from systematic observation of nature (Kimmerer, 2002). It is rational and reliable and has the capacity to assess, control, monitor and make predictions about resources, succession, weather, species interaction and sustainable harvesting system (Ellen, & Harris, 2000; Kimmerer, 2002). Furthermore, it recognises the lived experiences of the pre-service teachers and the students that they would ultimately teach in schools, and provides great opportunities to connect to sustainability embedded in those experiences.

9.2.3 Pedagogy

In this section, the use of currently advocated pre-service teacher education pedagogy and EEfS pedagogy at the College prior to the intervention are discussed.

9.2.3.1 Pedagogy in Pre-service Teacher Education

In Phase One of the study, the pre-service teachers reported that the main teaching approaches used in EEfS-related courses were lecturing followed by group work. Lecturing is a teacher-centred learning approach, which is not a widely-recommended approach for learning in teacher education because it reduces the chance of the students to use the information available from their own experiences to develop new knowledge (Ballantyne & Packer, 1996; Sterling, 2001). The common use of lecturing could be because this method requires teaching staff to take less time and resources to prepare and present their material, and it may also mean they do not use other approaches due to lack of resources and funding (Cowie & Eames, 2004). Furthermore, it could mean the teaching staff were unaware of the benefits of using student-centred approaches.

The second most commonly used approach was working and learning in a group, which is one of the recommended learning approaches for pre-service teacher education (Macaulay & Gonzalez, 1996; Mandal, 2009). This could be because the teaching staff knew about the benefits of students learning together in small groups. Also the staff may have used group work because it is easier to prepare using less time, without them actually being aware of its benefits, as they gave no clear explanation for using the approach. There was no evidence of the use of other active student-centred learning activities in EEfS-related courses at the College. However, the pre-service teachers reported being taught about a number of student-centred learning approaches, including cooperative, constructivist and socio-cultural learning approaches in their courses (Ballantyne & Packer, 1996; Mandal, 2009), but less about approaches such as inquiry-based learning and experiential learning (Barker & Rogers, 2004; Lipowski, 2008).

The analysis seems to indicate that some knowledge about student-centred learning approaches was delivered through lectures and not through practically modelling them. This could be because the teaching staff were not aware of the

benefits of modelling these approaches to the pre-service teachers (Lortie, 2002; Loughran, 2006; Mcleod, 2011). As such, it would seem important to emphasise student-centred learning approaches in the intervention by modelling them.

9.2.3.2 Pedagogy for delivering EEfS

In analysis of the college documents and responses of the participants, it was discovered that there indications of interest to use some EEfS pedagogies but there was no evidence to show that they had been used. For example, there was a lack of evidence of:

- EEfS being viewed and dealt with as a multidisciplinary subject, relating natural, social, cultural and economic systems;
- students involvement in deciding what they wanted to learn, and how they want to learn what they wanted to learn;
- field trips or excursions as part of delivery of EEfS at the college. This could be due to lecturers being unaware of the benefits of students learning EEfS from direct contact and observation;
- engaging students in resolving local workable environmental issues when delivering EEfS at the college ; and
- evidence of use of critical reflections of lessons learnt and actions taken.

These are active learning strategies which can empower the students to exercise responsibility and take appropriate actions (Baker & Rogers, 2004; Lucas, 1979; Tilbury, 1995), however they appeared to be lacking as approaches being used in teacher education to train the pre-service teachers. The lack of evidence of use of these EEfS pedagogies may be because teaching staff were unaware of the benefits of using them, or it could also be due to lack of time, funds and other resources, particularly with regard to field trips. This is a common problem in many schools and institutions, with the reason often being given as an overcrowded curriculum (Cowie & Eames, 2004). Therefore, it seemed important that any intervention for EEfS at the College would attempt to build in these EEfS pedagogies, where possible.

The analysis of policies, student knowledge and teacher pedagogy led to an understanding that there were gaps between existing practice at the College and PNG expectations and international recommendations for EEfS. These gaps were addressed through the design of a teaching intervention which is discussed next.

9.3 The intervention

The design of the intervention was informed by the contemporary literature on teacher education and EEfS and the existing practice examined in the Phase One Study. The discussion in this section is in response to research question two: How can a course be designed to reflect:

- Local environment and sustainability issues;
- Key Concepts of EEfS;
- Local traditional knowledge; and
- Current ideas about pedagogy in teacher education;
- Current ideas about EEfS pedagogy?

9.3.1 Content Knowledge

The study of local environmental issues, key concepts of EEfS and local traditional knowledge were included in the intervention as the content.

9.3.1.1 Environmental Issues

The intervention included local environmental issues as contexts for developing knowledge, values and attitudes, because analysis of participants' responses in the Phase One study indicated:

- a lack of emphasis on environment and sustainability problems during the delivery of EEfS at the college; and
- they felt that PNG was experiencing environmental issues and that they should learn more about them at the College.

The intervention course was designed to help the pre-service teachers to learn about environmental issues by reading about, observing, discussing and reflecting on them as individuals, in pairs, in groups and in classes. The problems

were also studied or covered through real and simulated excursions, role plays and games. Including environmental issues in EEfS is being consistent with the knowledge goal of EEfS in the *Tbilisi Declaration* (UNESCO, 1978) and Tilbury's idea about EEfS as issued-based education (Tilbury, 1995). Furthermore, the causes, effects and solutions of environment and sustainability problems were studied through the pre-service teachers doing a project on identifying, investigating and resolving local environment and sustainability problems. Engaging the students in identifying and resolving environmental problems is being consistent with the participation goal of EEfS in the *Tbilisi Declaration* (UNESCO, 1978), Tilbury's idea about EEfS as being action-oriented education (Tilbury, 1995), Lucas' idea about education being about, in and for environment (Lucas, 1979), and that such a focus on local issues can help to produce action competent people (Jensen & Schnack, 1997).

9.3.1.2 Key Concepts of Environment and Sustainability Education

Key concepts of EEfS were included in the intervention because analysis of the participants' responses in the Phase One study appeared to indicate a lack of emphasis on key concepts of EEfS, which includes the relationship between natural, social, cultural and economic systems, during the delivery of EEfS at the college. Including study of key concepts of EEfS in the intervention was being consistent with the development of awareness and sensitivity to environment issues as one of the goals of EEfS in the *Tbilisi Declaration* (UNESCO,1978).

The key concepts included in the intervention were biodiversity, local traditional knowledge as cultural diversity, interdependence, lifestyle and sustainable actions or practices. Like environment and sustainability issues, the intervention key concepts of EEfS were read about, observed, discussed and reflected on as individuals; in pairs, groups and class; and studied or covered through real and simulated excursions, role plays and games. The key concepts were studied as part of holistic study of environment and sustainability issues, as it is recommended to address these issues in a multidisciplinary way (Chapman &

Eames, 2007; Tilbury, 1995). Sustainable action was the most common concept studied and stressed in the intervention as this is a key concept in EEfS (IUCN/UNEP/WWF, 1991), and one that many teachers find challenging to understand (Barker & Rogers, 2004). Putting emphasis on sustainable action is also being consistent with current EEfS literature, including Tilbury's idea of EEfS as action-oriented education (Tilbury, 1995).

An important concept that was studied and stressed in the intervention was local traditional knowledge, which is discussed next.

9.3.1.3 Local Traditional Knowledge

The local traditional knowledge was included in the intervention course because the analysis of existing practices seemed to indicate a lack of emphasis on local traditional knowledge about environment and sustainability in the delivery of EEfS at the College. The intervention course included local traditional knowledge, which it is relevant for PNG as the majority of its people live in rural areas and employ traditional methods of gardening, hunting, fishing and cooking (Mcleod, 2011; Tilbury, 1995). Efforts were made to cover local traditional knowledge in the lessons to help the students share with each other and understand how resources from the forests are used for purposes like food, medicines, fuel and cooking and eating utensils (Mcleod, 2011). The pre-service teachers then were asked to complete a reflection journal on the lessons using critical reflection to help them think deeply about these practices and how they connect to concepts of sustainability (Tilbury, 1995). There were also lessons in which the pre-service teachers worked in groups to share their knowledge about hunting, gathering, fishing, gardening and cooking, and about plants and animals used as food, medicine, decorations, building materials and then to report their combined knowledge to the class. Teacher educators utilizing local traditional knowledge about environment and sustainability when delivering EEfS is consistent with chapter 26 of *Agenda 21* which promotes recognition and strengthening of indigenous communities and their knowledge in EEfS (UNCED, 1992), and

Tilbury's ideas about EEfS as being value based and relevant education (Tilbury, 1995).

9.3.2 Pedagogical Knowledge and Skills

The pedagogical knowledge and skills related to pre-service teacher education and EEfS that were included in the intervention are discussed in this section.

9.3.2.1 Pedagogy in pre-service teacher education

In the existing practice at the College, the most commonly used method of delivering EEfS in teachers college was found to be lecturing, whilst many of the currently advocated learner-centred learning approaches were lacking, excepting group work. The pre-service teachers were regularly lectured and they worked in groups to learn to discuss issues, complete work, do research and presentations.

Therefore, other student-centred approaches that are currently advocated were included in the intervention. The most frequently used learning strategies were inquiry based learning, experiential learning and cooperative learning in that order (Barker & Rogers, 2004; Lipowski, 2008; Mandal, 2006). These learning approaches were frequently used because the participants of the Phase One Study had indicated a need for more teaching, and particularly modelling of these approaches, and because they connect well with learning that is issue-based and relevant (Barker & Rogers, 2004; Fien & Tilbury, 1996; Moore, 2004).

9.3.2.2 Pedagogy in EEfS

Analysis of pre-service teachers' responses indicated that they had varied views about many environment and sustainability concepts, and that there was a lack of evidence of the use of EEfS pedagogies to help the pre-service teachers develop understanding of these concepts. Thus, the intervention course included EEfS pedagogical practices such as using environment and sustainability issues as the context for learning. These issues included biodiversity depletion, endangered species, deforestation, land disputes, land degradation, and

population growth. In addition, the intervention was designed to help the pre-service teachers study EEfS as a multidisciplinary subject (Eames & Cowie, 2004) and to study it holistically through locally relevant issues and concepts, first-hand experience, engagement in resolving issues, and critical reflection (Fien & Tilbury, 1996; Tilbury, 1995). The course was designed to help the pre-service teachers to develop knowledge, values and skills about EEfS pedagogies by reading and discussing about these pedagogies, observing and reflecting on them and by participating in EEfS lessons that employ them (Fien & Tilbury, 1996; Tilbury, 1995). The learning activities and approaches expected to be used by the pre-service teachers were modelled to them, and the pre-service teachers were asked to reflect on their use (Lortie, 2002; Loughran, 2006; Russell & Loughran, 2007). These pedagogies were used to encourage pre-service teachers to develop action competence by gaining knowledge and experience by taking actions and reflecting on the lessons learnt and the actions taken in the intervention (Fien & Tilbury, 1996; Tilbury, 1995).

The impact of intervention is discussed next.

9.4 Impact of the intervention

The impact of intervention on pre-service teachers' knowledge, perceptions, and attitudes is discussed in this section and responds to research question three: What impact does the intervention have on pre-service teachers' perceptions about:

- environment and sustainability concepts and issues
- pre-service teacher education, and EEfS, pedagogy
- their own competence for action?

9.4.1 Impact on Content Knowledge

The pre-service teachers' perceptions of their learning of environmental issues in PNG, key concepts of sustainability, and local traditional knowledge of PNG in the intervention are discussed beginning with environmental issues.

9.4.1.1 Environmental issues

Firstly, the pre-service teachers were aware of environment and sustainability issues prior to the intervention on EEfS which means they had some knowledge about the topic before they started learning about it in the intervention. This recognition is in line with a constructivist view that every learner comes to a learning situation as a unique individual with unique needs, interests, knowledge and experience (Ballantyne & Packer, 1996; Terwel, 1997).

Mining, pollution, global warming and deforestation were viewed as problems prior to the intervention, perhaps because these environmental issues are frequently discussed in the national local newspapers. On the other hand, the finding that pre-service teachers did not view poverty, biodiversity depletion and land use as environmental problems is contradictory to the discussions in the literature, and may indicate lack of knowledge about environment and sustainability issues. With the issue of poverty, where PNG is labelled chronically poor in a UN report by Cammack (2009), and issue of land use, which is discussed frequently as and disputes and compensations, it could be that the pre-service teachers did not view it as an issue affecting the nation.

Secondly, prior to the intervention the pre-service teachers only identified mining and logging and other industrial activities as the main environmental problems, and some went on to connect these activities to all other biological and physical environment problems. They did not make explicit connections that all people including themselves are in one way or another contributing to the destruction of the environment, which may lead them to not feel responsible for resolving environmental issues (Jensen & Schnack, 1997). However, after the intervention a number of participants realised that deforestation and depletion biodiversity can also be caused by people's normal survival activities such as gardening, building house, fishing, hunting and gathering (Cammack, 2009). Furthermore, peoples' survival activities were viewed as the main causes of biodiversity depletion, deforestation, endangerment of threatened species, land

degradation, pollution and global warming, and that, for some, these in turn were seen to be caused by rapid population growth. This finding may be linked to the majority of people in PNG living in rural areas and employing local traditional ways of gardening, fishing, hunting and gathering. Also, developing knowledge about environment and sustainability issues is one indication of developing action competence (Fien & Tilbury, 1996)

Thirdly, the pre-service teachers' knowledge about environmental issues appeared to increase, leading them to change their perception about some environmental issues. Most pre-service teachers perceived that biodiversity depletion, deforestation, threats to endangered species, land dispute and degradation, pollution, global warming, mining, population growth, and unequal resource distribution are issues in PNG. In particular, biodiversity depletion, endangered species, land dispute and degradation, population growth and unequal resource distribution. In addition, the explanations that the pre-service teachers gave of their views in the post-intervention questionnaire increased both quantitatively and qualitatively, with more explaining their views and identifying more and different causes and effects of the environmental issues. In particular, there were large increases in the number of pre-service teachers who commented on endangered species, depletion of biodiversity, land dispute and degradation and population growth. This finding seems to confirm Tilbury's view about making EEfS relevant and issue-based can increase knowledge and values (Tilbury, 1995), and Lucas' view about providing EEfS as education in the environment (Lucas, 1979) to improve learning (see also Ministry of Education, 1999).

Fourthly, also after the intervention, the pre-service teachers seemed more ready to acknowledge that people including themselves are causing environmental problems and so people like themselves need to take part in solving these problems (Jensen & Schnack, 1997). They also identified education as a solution which they can be involved in, to address these environmental

issues indirectly by providing education and awareness to their students and their families and communities. This finding is consistent with findings in a study by Gopal (2004) who found that those who gain more knowledge about environmental issues are more likely to take action to resolve the issues. Thus, inclusion of environmental issues in the intervention may have contributed to an increase in pre-service teacher's perceptions of their knowledge about environmental issues in PNG.

Fifthly, interestingly, the pre-service teachers had varied views about poverty in PNG, which did not change much after the intervention. The finding that the pre-service teachers had varied views about poverty in PNG that persisted in spite of efforts in the intervention to help the pre-service teachers understand poverty was a problem in PNG. The response is unexpected but it is consistent with a UN report by Cammack (2009) that found that people in PNG, especially the rural people, do not see themselves as poor. This is because their view about poverty is based around basic food and shelter from the natural and social environment, regardless of the quality. In other words, their perception of poor people is people without food, shelter, land relatives and friends. Thus, since they have food, shelter, land, friends and relatives they do not regard themselves as poor.

In addition to that, culturally people share with each other the little they have. This may be possibly due to their view of poverty and the socio-cultural support system that is practiced in almost all societies in PNG, known as the wantok system. Under this system, no one is expected to be poor in PNG, because every person is part of a clan, and all clans or tribes have pieces of land in which all the members are expected to use the land and all other resources on clan lands. In the wantok system as a social support system, people in the family and clan are expected to share what they have or earn with other people in the family or clan, especially the poor and needy and so no one is supposed to be rated poor (Wantok System, 2010). All people are expected to share with each other regardless of where they reside or work. Apart from that, they are allowed by a

law to trade informally and so when they need money, they can get the materials from the environment or their subsistence gardens and sell them and get money. However, tribal fights and land degradation are increasingly becoming a problem due to rapid population growth, contributing to the wantok system not working as has in the past.

Finally, after the intervention, the pre-service teachers seemed more ready to acknowledge that people including themselves are causing environmental problems and so people need to take part in solving these problems. They also identified education as a solution which they can be involved in, to address these environmental issues indirectly by providing education and awareness to their students and their families and communities. These findings are in line with EEfS goals from the *Tbilisi Declaration* (UNESCO-UNEP, 1978), and may be linked to the efforts made to help the pre-service teachers learn and develop knowledge, skills and values to take action to contribute to future environmental sustainability (Jensen & Schnack, 1997). Pre-service teachers identified education as a solution which they can be involved in, to address environmental issues indirectly by providing education and awareness to their students and their families and communities. This view about education as one solution is consistent with proposal in the Charter of Belgrade (UNESCO, 1976), *Tbilisi Declaration* (UNESCO-UNEP, 1978), and emphasis by UNCED as critical for promoting sustainability and improving capacity of people to address environment and sustainability issues (UNESCO, 1992), as well as Jensen and Schnack's idea that action taken can be both or either direct and in direct as long as it contributes to future sustainability (Jensen & Schnack, 1997).

9.4.1.2 Key Concepts of EEfS

Firstly, prior to the intervention a number of the respondents considered social and economic development activities were affecting the natural environment,

and that people's social and cultural backgrounds affected their attitude towards the environment. Like any other learning situation, learners in this case had some prior knowledge about key concepts of environment and sustainability, including EEfS before formally learning about it (Ballantyne & Packer, 1996; Terwel, 1997).

The pre-service teachers' perceptions of their knowledge about key concepts of EEfS increased after the intervention. The greatest changes observed were in their perceptions that social and economic development activities are causing environmental problems, followed by the view that people living in rural areas in PNG are causing environmental problems, and that people's social and cultural backgrounds affect their attitude to the environment. The view that social and economic development activities are causing environmental problems is consistent with current views of people about development (Chapman & Eames, 2007). Unsustainable social and economic developments usually cause other environmental problems because social and economic developments are occurring in the environment and as systems; they are interdependent with the other systems (Chapman & Eames, 2007). The view that people living in rural areas in PNG are causing environmental problems is indicative that most of its people live in rural areas and use resources directly from the environment. The view that people's social and cultural backgrounds affect their attitude towards the environment is consistent with Jensen and Schnack 's view that environmental problems are social problems structurally anchored in the society and people's way of living (Jensen & Schnack, 1997).

Secondly, prior to the intervention there was a diverse range of beliefs in response to the statement "The use of advanced technology in cities is causing environmental problems". However, after the intervention there was a clear increase in the number of participants who agreed with this statement. advanced technologies were discussed as producing and emitting waste into the

environment and extracting more resources out of the environment, as in fishing and mining industries, as well as supporting economic growth and development.

Thirdly, prior to the intervention a majority of the participants said that development in transport and communication had improved the quality of life in PNG (Watson, 2009). After the intervention, the proportion of pre-service teachers who supported these statements decreased slightly; however, the majority maintained their view. This seems to indicate a perception amongst participants that because PNG still has a great lack in transport and communication systems, that this may in turn suppress or hinder other activities and developments (Cammack, 2009; Watson, 2009)

Lastly, prior to the intervention the many of the pre-service teachers were uncertain of their beliefs about whether they should learn to live in harmony with their environment, or that people in PNG should learn how to manage the environment so as to improve quality of life. After the intervention, this uncertain group was very dominant (80% of participants), indicating that this may be a highly complex concept for these pre-service teachers, reflecting the tensions between preservation and exploitation that currently exist in PNG society.

9.4.2 Impact on Pedagogy

The impact of the intervention on pre-service teachers' perceptions about teacher education, and EEfS, pedagogies is discussed in this section.

9.4.2.1 Pedagogy for Teacher Education

Prior to the intervention, the pre-service teachers perceived that pedagogies such as constructivist, experiential, inquiry based cooperative and socio-cultural learning were appropriate for teaching environment and sustainability (Ballantyne & Packer, 1996; Baker & Rogers, 2004; Mandal, 2006). The pre-service teachers indicated that they had some knowledge about these learning strategies before the intervention. A high number of pre-service teachers identified experiential, inquiry based and cooperative learning as appropriate for

teaching EEfS and these are common approaches the participants are expected to be exposed to at the College, as they were recently introduced as part of the educational reform in PNG (Maha et al., 2002). Apart from that, experiential learning is also used in the traditional education system where important survival information, skills and knowledge are passed from one generation to another through experiences.

After the intervention, the number of pre-service teachers who perceived that student-centred learning strategies such as constructivist, experiential, inquiry-based, cooperative and socio-cultural learning were appropriate for teaching environment and sustainability generally increased (Ballantyne & Packer, 1996; Barker & Rogers, 2004; Lipowski, 2008; Mandal, 2006; Mcleod, 2011). It is inferred that the efforts made in the intervention has led them to become more aware that student centred learning strategies such as constructivist, experiential, inquiry based cooperative and socio-cultural learning were appropriate for teaching EEfS in PNG schools (Apedoe, Walker & Reeves, 2006; Ballantyne & Packer, 1996; Barker & Rogers, 2004; Mcleod, 2011).

The greatest increase in the pre-service teachers' perceptions of usefulness in delivering EEfS was observed in their views about the use of traditional teaching methods, but the total number of pre-service teachers who perceived traditional teaching methods were appropriate for teaching in schools was still lower compared to the number that identified the other pedagogies mentioned above as appropriate for teaching in schools. It is inferred that the efforts made in the intervention has led them to become more aware that traditional teaching methods are appropriate methods for teaching in PNG schools. According to Kimmerer (2002), local traditional knowledge system has the capacity to provide knowledge for decision-making about environmental and sustainability issues. That is consistent with Chapter 26 of Agenda 21 which calls for promotion and strengthening of local traditional knowledge in EEfS (UNCED, 1992). The finding that local traditional methods were less valued than other pedagogies may have

been because local traditional knowledge and learning systems have been suppressed in the formal education system for a long time, even till recently (Openg, 1998)

Most pre-service teachers perceived that 'Learners learn best when given information by the teacher' prior to the intervention, but many participants reported a different view after the intervention and the pre-service teachers who perceived that 'Learners learn best when given information by the teacher' reduced in number, and number of pre-service teachers who disagreed increased, and they tended to describe the teacher more as a facilitator.

9.4.2.2 EEfS Pedagogy

Firstly, there is evidence of change in the perceptions of the pre-service teachers after the intervention. Prior to the intervention, more than half of the participants perceived that:

- knowing the cause of environmental problems is important for solving problems;
- experience is necessary for learning environmental and sustainability;
- understanding environmental and sustainability involves thinking of values; and
- and critical reflection about environment and sustainability learning is necessary.

The proportions of pre-service teachers who perceived these elements to be important in EEfS increased by 10-30% after the intervention. It is inferred that the efforts made in the intervention has led them to become more aware of the learning activities and approaches appropriate for delivering EEfS in PNG schools.

Secondly, prior to the intervention most pre-service teachers perceived that environmental and sustainability issues should be taught through science subjects in schools. After the intervention, the number of pre-service teachers that disagreed with the statement 'environmental and sustainability issues should be taught through the science subjects' in schools increased. This finding

was in line with their responses when they were asked to identify the subjects in primary school that could include environment and sustainability, as they identified nine different subjects, which was five more subjects than they identified for teaching EEfS in the pre-intervention questionnaire. It is inferred that the efforts made in the intervention has led the participants to become more aware that EEfS concepts can be delivered through a number of different subjects in PNG schools. This finding is consistent with current literature on EEfS that environmental issues are multidisciplinary issues and should be studied holistically (Tilbury, 1995; Eames & Cowie, 2004), because environmental issues are usually caused by several factors or actions of people, all of which are interconnected with and affect each other (Sterling, 2001). However, about half of the pre-service teachers were unsure or agreed with the statement 'environmental and sustainability issues should be taught through the science subjects in schools', and this may reflect that the intervention was offered in place of a science course at the College and was delivered by science lecturers. It may also be that the statement on the questionnaire was unclear, and may have been better phrased as 'environment and sustainability issues should *only* be taught through science subjects in schools'.

Thirdly, the greatest change after the intervention was observed in pre-service teachers' agreement with the statement 'critical reflection about environment and sustainability learning is necessary', showing a 30% increase in agreement to 97%. It is inferred that the efforts made in the intervention has led them to become more aware of the benefits of critical reflection in EEfS lessons. This is consistent with literature on EEfS that EEfS is a process of critical analysis of interrelation of systems operating in the environment (Tilbury, 1995; Fien & Tilbury, 1996).

9.4.3 Impact on Action Competence

This section discusses the apparent impact on development of the pre-service teachers' action competence through gaining knowledge, experiences, carrying

out reflection, seeing connectedness and a willingness to take action through teaching EEfS.

The three most commonly identified environmental issues identified were endangered species, pollution and land related problems. Endangered species was one of the three main issues identified by the pre-service teachers in the research. This may be because the issue of endangered species was thoroughly studied in the intervention which included an excursion where the pre-service teachers actually saw the endangered species, and after seeing them and learning about them, they reflected on their learning.

The finding that the pre-service teachers reported making a commitment to take action to contribute to a sustainable future is important and it is inferred that the efforts made in the intervention has caused them to develop knowledge and values necessary for taking to contribute to future sustainability. It is inferred that (1) more exposure to the environmental and sustainability issues have made the pre-service teachers more aware and concerned about the issues, and (2) local and more solvable issues were identified and noted for possible actions by the pre-service teachers.

Pollution and land related problems are local issues which the pre-service teachers could contribute to addressing. The land, water and air pollution are examples of local issues caused by people disposing of rubbish or waste, which it would be possible for the pre-service teachers to take necessary actions to avoid, and educate others to do the same. Thus, it is reasonable that pre-service teachers were concerned about these issues and made commitment to address them. Land-related problems are issues of concern in PNG because 97% of the land is owned by the customary land owners, collectively by the people who live on it or by clan members and they manage or control land division, use, and transfer according to time-honoured tradition, which varies from area to area (Cammack, 2009). It is becoming a big problem that needs attention because not

all clan members stay on the clan land because of a need for education and employment, the numbers of people in the clans are rapidly increasing, and at the same time there are intermarriages, all of which mean not everyone on the land is full clan owner. This leads to land disputes which are complex because there are no written records kept for ownership history and land boundaries. Pre-service teachers expressed concern about taking some action to resolve issues related to their land to help others to do the same.

The experience the participants had in identifying environmental issues, the causes and effects of the problems and their possible solutions at this stage has influenced them to make commitment to take both direct and indirect actions, including teaching EEfS (Moore, 2004). This finding is consistent with the participation goal of EEfS (UNESCO-UNEP, 1978), Tilbury's idea about issue-based and action-oriented EEfS being effective in developing experience, knowledge and values necessary for taking appropriate actions to contribute to future sustainability (Tilbury, 1995), Lucas' idea about education in and for the environment (Lucas, 1979), and Jensen and Schnack's idea of action competence (Jensen & Schnack, 1997).

Reflecting on EEfS lessons and learning activities may have contributed to the pre-service teachers developing action competence. This was indicated by the fact that the participants who reflected on the learning activities said they were planning not only to teach EEfS but also to use the method they identified from the lessons as good learning activity for delivering EEfS. Furthermore, their reflections in their journals showed evidence of growing awareness of issues and concerns for teaching about these to their own students. These are some indications of developing action competence within EEfS (Fien & Tilbury, 1997).

Learning through EEfS lessons that utilized traditional knowledge has influenced the pre-service teachers to utilize traditional knowledge in their own teaching and they reported that they planned to utilize traditional knowledge to teach

EEfS (Fien & Tilbury, 1997). Utilizing local traditional knowledge in delivery of EEfS is consistent with call for utilizing local traditional knowledge in EEfS made in the intergovernmental conferences since 1977 (e.g. UNESCO, 1978; UNCED 1992), which promotes the recognition and strengthening of the role of indigenous people and their knowledge in EEfS, and also reinforces the idea that EEfS is about relevance and holistic education, something implicit within local traditional knowledge.

There was evidence that the learning activities and approaches modelled in the intervention were taken on board by the pre-service teachers. Thus, half of them indicated they would use KWL charts and excursions to deliver EEfS, which promote constructivist, experiential and inquiry based learning. About a third of participants said they wanted to use simulation and the Follow me game which promote constructivist, socio-cultural, experiential and inquiry based learning (Ballantyne & Packer, 1997; Barker & Rogers, 2004; Mcleod, 2011; Svoboda & Whalen, 2005). This finding indicates that the pre-service teachers may have developed their knowledge and skills about teaching and learning of EEfS from the efforts made in the intervention, and became empowered not only to teach EEfS, but also to use the method they identified as appropriate learning activity in their context for delivering EEfS. This building of skills to take action is important in the development of action competence.

Finally, the finding that the pre-service teachers made commitments to take some form of action to contribute to a sustainable future of PNG is fundamental to the development of action competence. It can be inferred that the efforts made in the intervention has helped the participants in making a commitment to take action (Jensen & Schnack, 1997). Due to limited time, the pre-service teachers could not take action on the local issues they were investigating but they did make commitment to take actions and so it appears that the implementation of the intervention course had contributed to developing knowledge, skills and values towards action competence.

9.5 Conclusion

This study in a Teachers College of the existing beliefs and practices in EEfS, the design and implementation of an intervention on EEfS, and resulting changes in teachers' knowledge and competence to act in EEfS is relevant for PNG because it is consistent with the PNG Constitution, TENCG and the NCS. All people of PNG, including teacher educators and teachers, are expected by the Government to take action to contribute to the future sustainability of PNG's environment, society and resources. The Department of Education expects all educators including the primary school teachers to take action to contribute to future sustainability of PNG's environment and resources, especially by delivering EEfS related subjects in primary schools. Like the Department of Education, the Division of Teacher Education expects teacher educators, especially science and social science lecturers, to deliver EEfS to pre-service teachers and influence them to deliver EEfS to their own students in primary schools. However, at present in PNG, documents provided by these institutions to guide teachers and teacher educators provide no clear instructions for the delivery of EEfS and this has created a significant gap, which the work in this study attempted to address.

The participants of Phase One Study were aware of both the existence of, and the need for, pre-service teachers to learn about environmental and sustainability issues. They also wanted to learn concepts of EEfS including sustainability; social and economic sustainability; sustainable resource use or management; and cultural and biological diversity because they understood that there was a need for them to clearly understand the key concepts of EEfS. Furthermore, the participants identified benefits of utilizing, and lack of emphasis on, local traditional knowledge in current practices of EEfS at the College and also. Furthermore, they also identified the benefit of using, and lack of emphasis on, active student-centred EEfS learning strategies in the practices at the College. Finally, they understood the importance of engaging students in identifying and resolving environmental problems as part of EEfS.

The design and implementation of the intervention included local environment and sustainability problems as contexts for studying concepts related to causes, effects and solutions of problems using student-centred EEfS strategies including constructivist, inquiry based and experiential learning (Bandura, 1977; Barker & Rogers, 2004; Fien & Tilbury, 1996; Tilbury, 1995). Keeping in mind the barriers of teaching EEfS, different approaches were used in the intervention. For example, instead of having many field trips to help the pre-service teachers learn as much as they can, they had one actual field trip which was accompanied by completion of worksheet and then a reflection journal. Other knowledge and experiences were developed through simulation, role play and games. Some information on local traditional knowledge was drawn from the students' families, clan or tribe members, instead of having a further field trip to gather this knowledge. Such practices were time and cost efficient, yet were of high relevance to the students.

There was evidence that pre-service teachers had prior knowledge before the intervention about environmental problems in PNG. The level of knowledge about these issues appeared to increase through the intervention,. particularly in the areas of biodiversity, land ownership and degradation. It is perhaps not surprising that the participants identified endangered species and biodiversity depletion as issues in PNG, because a majority of PNG people live in rural areas and use plants and animals from the environment as food, medicines, clothes, decorations, fuel and materials for housing. These species can also be destroyed through gardening, logging and mining activities. The pre-service appeared to understand that all activities carried out by people result in depletion of the biodiversity of PNG and endangering of species, and that people need to to be educated to take well informed actions, so that they can reduce the rate of depletion.

Land ownership and degradation are environment and sustainability issues in PNG because 97% of the land in PNG is traditionally owned by the people in clans. The people in the clan decide how the land is used and descriptions, landmarks and history and paths of land inheritance are passed on verbally without written records. That land ownership system, traditional education, and information keeping systems was valued and followed well before Western education and influence on lifestyle, property ownership, education, and information keeping systems. The pre-service teachers appeared to develop understanding that traditional customary land ownership system is becoming problematic because many people in PNG are confused by the fact that while they are still employing traditional methods of hunting, gathering, gardening and cooking, they are also influenced by Western ideas. This includes a move away from holding traditional beliefs and values, which impinges on the integrity of local traditional education and information keeping systems.

There was evidence that pre-service teachers had some prior knowledge about key concepts of EEfS. However, it appears that this knowledge was increased by the intervention resulting in increases in the number of pre-service teachers perceiving that:

- social and economic development have effects on natural environment;
- social and cultural background of people influence their behaviour towards the environment and its resources;
- using advanced technology has impact on the environment; and
- activities of people both in urban and rural are having impact on the environment.

The greatest change in pre-service teachers perceptions about key concepts of EEfS was observed in their view about social and economic development activities having impact on the environment. They perceived that there is a need to help people understand about sustainable economic development activities which will improve the economy of the country at the same time as improving peoples' lifestyle. The intervention also appeared to develop the pre-service

teachers' perception that people in rural areas have an impact on the environment, and the influence of peoples' social and cultural background on their behaviour towards the environment.

Like their content knowledge, there was evidence that pre-service teachers had some prior knowledge about teacher education pedagogy. However, it appears that this knowledge was increased by the intervention, resulting in increases in the number of pre-service teachers perceiving that constructivist, experiential, inquiry-based, cooperative and socio-cultural learning were appropriate for teaching and learning. The greatest change of perception observed was in their view that experiential, inquiry-based, and cooperative learning were appropriate learning approaches for delivering EEfS.

As with their teacher education pedagogy, there was evidence that pre-service teachers had some prior knowledge about EEfS pedagogy. However, it appears that this knowledge was increased by the intervention, resulting in increases in the number of pre-service teachers perceiving that an EEfS course should be: relevant to learners' needs, culture and the national curriculum; seen as a multidisciplinary subject; be studied holistically; utilise students' experiences and values; and based on critical reflection on all actions and learning. The greatest change in pre-service teachers views after the intervention about EEfS pedagogy was observed in the view that EEfS should be based on critical reflection of all actions taken and lessons learnt, and that EEfS should be studied holistically. There was less change in the pre-service teachers who viewed environmental issues as being multidisciplinary, compared to their views on other aspect of EEfS. Thus, more work on emphasising environmental issues as multidisciplinary in the delivering EEfS in teacher education would be useful.

The pre-service teachers reported or demonstrated having gained the knowledge, experience, skills and values required for taking actions to contribute to future sustainability, which in turn resulted in pre-service teachers:

- thinking of providing opportunities for their students to be engaged in action experience, when they they teach EEfS;
- thinking of helping their students to develop knowledge about environment and sustainability issues and concepts using the modelled learning activities and approaches;
- making commitment to help their students to develop positive attitude towards learning EEfS;
- making commitment to take action to contribute to future sustainability, which includes teaching EEfS to their students, to help them develop their knowledge, skills, attitudes, behaviour and competence for sustainable action.

The implementation of the intervention appeared to be effective in developing pre-service teachers' knowledge and skills and in them making a commitment to take some form of action to contribute to the sustainable future of PNG. It is difficult to know at this stage if they will actually carry out the plans and commitments they made to act sustainably or teach EEfS. However, it is possible to say that all learning experiences and actions taken in the intervention will become experiences that may facilitate future actions (Jensen & Schnack, 1997). Thus, it can be said that, pre-service teachers, who learnt and had experiences in environment and sustainability issues as part of their EEfS lessons have developed action competence (Fien & Tilbury, 1996; Jensen & Schnack, 1997; Moore, 2004).

This study has found that further work on social justice issues including poverty and unequal resource distribution and local traditional knowledge would be useful in EEfS in the Teachers' College. Revision of the Teacher Education National Curriculum Guideline to include more specific guidance on delivering EEfS in teacher education, and more research on EEfS in pre-service teacher education would be useful for teacher education in EEfS in PNG.

9.6 Recommendation

9.6.1 Implications for practice

Firstly, providing the findings of the research to teacher educators in all teacher education colleges in PNG may help develop EEfS in those institutions. Secondly, a further implication is to provide in-service professional development for EEfS teacher educators in the colleges on content and pedagogies used in the intervention course. Thirdly, the existing environmental science course in the Teachers' College of this study should be revised to richly include environment and sustainability concepts and issues. Finally, the findings of the study should be presented to the National Teacher Education Board of PNG with a view to a revision of Teacher Education National Curriculum Guideline to allow stronger encouragement for EEfS in teachers colleges in line with the demands of the PNG Constitution and the expectations of *Agenda 21*.

9.6.2 Implications for Further Research

Further research following on from this study could be:

- conducted into the operation of EEfS related courses in other areas of the teacher education curriculum in other teachers' colleges;
- conducted while implementing the intervention in a full semester and evaluate student actions (development of action competence) of the pre-service teachers as they take actions to address the local environmental issues;
- conducted while implementing the intervention in a full semester and evaluate pre-service teachers' professional competencies as they prepare and present EEfS lessons in primary schools; and
- conducted to examine how pre-service teachers who have completed EEfS courses at the Teachers College are teaching EEfS in primary schools in their first or second year of teaching.

Most of the above mentioned aspects could not be covered in this current study due to time limitations.

References

- Acar, B. & Tarhan, L. (2007). Effect of Cooperative Learning Strategies on Students' Understanding of Concepts in Electrochemistry. *International Journal of Science and Mathematics Education*. 5(2), 349 – 373. DOI: [10.1007/s10763-006-9046-7](https://doi.org/10.1007/s10763-006-9046-7)
- Aka, J. (2001). *Papua New Guinea report: A report presented to the ESCAP at the third sub-regional training workshop on environment statistics*. 30 April -11 May, 2001, Port Vila, Vanuatu.
- Allen, B., Bourke, R. M., & Gibson, J. (2005). Poor rural places in Papua New Guinea *Asia Pacific Viewpoint*, 46(2), 201-207. DOI: [10.1111/j.1467-8373.2005.00274.x](https://doi.org/10.1111/j.1467-8373.2005.00274.x)
- Antweiler, C. (2004). Local Knowledge Theory and Methods: An Urban Model from Indonesia. In A. Bicker, P. Silitoe & J. Potier (Eds.), *Investigating Local Knowledge: New Direction New Approaches*. Aldershot, England: Ashgate Publishing Limited.
- Apedoe, X., Walker, S.E., & Reeves, T.C. (2006). Integrating inquiry-based learning into undergraduate geology. *Journal of Geoscience Education*, 54(3), 414-421.
- Archie, M., Simmons, B., Heimlich, J. E., & Daudi, S. S. (2002). Environmental education and the social studies: Making the connections. In Heimlich, J. E. (Ed.), *Environmental education: A resource handbook*. Bloomington, IN: Phi Delta Kappa Educational Foundation.
- Aung, T.H., Kaluwin, C., & Lennon, G. W. (Eds.). (1998). *Climate change and sea level. Part one: Physical science*. National Tidal Facility, the Flinders University of South Australia, Bedford Park.

- Arua, A. & Eka, D. J. (2002). Wantok system. *Melanesian Journal of Theology*, 18(1), 6 -18. Retrieved on 14 January 2012 from <http://www.cltc.spwd.net.nz/LinkClick.aspx?fileticket=jpQW6QvvBVI%3D&tabid=80>
- Avalos, B. (1991). Context, training theory, and teaching practice. *Teaching and Teacher Education* 7 (2), 169-184. DOI: [10.1016/0742-051X\(91\)90025-K](https://doi.org/10.1016/0742-051X(91)90025-K)
- Avalos, B. (1992). The need for educational reform and the role of teacher education: The case study of Papua New Guinea. *International Journal of Educational Development*, 12(4), 309-318. DOI: [10.1016/0738-0593\(92\)90006-8](https://doi.org/10.1016/0738-0593(92)90006-8)
- Baharuddin, A. H. J. , with the Institut Kaijan Dasar. (1995). *Environment and development: Ethical and educational considerations*. Kuala Lumpur, Malaysia: Institut Kaijan Dasar.
- Ballantyne, R.R., & Packer, J.M. (1996). Teaching and learning in environmental education: Developing environmental conceptions. *Journal of Environmental Education*, 27(2), 25-32. DOI: [10.1080/00958964.1996.9941455](https://doi.org/10.1080/00958964.1996.9941455)
- Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.
- Barker, M. (2002). Issue based environmental education. A case study with kahikatea forest fragments. In R.K Coll (Ed), *STERpapers 2002* (pp. 2-12). Hamilton, New Zealand: University of Waikato.
- Barker, J. (2008). *Ancestral Lines: The Masins of Papua New Guinea and the fate of the rainforest*. Canada: Broadview Press.
- Barker, M., & Rogers, L. (2004). "In, about and for": Exploring the foundations of environmental education, *Set*, 2, 15-18.

- Barry, C., (2006). Environmental education is history: The extent to which modern history education adopts characteristics of socially critical environmental education. *Australian Journal of Environmental Education*, 22(1), 3-13.
- Basit, T. N. (2010). *Conducting research in educational contexts*. New York, NY: Continuum International Publishing Group.
- Bell, B., & Gilbert, J. (1996). *Teacher development: A model from science education*. London, England: Falmer Press.
- Bhandari, B.B., & Abe, O. (2000). Environmental education in the Asia-Pacific region: Some problems and prospects. *International Review for Environmental Strategies*, 1(1), 57-77.
- Bigge, M. L., Shermis, S. (1992). *Learning theories for teachers*. New York: Harper Collins
- Bishop, K.N., & Scott, W.A.H. (1998). Deconstructing action competence: Developing a case for a more scientifically-attentive environmental education. *Public Understanding of Science*, 7, 225 – 236.
- Block, J. (1982). Assimilation, accommodation and and the dynamics of personality development. *Child Development*, 53(2), 281-296.
- Bolstad, R. (2003). Environmental education: Roots in the past, visions of the future, opportunities in the present. *set: Research Information for Teachers*, 3, 10-14.
- Bolstad, R., Cowie, B., & Eames, C. (2004). *Environmental education in New Zealand schools: Research into current practice and future possibilities*.

Volume 1- 4: Summary of the research findings. Wellington, New Zealand: Ministry of Education.

Braus, J. (1995). Environmental education. *BioScience*, 45, 45-51.

Breiting, S. (2009). Issues for environmental education and ESD research development: looking ahead from WEEC 2007 in Durban. *Environmental Education Research*, 15(2), 199-207.

Breiting, S., Hedegaard, K., Morgensen, F., Nielson, K., & Schnack, K. (2009). Action competence, Conflicting interests and Environmental Education: *The MUVIN programme*. Copenhagen: CPU Aarhus University.

Broadfoot, J., & Paullon, R. (2002). *Environmental science lecturer's guide: Lecturer support material*. Port Moresby, Papua New Guinea: Primary and Secondary Teacher Education Project (PASTEP).

Burke, C. (1996). The changing agenda in teacher education in Papua New Guinea. *International Journal on Educational Development*, 16(1), 41-51.

Burns, R.B. (1997). *Introduction to research methods* (3rd ed.). Melbourne, VIC, Australia: Addison Wesley Longman.

Burns, R. (2000). *Introduction to Research Methods*. Melbourne, VIC, Australia: Longman

Burton, D., & Bartlett, S. (2009). *Education studies series: Key issues for education researchers*. New Delhi, India: Sage.

Cammack, D. (2009). *Chronic poverty in Papua New Guinea. Background paper for the Chronic Poverty Report 2008-09*. Port Moresby, Papua New Guinea: Retrieved from Retrieved 10 June 2011 from <http://www.chronicpoverty.org>

- Chalmers, D. R. C., & Pliwala, A. H., (1984). *An introduction to the law in Papua New Guinea* (2nd ed.). London, Sweet and Maxwell Ltd.
- Chapman, D., & Eames, C. (2007). *Position paper: Backgrounding new guidelines for EE/EfS*. Retrieved 12 December 2007 from <http://sci.waikato.ac.nz/consultatione>
- Clarke, J. I. (1993). Education, population and Sustainable Development. *International Review of Education*, 39(1/2), 53-61.
- Clarkson, P. C., Owens, K. O., Toomey, R., Kaleva, W., & Hamadi, T. (1998). *The Development of A Process for the Evaluation of Teacher Education*. Port Moresby, Papua New Guinea. Retrieved from Retrieved 1 November 2008 from <http://www.aare.edu.au/01pap/cla01231.htm>
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London, England: Routledge.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London, England: Routledge.
- Coleman, N. (2008, November). Frogs in a perfect habitat. *Our way*.
- Conway, W. (1995). *How nature works*. New York, NY: Wildlife Conservation Society.
- Copus-Campbell, S. & Hayward-Jones, J. (2009 May). *Tackling extreme poverty in Papua New Guinea*. Retrieved on 12 January 2012 from <http://www.lowyinstitute.org/Publication.asp?pid=1050>
- Cooze, A. (2006). *One hundred ideas for trainee teachers*. London, England: Continuum.
- Costley, C., Elliot, G., & Gibbs, P. (2010). *Doing work based research: Approaches to enquiry for insider-researchers*. London, England: Sage.

- Cowie, B. and Eames, C., (2004). *Environmental education in New Zealand Schools: Challenges for sustainability. Set, 3, 19-23.*
- Creswell, J. W. (2002). *Educational research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research.*
- Creswell, J. W. (2003). *Research Design: Qualitative, quantitative, and mixed approaches: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (2nd ed.).* London, Sage.
- Creswell, J. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research (2nd ed.).* Upper Saddle River, NJ: Pearson Education.
- Creswell, J. W. (2008). *Educational research: planning, conducting, and evaluating quantitative and qualitative research. (3rd ed.).* Boston:Pearson, c2012.
- Creswell, J. (2009). *Research design :Qualitative, Quantitative, and mixed methods approaches. (3rd ed.)* London , UK: Sage Publication Ltd.
- Curry, G., & Koczberski, G. (2009). Finding common ground: Relational concepts of land tenure and economy in the oil palm frontier of Papua New Guinea. *The Geographical Journal* 175(2), 98 - 112.
- Cutter-Mackenzie, A., & Miles, R. (2006, October) *Environmental education: Is it really a priority in teacher education?* Paper presented at the Conference of the Australian Association for Environmental Education, Bunbury, WA, Australia.
- Cutter-Mackenzie, A., & Tilbury, D. (2002). Meeting commitments for a sustainable future: Environmental education in pre-service teacher education. In Knight, B.A.(Ed). *Reconceptualising learning in the knowledge society* (pp. 17-34). Flaxton, QL, Australia: Post Pressed.

- Cutter-Mackenzie, A. Clarke, B., & Smith, P. (2008). A discussion paper: The development of professional teacher standard in environmental education. *Australian Journal of Environmental Education*, 24(1), 3-13.
- Denzin, N. K., & Lincoln, Y.S. (1994). Introduction: Entering the field of qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research*. Thousand Oaks, CA: Sage.
- Denoon, D. (2002). Papua New Guinea's crisis: Acute or chronic? *World Affairs*, 164(3), 115-122.
- Dewey, J. (1899). *The school and society*. Chicago University Press.
- Dewey, J. (1938). *Experience and education*. New York, NY: Macmillan.
- Dicson-Waiko, A. (2003). Civil society and nation building. In D. Kavanamur, C. Yala & Q. Clement (Eds.), *Building nation in Papua New Guinea: Views of the post independent generation* (pp. 247-248). Caberra, Australia: Pandanus books.
- Eames, C., & Cowie, B., (2004). Environmental education in New Zealand schools: Characteristics of achievements. Set,2, 19-24.
- Eames, C., Cowie, B., & Bolstad, R. (2008). An evaluation of characteristics of environmental education practice in New Zealand schools. *Environmental Education Research*, 14(1), DOI: 35 - 51
10.1080/13504620701843343
- Edelson, D. C. (2001). Learning for use: A framework for the design of technology-supported inquiry activities. *Journal of Research in Science Teaching*, 2001 38(3), 355 - 385. DOI: [10.1002/1098-2736\(200103\)38:3<355::AID-TEA1010>3.0.CO;2-M](https://doi.org/10.1002/1098-2736(200103)38:3<355::AID-TEA1010>3.0.CO;2-M)

- Edwards, A., & Protheroe, L. (2003). Learning to see in classrooms: What are student teachers learning about teaching and learning while learning to teach in schools? *British Educational Research Journal*, 29(2), 227-242. DOI: [10.1080/0141192032000060957](https://doi.org/10.1080/0141192032000060957)
- Elkind, D. (2004). The problem with constructivism. *The Educational Forum*, 68(4), 306-312.
- Ellen, R., & Harris, H. (2000). Introduction. In R. Ellen, P. Parkes & A. Bicker (Eds.), *Indigenous knowledge and its transformation* (Vol. 5). Amsterdam, The Netherlands: Harwood academic publishers.
- Emmanuel, R. & Adams, J. N. (2011). College students' perceptions of campus sustainability. *International Journal of Sustainability in Higher Education*, 12(1), 79-92. DOI: [10.1108/14676371111098320](https://doi.org/10.1108/14676371111098320)
- Ernst, J., & Monroe, M. (2004). The effects of environment-based education on students' critical thinking skills and disposition towards critical thinking. *Environmental Education Research*, 10(4), 507-522. DOI: 10.1080/1350462042000291038
- Erero, S. (2004, February 5). Research on the atolls. *Post-Courier*, p. 19.
- Esa, N. (2010). Environmental knowledge, attitude and practices of student teachers. *International Research in Geographical and Environmental Education*, 19(1), 39-50. DOI: [10.1080/10382040903545534](https://doi.org/10.1080/10382040903545534)
- Esonu, B. (2009). *An analysis of the concept of 'sustainability' in mining agreements in Papua New Guinea: The case of Hidden Valley/Hamata Mine*. (Unpublished master's thesis). University of Waikato, Hamilton, New Zealand.

- Eyford, H. (1993). Relevant education: The culture dimension. *Papua New Guinea Journal of Teacher Education*, 29(1), 9 -20.
- Fien, J. (1995). Teaching for Sustainable World: The environment and development project for teacher education, *Environmental Education Research*, 1(1), 21-33.
- Fien, J. (2003). Education for a Sustainable Future: Achievements and Lessons from a Decade of Innovation, from Rio to Johannesburg. *International Review for Environmental Strategies*, 4, (1), 5 – 20.
- Fien, J. (2006). A letter from the future: UNESCO and the Decade of Education for Sustainable Development. *Australian Journal of Environmental Education*, 22(1), 63-70.
- Fien, J., & Tilbury, D. (1996) *Learning for a sustainable environment: An agenda for teacher education in Asia and the Pacific*. Bangkok, Thailand: UNESCO.
- Ferreira, J., Ryan, L. & Tilbury, D. (2007). Mainstreaming Education for Sustainable Development in Initial Teacher Education in Australia: A Review of Existing Professional Development Models. *Journal of Education for Teaching: International Research and Pedagogy*, 33(2), 225-239. DOI: [10.1080/02607470701259515](https://doi.org/10.1080/02607470701259515)
- Freddy, G. (2007, November 30). Rising sea brings reality home. *Post-Courier*. <http://www.postcourier.com.pg/20120228/tuhome.htm>
- Freedman, R., & Stumpf, S. (1980). Learning style theory: Less than meets the eye. *Academy of Management Review*, 5, 445-447.
- Gall, M.D., Borg, W.R., & Gall, J.P. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson/Allyn & Bacon.

- Gibson, J. (2000). The impact of growth and distribution on poverty in Papua New Guinea, *Applied Economics Letters*, 7(8): 605-607. DOI: 10.1080/13504850050059096
- Gibson, J., Allan, B., & Bourke, R. M. (2005). Poor rural places in Papua New Guinea. *Asia Pacific view point*, 46(2), 201. DOI: 10.1111/j1467-8373.2005.00274.x
- Gibson, J., Datt, G., Allen, B., Hwang, V., Bourke, R. M., & Parajuli, D. (2005). Mapping poverty in rural Papua New Guinea. *Pacific Economic Bulletin*, 19(4), 14-29.
- Gibson, J., & Olivia, S., 2002. An illustration of the average time measure of poverty. *Working Papers in Economics 02/04*. Hamilton, New Zealand: University of Waikato, Department of Economics.
- Gibson, J., & Rozelle, S. (2003). Poverty and access to roads in Papua New Guinea. *Economic Development and Cultural Change*, 52(1), 159 - 185. DOI: 10.1086/380424
- Goodland, R. (1995). The concept of environmental sustainability. *Annual Review of Ecology and Systematics*, 26, 1-24.
- Gopal, R. (2004). The understanding of environmental issues among the trainee teachers in Batu Lingtang Teachers' College. *Jurnal Penyelidikan MPBL*, Jilid 5 38-54.
- Gough, G. A. (1997). *Environmental education in a climate of educational change*. Melbourne, Vic., Australia: Australian Council of Educational Research.
- Gough, A. (2006). A long, winding (and rocky) road to environmental education for sustainability. *Australian journal of environmental education*, 22(1), 71-76.

- Government of Papua New Guinea, & United Nations in Papua New Guinea. (2004). *Progress Report for Papua New Guinea 2004*. Port Moresby, Papua New Guinea: Government of Papua New Guinea.
- Greenall, A. (1978). *Environmental Education Teachers' handbook*, Longman Cheshire, Melbourne.
- Government of Papua New Guinea. (2004). *Millennium development goals: Progress report for Papua New Guinea 2004/United Nations development programme*. Port Moresby, Papua New Guinea: Author.
- Guba, E.G. (1990). The alternative paradigm dialog. In E.G. Guba (Ed.), *The paradigm dialog* (pp. 17-30). Newbury Park, CA: Sage.
- Harcourt, S. V. (1980). *Commerce and Development in Papua New Guinea*. Hongkong Longman
- Harrington, R. A., & Enochs, L. G. (2009). Accounting for pre-service teachers' constructivist learning environment experiences. *Learning Environment Research, 12*(1), 45-65.
- Harrison, T., & Clarke, J. (2003). Implementing an ecological simulation: Do children's knowledge and attitudes change? *Australian Journal of Environmental Education, 19*, 37-46.
- Hartas, D. (Ed.). (2010). *Educational research and inquiry: Qualitative and quantitative approaches*. New York, NY: Continuum.
- Hegarty, K. (2008). Shaping the self to sustain the other: Mapping impacts of academic identity in education for sustainability. *Environmental Education Research, 14*(6), 681 – 692. DOI: [10.1080/13504620802464858](https://doi.org/10.1080/13504620802464858)
- Heimlich, J. E. (Ed.). (2002). *Environmental education: A resource handbook*. Bloomington, IN: Phi Delta Kappa Educational Foundation.
- Heimlich, J. E., & Daudi, S. S. (2002a). Making the experience of environmental education experiential. In Heimlich, J. E. (Ed.), *Environmental education:*

- A resource handbook*. Bloomington, IN: Phi Delta Kappa Educational Foundation.
- Heimlich, J. E., & Daudi, S. S. (2002b). Project WILD: An experience in experiential education in Heimlich, J. E. (Ed.), *Environmental education: A resource handbook* (p.17-19). Bloomington, IN: Phi Delta Kappa Educational Foundation.
- Heimlich, J. E. & Daudi, S. S. (2002c). Environmental Education as Defined by the Practitioners. In Joe E. Heimlich, *Environmental Education: A Resource Handbook* (p,13-16). USA: Phi Delta Kappa Educational Foundations.
- Hicks, D., & Bord, A. (2001). Learning about global: why most teachers only making things worse. *Environmental Education Research*, 7(4), 413- 425.
- Huckle, J. (1991). Education for sustainability. Assessing paths to the future. *Australian Journal of Environmental Education*, 7, 43-62.
- Huckle, J., & Sterling, S. (Eds.). (1996). *Education for sustainability* London: Earthscan Publications Ltd.
- Independent State of Papua New Guinea. (2000). *Environmental Act 2000*. Port Moresby, Papua New Guinea: Government of PNG.
- IUCN. (1980). International Union for the Conservation of Nature and Natural Resources in collaboration with the United Nations Environment Program. *World conservation strategy*. Gland, Switzerland: ICUN
- IUCN, UNEP & WWF. (1991). *Caring for the Earth: A strategies for sustainable living*. London, Earth-Scan Publications.
- Jenkins, E. W. (2003). Environmental education and public understanding of science. *Frontiers in Ecology and Environmental Education*, 1(8), 437-443. DOI: [10.2307/3868141](https://doi.org/10.2307/3868141)
- Jensen, B. B., & Schnack, K. (1997). The action competence approach in environmental education. *Environmental Education Research*, 3(2), 163-178. DOI: 10.1080/1350462970030205

- Janesick, V.J. (2003). The choreography of qualitative research design: Minutes, improvisations, and crystallization. In N.K. Denzin & Y.S. Lincoln (Eds.), *Strategies of qualitative inquiry* (pp. 46-79). Thousand Oaks, CA: Sage.
- Johnson, B., & Christensen, L. (2004). *Educational research: Quantitative, qualitative and mixed approaches*. London, England: Sage.
- Johnson, D., Johnson, R., & Smith, K. A. (1998). Cooperative learning returns to college: What evidence is there that it works? *Clearinghouse*, 30(4), 26-35.
- Joku, H. (2009, July 4). Attention for climate needed. *Post-Courier*. Retrieved on 12 December 2011 from <http://www.postcourier.com.pg/20120228/tuhome.htm>
- Kambuou, R. N. (1995). *Papua New Guinea: Country report to the FAO international technical conference on plant genetic resources*. Port Moresby.
- Kavanamur, D., Yala, C., & Clement, Q. (2003). Introduction: A mixed inheritance. In D. Kavanamur, C. Yala & Q. Clement (Eds.), *Building a nation in Papua New Guinea: Views of the post-independence generation*(pp.1-10). Canberra, Australia: Pundanus Books, Research school of Pacific Asia Studies.
- Kekedo, J. (1985) "Equality and Participation in Melanesia", in P. King, V. Warakai, W. Lee, (Eds.). *From rhetoric to reality. Papua New Guinea's Eight Point Plan and National Goals after a decade* (pp. 350-355). Port Moresby, PNG, University of Papua New Guinea,
- Kennelly, J., Taylor, Neil & Maxwell, T. (2008). A student teachers' personal pathway to education for sustainability. *Australian Journal of Environmental Education*, 24(3), 3-13
- Kimmerer, R. W. (2002). Traditional Ecological Knowledge into Biological Education: A call to action. *Bioscience*, 52(5), 432-438. DOI: [10.1641/0006-3568\(2002\)052\[0432:WTEKIB\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0432:WTEKIB]2.0.CO;2)
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental

behaviour? *Environmental Education Research*, 8(3), 239-260. [DOI: 10.1080/13504620220145401](https://doi.org/10.1080/13504620220145401)

- Kolb, D. A. (1981). Experiential learning theory and the learning style inventory: A reply to Freedman and Stumpf. *The Academy of Management Review*, 6(2), 289-296.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
- Kukari, A. J. (2011). Cultural construction of indigenous pre-service teachers' identities prior to teacher education. *Contemporary PNG Studies DWU Research Journal*, 15(1), 134-145.
- Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing*. London, England: Sage.
- Kwa, E. P. (2003). Environment and development in Papua New Guinea: 25 years on. In D. Kavanamur, C. Yala & Q. Clement (Eds.), *Building nation in Papua New Guinea: Views of the post independent generation*(pp. 167-182). Caberra, Australia: Pandanus books.
- Lake, D.C. (1993). The cultural background of teachers college entry students and implications for science education. *Papua New Guinea Journal of education*, 24(1), 33-46.
- Latham, G., Blaise, M., Dole, S., Faulkner, J., Lang, J., & Malone, K. (2006). *Learning to teach: New times, new practices*. Melbourne, VIC, Australia: Oxford University Press.
- Lauer, S. (2002). *Resource management: Lecturer support material*. Port Moresby, Papua New Guinea: Primary and Secondary Teacher Education Project (PASTEP).
- Lauer, S., & Aitsi, L. (2002). *Land use and settlement: Lecturer support material*. Port Moresby, Papua New Guinea: Primary and Secondary Teacher Education Project (PASTEP).
- Lauer, S., & Rifi, L. (2002). *Environmental issues*. Port Moresby, Papua New Guinea: Primary and Secondary Teacher Education Project (PASTEP).

- Likert, R. (1932). *A technique for the measurement of attitudes*. NY: Columbia University Press.
- Littledyke, M. (2008). Science education for environmental awareness: Approaches to integrating cognitive and affective domains. *Environmental Education Research*, 14(1), 1-17. DOI: 10.1080/13504620701843301
- Lipowski, E. E. (2008). Developing great research questions. *American Journal of Health-System Pharmacy*, 65, 1667 - 1670. DOI: [10.2146/ajhp070276](https://doi.org/10.2146/ajhp070276)
- Lopata, C., Miller, K. A & Miller, R. H. (2003). Survey of actual and preferred use of cooperative learning among exemplar teachers. *The Journal of Educational Research*, 96(4), 232-239.
- Lortie, D., (1975). *Schoolteacher: A sociological study*. London, England: University of Chicago Press.
- Lortie, D. (2002). *Schoolteacher: A sociological study* (2nd ed.). Chicago: University of Chicago Press.
- Loughran, J. (2006). *Developing pedagogy of teacher education: Understanding teaching and learning about teaching*. New York, NY: Routledge.
- Lucas, A. (1979). *Environment and environmental education: Conceptual issues and curriculum implications*. Melbourne, VIC, Australia: Australian International Press and Publications.
- Magia, J. (2008). Environmental Science course overview. Lae: Balob Teachers College.

- Maha, A. Flaherty, T & Openg, A. (2002). Teaching and learning in the primary teachers college: PASTEP impact study 3. Port Moresby, Papua New Guinea: PASTEP.
- Mandal, R. R. (2009). Cooperative learning strategies to enhance writing skills. *The Modern journal of applied linguistics*, 1. Retrieved on 12 January 2012 from <http://www.mjal.org/journal/coop.pdf>
- Matang, R. A. S. (2008). *Enhancing children's' formal learning of early numbers knowledge through indigenous language and ethnomathematics: The case study of Papua New Guinea Mathematics curriculum reform experience*. Paper presented at the CME-11 Monterrey.
- McGregor, D. (2011). Linking Traditional Knowledge and Environmental Practice in Ontario. *Journal of Canadian Studies*, 43(3), 69-100.
- McLaughlin, D. (1990). Training Technicians or Educating Teachers: An internship program for teacher educators in Papua New Guinea. *Australian Journal of Teacher Education*, 15(1), 1-13.
- McNamara, V. (1989). The future direction of community teacher education, Unit 4 task force report. *Teacher education research project*. Port Moresby, Papua New Guinea, Department of Education.
- McKeown, R., & Hopkins, C. (2003). EE does not equal ESD: Defusing the worry. *Environmental Education Research*, 9(1), 117-128.
- Mclean, T. (2003). Environmental education in Otago primary schools: Education for the environment? *Set*, 1, 4-9.

- Mcleod, S. A. (2011). *Simply Psychology; Bandura | Social Learning Theory*.
Retrieved 14 January 2012, from
<http://www.simplypsychology.org/bandura.html>
- Merriam, S.B. (1988). *Case study Research in Education*. San Francisco, CA: Jossey
Bass.
- Miles, R., Cutter-Mackenzie, A., & Harrison, L. (2006). Teacher education: A
diluted environmental education experience. *Australian Journal of
Environmental Education*, 22(1), 49-60.
- Miller, T. (2007). *Living in the environment: Principles, connections and solutions*
(5th ed.): Jack Carey.
- Macaulay, B. A. & Gonzales, V.G. (1996, March). Enhancing the collabora-
tive/cooperative learning experience: A guide for faculty development.
Workshop presented at the AAHE National Conference on Higher
Education.
- Ministry of Education. (1999). *Guidelines for environmental education in New
Zealand Schools*. Wellington, New Zealand: Learning Media.
- Ministry for the Environment (New Zealand). (1998). *Learning to care for our
environment: A national strategy for environmental education*.
Wellington, New Zealand: Author.
- Morgensen, F., & Schnack, K. (2010). The action competence approach and the
'new' discourses of education for sustainable development, competence
and quality criteria. *Environmental Education Research*, 16(1), 59-74.
DOI: [10.1080/13504620903504032](https://doi.org/10.1080/13504620903504032)

- Moore, D. (2004). Experiential learning builds competence. *Leadership for Student Activities*, 32(9), 32.
- National institute for educational research. (1996). *Learning for a sustainable environment: Teacher education and environment in Asia and the Pacific*. Tokyo: National institute for educational research.
- Neuman, W. L (2000). *Social research methods: Qualitative and quantitative approaches* (4th ed.). Boston, MA: Allyn and Bacon.
- Neuman, W. L. (2006). *Basics of social research: Qualitative and quantitative approaches* (2nd ed.). Boston, MA: Allyn and Bacon.
- Ningal, T., Hartemink, A. E., & Bregt, A. K. (2007). Land use change and population growth in the Morobe Province of Papua New Guinea between 1975 and 2000. *Journal of Environmental Management*, 87(1), 117-124. DOI: [10.1016/j.jenvman.2007.01.006](https://doi.org/10.1016/j.jenvman.2007.01.006)
- Ninzipa, T. (2008). Natural and Cultural Environment Course Overview. Lae: Balob Teachers College[Course overview].
- Noho, B. (2010, March 23). Stamps feature images of sinking Carteret. *Post-Courier*, p. 5.
- Nolet, V. (2009). Preparing sustainability- literate teachers. *Teachers College Record*, (3), 409-442.
- Nongkas, C. M. (2007). *Leading educational change in primary teacher education: A Papua New Guinea study*. Fitzroy, VIC, Australia: Australian Catholic University.
- Norman, P. A. (2005). *Impact of Curriculum Reforms on some Teacher Education programs*. Paper presented at the 2005 National Curriculum Reform

Conference Sustainable curriculum development – the PNG curriculum reform experience.

- Obed, R., Unu, K., Tofuola, E. & Tuia, T.T. (2007). Values education in Pacific teacher education programmes. In P. Puamau (Ed) *Pacific voices teacher education on the move*.
- O'Connor, K. B. (2009). Northern exposures: Models of experiential learning in indigenous education. *Journal of Experiential Education*, 31(3), 415.
- Okole, H. Enhancing nation building through provincial government system in Papua New Guinea (2003). In D. Kavanamur, C. Yala & Q. Clement (Eds.), *Building a nation in Papua New Guinea: Views of the post-independence generation* (pp. 51-68). Canberra, Australia: Pundanus Books, Research school of Pacific Asia Studies.
- Okole, H. (2005). The 'Fluid' Party System of Papua New Guinea. *Commonwealth and comparative politics*, 43(3), 362-381. DOI: [org/10.1080/14662040500304924](https://doi.org/10.1080/14662040500304924)
- Openg, A. S. (1998). *Factors affecting educational change in PNG: The effectiveness of the introduction of grades 7 and 8 science in 'Top-up' primary schools*. University of New England, Armidale, Australia.
- Orathinkal, J., Tetang, A., & Kilip, J. M. (2011). Mercury concentration and its effect on the aquatic environment of the Lower Watut River, Morobe Province, Papua New Guinea. *Contemporary PNG Studies: DWU Research Journal*, 14, 38-50.
- Ormsby, A. (2002). Evaluating a teacher training environmental education program in Papua New Guinea. *Applied Environmental Education and Communication*, 91-99. DOI: [10.1080/15330150213998](https://doi.org/10.1080/15330150213998)

- Oulton, C., & Scott, W. (2000). A time for revisioning. In B. Moon, M. Ben-Peretz and S. Brown (Eds.), *Routledge Companion to Education* (pp. 489-501). London: Routledge.
- Papua New Guinea Government.(1975). *The Constitution of the Independent State of Papua New Guinea*, Government Printer, Port Moresby.
- Papua New Guinea Department of Education (PNGNDoE). (1995). *Papua New Guinea national education plan* (Vol. a). Port Moresby, PNG: PNG Department of Education
- Papua New Guinea Department of Education (PNGNDoE). (1999). *Primary education handbook* (Second Edition). Port Moresby, PNG: PNG Department of Education
- Papua New Guinea Department of Education (PNGNDoE). (2003a). *Upper primary science teacher's guide*. Port Moresby, Papua New Guinea: PNG Dept of Education.
- Papua New Guinea Department of Education (PNGNDoE). (2003b). *Making a living: Upper primary syllabus*. Port Moresby, Papua New Guinea: PNG Dept of Education.
- Papua New Guinea Department of Education (PNGNDoE). (2003c). *Environmental studies syllabus*. Port Moresby, Papua New Guinea: PNG Dept of Education.
- Papua New Guinea Department of Education (PNGNDoE). (2003d). *National curriculum statement for Papua New Guinea*. Port Moresby, Papua New Guinea: PNG Dept of Education.
- Papua New Guinea Department of Education (PNGNDoE). (2004a). *Teacher education national curriculum guideline*. Port Moresby, Papua New Guinea: PNG Dept of Education.

Papua New Guinea Department of Education (PNGNDoE). (2004b). *A national plan for education 2005-2014*. Port Moresby, Papua New Guinea: PNG Dept of Education.

Papua New Guinea Department of Education (PNGNDoE). (2005). *Papua New Guinea Primary and Secondary Teacher Education Project (PASTEP)*. Port Moresby, Papua New Guinea: PNG Dept of Education.

Parliamentary Commissioner for the Environment (PCE). (2004). *See change: Learning and education for sustainability*. Wellington, New Zealand: PCE.

Porritt, J. (2006). *Capitalism as if the world matters* (revised paperback ed.). London, England: Earthscan.

Pradhan, M. (2003). Promoting regional cooperation on environmental education and training in the Asia-Pacific: The role and contributions of the United Nations Environment Programme (UNEP). *International Review for Environmental Strategies*, 4(1), 45-58.

Pratchett, M. S., Schenk, T. J., Baine, M., Syms, C., & Baird, A. H. (2009). Selective coral mortality associated with outbreaks of *Acanthaster planci* L. In Bootless Bay, Papua New Guinea. *Marine Environmental Research*, 67(4-5), 230-236 author.

Prawat, R.S., & Floden, R.E. (1994). Philosophical perspectives on constructivist views of learning. *Educational Psychologist*, 29(1), 37-48.

DOI: [10.1207/s15326985ep2901_4](https://doi.org/10.1207/s15326985ep2901_4)

Rajaretnam, M. (1994). *Biotics & environmental education*. Kuala Lumpur, Malaysia: Institute for policy and research.

- Reid, A., Teamey, K. & Dillon, J. (2004). Value and utilizing traditional ecological knowledge: Tension in the context of education and the environment. *Environmental education research*, 10(2), 237-254.
- Roth, R. (1970). Environmental management education: Where to from here? *Theory into Practice*, 9(3), 187-190.
- Russell, T., & Loughran, J. (Eds.). (2007). *Enacting pedagogy of teacher education: Value, relationships and practices*. New York, NY: Routledge.
- Schlosberg, D., & Sisk, D. S. (2000). The Environmental Science/Policy Interface: Crossing Disciplinary Boundaries with a Team-Teaching Approach. *Political Science and Politics*, 33(1), 75-79.
- Servetti, S. (2010). Cooperative Learning Groups Involved in a Written Error Correction Task. *European Education*. 42(3), 7-25. DOI: 10.2753/EUE1056-4934420301
- Sillitoe, P. (2008). Contested knowledge, contingent classification: Animals in the Highlands of Papua New Guinea. *American Anthropologist*, 104(4), 1162-1171) doi: 10.1525/aa.2002.104.4.1162
- Silverman, D. (2004). *Qualitative research: Theory, method and practice* (2nd ed.). London: Sage.
- Sipos, Y., Battisti, B., & Grimm, K. (2008). Achieving transformative sustainability learning: Engaging head, hands and heart. *International Journal of Sustainability in Higher Education*, 9(1), 68-86. Doi: [10.1108/14676370810842193](https://doi.org/10.1108/14676370810842193)

- Solon, M. (1995). Reflections on Teacher Education in Papua New Guinea: Issues and Concerns. *Papua New Guinea Journal of Teacher Education*, 2(2), 20-22.
- Stabach, J. A., Dabek, L., Jensen, R., & Wang, Y.Q. (2009). Discrimination of dominant forest types for Matschie's tree kangaroo conservation in Papua New Guinea using high-resolution remote sensing data. *International Journal of Remote Sensing*, 30(2), 405-422.
- Stables, A. & Scott, W. (2002). The quest for holism in education for sustainable development. *Environmental education Research*, 9(1), 53-60.
- Steadman, D. W., White, J. P., & Allen, J. (1999). Prehistoric birds from New Ireland, Papua New Guinea: Extinctions on a large Melanesian island. *Proceedings of the National Academy of Sciences of the United States of America*, 96, 2563 - 2568.
- Sterling, S. (2001) *Sustainable education: Re-visioning learning and change*. Dartington, England: Green Books.
- Stevenson, R. B. (2007). Schooling and environmental/sustainability education: from discourses of policy and practice to discourses of professional learning. *Environmental Education Research*, 13(2), 265-285. DOI: [10.1080/13504620701295650](https://doi.org/10.1080/13504620701295650)
- Stir, J. (2006). Restructuring teacher education for sustainability: student involvement through a "strengths model" *Journal of Cleaner Production*, 14(9-11), 830-836. DOI: [10.1016/j.jclepro.2005.11.051](https://doi.org/10.1016/j.jclepro.2005.11.051)
- Svoboda, S., & Whalen, J. (2005). Using experiential simulation to teach sustainability. *Greener Management International*, 48, 57-65.

- Tal, T. (2010). Pre-service teacher's reflection on awareness and knowledge following active learning in environmental education. *International Research in Geographical and Environmental Education*, 14(4), 263-276. DOI: 10.1080/10382046.2010.519146
- Teaching and Learning Research Initiative (TLRI). (2010). A framework for developing action competence in EfS. Retrieved from Retrieved 19 December 2011 http://www.tlri.org.nz/assets/A_Project-PDFs/9245Appendix-F.pdf
- Telban, B., & Vavrova, D. (2010). Places and spirits in Sepik society. *The Asia Pacific Journal of Anthropology*, 11(1), 17-33. DOI: [10.1080/14442210903499400](http://dx.doi.org/10.1080/14442210903499400)
- Terwel, J. (1999). Constructivism and its implication for curriculum theory and practice. *Journal of Curriculum Studies*, 31(2), 195 -199. DOI: [10.1080/002202799183223](http://dx.doi.org/10.1080/002202799183223)
- Thakadu, O. (1997). *Indigenous wildlife management knowledge systems and their role in facilitating community based wildlife management projects in Botswana*. Master of Science Thesis, University of Natal, Pietermaritzburg, South Africa
- Ti, L. K., Chen, F.G., Tan, G.M., Tan, W.T., Tan, J. M. J., Shen, L., & Goy, R.W. (2009). Experiential learning improves the learning and retention of endotracheal intubation. *Medical Education*, 43(7), 654 - 660.
- Tilbury, D. (1995). Environmental education for sustainability: Defining the new focus of environmental education in the 1990s. *Environmental Education Research*, 1(2), 195-212.

- Tilbury, D. and Wortman, D. (2004). *Engaging People in Sustainability*. Commission on Education and Communication, IUCN, Gland, Switzerland and Cambridge, UK.
- Tilbury, D., Stevenson, R. B., Fien, J., & Schreuder, D. (2002). *Education and Sustainability Responding to the Global Challenge*. Gland, Switzerland Gland, Switzerland IUCN--The World Conservation Union
- Tiu, S. A. (2007). *The Role of Indigenous Knowledge in Biodiversity Conservation: Implications for Conservation Education in Papua New Guinea* University of Waikato, Hamilton, New Zealand.
- TKI. (2011a). The Key Concepts Underlying Environmental Education. *Education for sustainability* Retrieved on 1 November 2011, from <http://efs.tki.org.nz/Curriculum-resources-and-tools/Environmental-Education-Guidelines/The-Key-Concepts-Underlying-Environmental-Education>
- TKI. (2011b). The Key Dimensions of Environmental Education. *Education for sustainability* Retrieved 1 November 2011 from <http://efs.tki.org.nz/Curriculum-resources-and-tools/Environmental-Education-Guidelines/The-Key-Dimensions-of-Environmental-Education>
- TKI. (2011c). Action competence. *Education for sustainability* Retrieved 1 November 2011 from <http://efs.tki.org.nz/EfS-in-the-curriculum/Taking-action/Action-competence>
- Tuaru, V. (2006). *Examining the reasons behind gender inequality in Papua New Guinea higher education: Implication of women in national development. Towards recommended gender equity strategies*. ATN WEXDEV Conference 2006: Change in Climate: Prospectus of gender equity in universities.
- Turia, R.C.H. (2003). Efficient management of forest resources. In D. Kavanamur, C. Yala & Q. Clement (Eds.), *Building a nation in Papua New Guinea*:

Views of the post-independence generation(pp. 183-200). Canberra, Australia: Pundanus Books, Research school of Pacific Asia Studies.

Turner, N., J., Ignace. M. B & Ignace, R. (2000). Traditional Ecological Knowledge and Wisdom of Aborininal Peoples in Bristish Columbia. *Ecological Application*, 10(5),1275-1287.

Unit Test. (2008). *Environmental Science Test*. Balob Teachers College.

United Nations Conference on Environment and Development (UNCED). (1992, June). Promoting education and public awareness and training, *Agenda 21*, United Nations Conference on Environment and Development. Rio de Janeiro, Brazil. New York, NY: United Nations.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (1976). *The Final Report of the International workshops on Environmental Education, Belgrade (Yugoslavia) : Tbilisi (14-26 October 1977)*, Document ED-76WS/97 UNESCO, Paris

United Nations Educational, Scientific and Cultural Organization (UNESCO). (1977). *The Final Report: Tbilisi (13-22 October 1975)*, DOC MP/49, UNESCO, Paris.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (1978). *The final report: International conference on environmental education*. Paris, France: UNESCO

United Nations Educational, Scientific and Cultural Organization-United Nations Environment Program (UNESCO-UNEP). (1978). *The Tbilisi Declaration, Connect, III(I)*, 1-8.

- United Nations Educational, Scientific and Cultural Organization (UNESCO).
(1992) Environmental Education for Sustainable Societies and Global
Responsibility: Global Forum (Earth Summit) Responsibility.
- United Nations Educational, Scientific and Cultural Organization (UNESCO).
(1995). Intergovermental workshop on re-orienting environmental
education for sustainable development.
- United Nations Educational, Scientific and Cultural Organization-United Nations
Environment Program (UNESCO-UNEP). (1989). Environmental literacy
for all, *Connect*, XIV (2), 1-2.
- United Nations Educational, Scientific and Cultural Organization-United Nations
Environment Program (UNESCO-UNEP). (1990). Environmentally
educated teachers: The priority of Priorities, *Connect*, XV (1), 1-3
- United Nations Educational, Scientific and Cultural Organization-United Nations
Environment Program (UNESCO-UNEP). (1992). UNCED: The Earth
Summit, *Connect*, XVII (12), 1-2.
- United Nations Educational, Scientific and Cultural Organization -United Nations
Environment Program (UNESCO-UNEP). (1988). International Strategy
for Action in the field of Environmental Education and Training for the
1990s
- United Nations Educational, Scientific and Cultural Organization-United Nations
Environment Program (UNESCO-UNEP). (2002). Cultural diversity and
biological diversity for sustainable development.
- Van Damme, L. S. M., & Neluvhalani, E. F. (2004). Indigenous knowledge in
environmental education processes: Perspectives on a growing research
arena. *Environmental Education Research*, 10(3), 352-370. DOI:
10.1080/1350462042000258189

- Van Petegem, P., Blicek, A & Pauw, J. (2007). Evaluating the Implementation Process of Environmental Education in Preservice Teacher Education: Two Case Studies. *Journal of Environmental Education*, 38(2), 47-54.
DOI: [10.3200/JOEE.38.1.47-54](https://doi.org/10.3200/JOEE.38.1.47-54)
- von Glasersfeld, E. (1991). Cognition, construction of knowledge, and teaching. In M. R. Matthews (Ed.), *History, philosophy, and science teaching*. New York, NY: Teachers College Press.
- von Glasersfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Synthese*, 80(1), 121-140.
- Vygotsky, L.S. (1962). *Thought and language*. Cambridge, MA: MIT Press.
- Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Waldrip, B. (1993). The state of science teachers in Papua New Guinea. *Papua New Guinea Journal of Education*, 24(1), 59-67.
- Wals, A. (1990). Caretakers of the environment: A global network for teachers and students to save the earth. *Journal of Environmental Education*, 21(3), 3-7.
- Wantok System: A Traditional Social Security System in Papua New Guinea
Retrieved 6 February 2012 from
http://www.infobarrel.com/Wantok_System:_A_Traditional_Social_Security_System_in_Papua_New_Guinea#ixzz1mPzcSFL2
- Watson, A. (2010). *Communication and culture: Mobile telephony in PNG villages*. Paper presented at the 19th Annual Conference of the Asian Media: Information and Communication Centre: Technology and Culture:

Communication Connectors and Dividers. Retrieved from
<http://eprints.qut.edu.au/32787/1/c32787.pdf>

- Wiersma, W., & Jurs, S. G. (2009). *Research methods in education: An introduction* (9th ed.). Boston, MA: Pearson Education, Inc.
- Westermarck, G. (1995 or 1997). Clan claims: Land, law and violence in the Papua New Guinea Eastern Highlands. *Oceania*, 67(3), 218-233.
- Wolanski, E., & Gibbs, R. J. (1995). Flocculation of suspended sediments in the Fly River estuary, Papua New Guinea. *Journal of Coastal Research*, 11(3), 754-762.
- Wolff, S. (2004). Analysis of documents and records. In U. Flick, E. von Kardorff & I. Steinke (Eds.), *A companion to qualitative research* (pp. 284-288). London, England: Sage.
- Wolk, L. E. (2000). Up a tree in New Guinea: in the rainforests of New Guinea, kangaroos leap through trees, lizards dine while dangling, and bugs insist they're swaying plants, 25(4), 12.
- World Commission on Environment and Development (WCED)(1987). *Our common future*. Oxford, England: Oxford University Press.
- Zandvliet, D. B., & Fisher, D. L. (Eds.). (2007). *Sustainable communities, sustainable environments: The contribution of science and technology education*. Rotterdam, The Netherlands: Sense Publishers.

Appendices

Appendix One. A letter to the principal of Teachers College seeking permission to conduct research at the college in Papua New Guinea



Centre for Science & Technology Education Research
Private Bag
Hamilton 3105, New Zealand

12th August 2008

The Principal,
Balob Teachers college
P. O. Box 2127
Lae
Papua New Guinea

Subject: Research on Environmental Education at Balob Teachers College.

I am writing this letter to formally inform you about the research study that I would like to carry out at Balob Teacher's College this year and next year, 2009. My study involves development and implementation of an environmental education course at the college.

I informed the curriculum development committee for the university at the beginning of this year that I would like to develop this course as part of my PhD program at the University of Waikato.

In order to develop the course I need to carry out a baseline study on current views and practices in environmental education at the college. The purpose of the study is to find out the views and experiences of lecturers in teaching about the environment, and the knowledge, skills and attitudes that the students develop with the current program, and find out how it may be improved and offered as a multidisciplinary course approached holistically. This is when science, social science and other environment and development related learning

areas are merged. Using the information from the baseline study, a course will be designed, implemented and evaluated. The information will then be reported in my thesis. A curriculum for a course revised from data collected will be ready for implementation in 2010.

In the baseline study which will be at the beginning of November this year, I would like to involve five lecturers in the interviews of up to one hour, and about sixty students in completing a 30 minute questionnaire, and a small group of these will also be asked to participate in a focus group interview lasting up to 30 minutes. Interviews will be audio taped with the permission of the participants. Then I would like to involve two lecturers and their students enrolled in the course in the implementation and evaluation of the course in 2009. This will involve two interviews with each lecturer of up to one hour each, completion of two 30 minute questionnaires by the students, some observations of the classes in the paper, and some analysis of the reflective journals kept by the students throughout the paper. Interviews will be audio taped with the permission of the participants.

If you give permission for me to collect data in the college, I will seek informed consent from the lecturers and students involved, prior from collecting data from them. Any data collected from them will be kept confidential to me, and my supervisor at the University of Waikato. Any lecturer or student will be free to decline to be involved, and to withdraw from involvement at any time.

I have written to the Chairperson of the Curriculum Development Committee of Lutheran University of PNG, Mr. Zongoreng on the 12th April concerning this issue and further discussed with him on the phone which he fully supported.

I would appreciate your permission for the college to be involved with this project. If you need any more details about the project or in the event of any issues arising from the research contact me. If I cannot clarify the issue contact

the Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357)

If you give consent for the college to be involved, please sign the attached consent form and return it to me at the college/University of Waikato.

Thank you for your understanding and support.

Yours sincerely

.....

Asaku Openg



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Research Consent Form Principal

I have read the attached letter of information.

I understand that:

My College's participation in the project is voluntary.

Staff and students will be involved in data collection as specified in the attached letter.

I have the right to withdraw the college from the research at any time.

I can direct any questions to Asaku Openg.

For any unresolved issue I can contact Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357)

I give consent for Balob Teacher's College to be involved in the project under the conditions set out above.

Name: _____

Signed: _____

Date: _____

Please Return to Asaku Openg

**Appendix Two. A letter of Information and Consent to the Lecturer
Participant of Phase One Study**



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Centre for Science & Technology Education Research

Private Bag

Hamilton 3105

New Zealand

12th August 2008

Dear Colleague

Subject: Research on Environmental Education at Balob Teachers College

I am writing this letter to formally inform you about the research study that I will carry out at Balob Teacher's college this year and next year, 2009. My study involves development and implementation of an environmental education course at the college. The Principal of the College has given me permission to conduct this study.

In order to develop the course I need to carry out a baseline study on current views and practices in environmental education at the college. The purpose of the study is to find out the views and experiences of lecturers in teaching about the environment, and the knowledge, skills and attitudes that the students develop with the current program, and find out how it may be improved and offered as a multidisciplinary course approached holistically. This is when science, social science and other environment and development related learning areas are merged. Using the information from the baseline study, a course will be designed, implemented and evaluated. The information will then be reported in my thesis. A curriculum for a course revised from data collected will be ready for implementation in 2010.

I hope that this research project may not only hold educational value for my professional development but that both you and institution may also find it useful and consider it as an additional knowledge and development for environmental related courses at the college. It is for this reason that I wish for your honest and accurate contribution to this research.

I have therefore attached an interview schedule outlining what I will be seeking your view on. It should take only one hour of your time. You are not obliged to respond to this interview, however if you choose to do so, I would very much appreciate it. There are no right or wrong answer to these questions.

Your answers will of course be confidential. Your name will not be used in recording the result of the study. However for the purpose of analysing data, I would like some back ground information about you.

If you need any more details about the project or in the event of any issues arising from the research contact me. If I cannot clarify the issue contact the Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357)

If you give consent for the college to be involved, please sign the attached consent form and return it to me at the college/University of Waikato.

Your participation and contribution will be greatly appreciated.

Yours Faithfully

.....

Asaku Openg

Appendix Three. A Letter of Information and Consent to the Lecturer Participant in Phase Two Study



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Centre for Science & Technology Education Research
Private Bag
Hamilton 3105
New Zealand

12th August 2008

Dear Colleague

Subject: Implementation and evaluation of EEFS at the Balob Teacher's College

I am writing this letter to formally invite you to participate in the phase 2 of the research study that I will carry out at Balob Teacher's College this year, 2009. My study involves implementation and evaluation of EEFS course at the college. The Principal of the College has given me permission to conduct this study. This study involves implementation and evaluation of the course which will result in developing final draft of EEFS course for the Pre service Teacher Education program in PNG.

In order to develop the final draft of the course, I need you to implement the draft EEFS course as elective to year two students at the college. In order to develop the final draft of the course, I need you to implement the draft EEFS course as elective to year two students at the college. You will be given an inservice on the draft EEFS course. I will observe some of your lesson preparation and presentations and have access to some student's reflective journal with you and their permission. The students in you class will also complete two questionnaires, one before taking the course and one at the end of the course.

The information from evaluation form will then be reported in my thesis while the revised course will be ready for implementation in 2010.

I hope that this research project may not only hold educational value for my professional development but that both you and institution may also find it useful and consider it as an additional knowledge and development for environmental related courses at the college. It is for this reason that I wish for your honest and accurate contribution to this research.

Your answers will of course be confidential. Your name will not be used in recording the result of the study. However for the purpose of analysing data, I would like some back ground information about you.

If you need any more details about the project or in the event of any issues arising from the research contact me. If I cannot clarify the issue contact the Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357).

Your participation and contribution will be greatly appreciated.

Yours Faithfully

.....

Asaku Openg



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

**Research Consent Form –Participant Lecturer Phase
two study.**

I have read the attached letter of information.

I understand that:

1. My participation in the project is voluntary.
2. I will be involved in data collection as specified in the attached letter.
3. I have the right to withdraw myself from the research at any time.
4. I can direct any questions to Asaku Openg.

For any unresolved issue I can contact Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357)

I give consent to be involved in the project under the conditions set out above.

Name: _____

Signed: _____

Date: _____

Please Return to Asaku Openg

Appendix Four. A Letter of Information and Consent to the Pre-service Teachers Participant in the Two Study



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Centre for Science & Technology Education
Research
Private Bag
Hamilton 3105
New Zealand

12th August 2008

Dear Student Teacher

Subject: Implementation and evaluation of EEFS at the Balob Teacher's College

I am writing this letter to formally invite you to participate in the phase 2 of the research study that I will carry out at Balob Teacher's College this year. My study involves implementation and evaluation of EEFS course at the college. The Principal of the College has given me permission to conduct this study. This study involves implementation and evaluation of the course which will result in developing final draft of EEFS course for the Pre service Teacher Education program in PNG.

In order to develop the final draft of the course, I need you to implement the draft EEFS course as elective to year two students at the college. You are one of the students that are taking the course on EEFS course. I will observe some of your lesson you will be participating in. I would also like to have access to your reflective journal with your permission. I would also like you to complete two questionnaires, one at the before taking the course and one at the end of the course. You are not obliged to respond to this all I want, however if you choose to do so, I would very much appreciate it.

The information from evaluation form will then be reported in my thesis while the revised course will be ready for implementation in 2010.

I hope that this research project may not only hold educational value for my professional development but both you and institution may also find it useful and consider it as an achievement in developing the EEFS course for the college. It is for this reason that I wish for your honest reporting and contribution to this research.

Your answers will of course be confidential. Your name will not be used in recording the result of the study. However for the purpose of analysing data, I would like some back ground information about you.

If you need any more details about the project or in the event of any issues arising from the research contact me. If I cannot clarify the issue contact the Project Director, Dr. Chris Eames at the University of Waikato (email: c.eames@waikato.ac.nz Phone; 00647 8384357).

Your participation and contribution will be greatly appreciated.

Yours Faithfully

.....

Asaku Openg



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

**Research Consent Form – Student Teacher Participant Phase
Two**

I have read the attached letter of information.

I understand that:

My participation in the project is voluntary.

I will be involved in data collection as specified in the attached letter.

I have the right to withdraw myself from the research at any time.

I can direct any questions to Asaku Openg.

For any unresolved issue I can contact Project Director, Dr. Chris Eames at the
University of Waikato (email: c.eames @waikato.ac.nz Phone; 00647 8384357)

I give consent to be involved in the project under the conditions set out above.

Name: _____

Signed: _____

Date: _____

Please Return to Asaku Openg

Appendix Five. Student Questionnaire for Phase One Study

UNIVERSITY OF WAIKATO - SCHOOL OF SCIENCE AND ENGINEERING THE QUESTIONNAIRE REGARDING CURRENT ENVIRONMENTAL AND SUSTAINABILITY EDUCATION PRACTICES IN PRE-SERVICES TEACHERS COLLEGE IN PAPUA NEW GUINEA

This survey is being carried out to find out the perceptions of trainee teachers about environment and sustainability education practices in pre-service primary teachers college in Papua New Guinea.

1. These are 7 pairs of statements; each pair has two different points of view on a particular topic. Place your view along the scale by circling a number between 1 and 5, where 1 means you strongly agree with the statement on the left, 3 means your views are evenly balanced between the two statements and 5 means you strongly agree with the statement on the right

a	Science and technology have improved our quality of life	1 2 3 4 5	Science and technology have worsened our quality of life
b	Modern industrial countries are seriously disturbing the natural environment	1 2 3 4 5	The natural environment is strong enough to cope with the impacts of modern industrial countries
c	People must learn to control nature in order to survive	1 2 3 4 5	People must learn to live in harmony with nature to survive
d	Economic growth should be given priority over environmental protection	1 2 3 4 5	Environmental protection should be given priority over economic growth
e	Natural resources should be preserved for the benefit of future generations	1 2 3 4 5	Natural resources should be used for the benefit of the present generations
f	The natural environment should be used to produce goods for people	1 2 3 4 5	The natural environment should be preserved for its own sake
g	Traditional knowledge, values and skills cannot be used to solve our current environmental problems	1 2 3 4 5	Traditional and local Knowledge and values are part of our lives and should be used to solve our current environmental problems

2. These are 6 pairs of statements; each pair has two different points of view on particular teaching and learning strategies. Place your view along the

scale by circling a number between 1 and 5, where 1 means you strongly agree with the statement on the left, 3 means your views are evenly balanced between the two statements and 5 means you strongly agree with the statement on the right.

a	I think learning is effective when it is based on teacher's questions and answers	1 2 3 4 5	I think learning is effective when it is based around students' questions and answers
b	I think students learn better when they are active participants in lessons	1 2 3 4 5	I think students learn better when they are passive participants in lessons
c	I think learning in small groups is effective because students share with each other and complete the given tasks as a group	1 2 3 4 5	I think learning in groups stops some students from learning because they depend on the others in the group to do their work
d	I think prior knowledge and experience facilitate learning	1 2 3 4 5	I think prior knowledge and experience are a barrier to learning
e	I think students will develop appropriate sustainability skills and attitudes when they are immersed in skills or are negotiating attitudes selected by the teacher without consulting the students	1 2 3 4 5	I think students will develop appropriate sustainability skills and attitudes when they are immersed in skills they chose to develop or are negotiating attitudes that they decided to negotiate for
f	I think environment and sustainability education is effective when the teacher tells the students all about the issues related to the environment because the teachers know all about the subject	1 2 3 4 5	I think environment and sustainability education is effective when the students are exposed to environmental issues and are allowed to take appropriate actions to solve the problems

3. Below are some environment and sustainable issues Please rate how important you feel they are to Papua New Guinea by circling 1, 2, 3 or 4 where:

1. Very important 2. Important 3. Not sure 4. Not important

a	Air, water and land pollution	1 2 3 4 5
b	Green house effect and global warming, their causes and effects	1 2 3 4 5
c	Ozone Depletion and its causes and effects on earth	1 2 3 4 5
d	Biodiversity (ecosystem, food chain and web disturbance)	1 2 3 4 5
e	Endangered plants and animals	1 2 3 4 5
f	Deforestation (cutting trees) resulting land degradation	1 2 3 4 5
g	Over population	1 2 3 4 5
h	Inequality in distribution of resource and poverty	1 2 3 4 5
i	Damage to the environment by mining	1 2 3 4 5

4. For the following teaching and learning strategies, please indicate how much you think you have been taught about each at this college by circling 1, 2, 3, 4 or 5 where:

- 1. I have been taught a lot about it by my lecturers**
- 2. I have been taught a little about it by my lecturers**
- 3. Not sure**
- 4. I have not been taught about it by my lecturers**
- 5. Don't know anything about it**

a	Constructivist learning use of prior knowledge and experience in learning	1 2 3 4
b	Sociocultural learning, influence of social cultural values/beliefs in learning	1 2 3 4

c	Experiential learning use of past and present experiences in learning	1 2 3 4
d	Inquiry based learning, learner asking and answering questions in learning	1 2 3 4
e	Cooperative learning, completing tasks and learning in small groups	1 2 3 4
f	Problem based learning	1 2 3 4

5. Below are statements about your involvement in learning and assessment activities in your courses at this college. Indicate your opinion about how involved you think you were in each activity by circling 1, 2, 3 or 4 meaning:

1. I was often involved 2. I was seldom involved 3. Not sure

4. I was hardly involved 5. I was never involved

a	In deciding what and how I should learn	1 2 3 4 5
b	In deciding how I should be assessed in my learning	1 2 3 4 5
c	In asking and answering questions in class and field activities	1 2 3 4 5
d	In sharing and using my prior knowledge to build new knowledge, skills and attitudes	1 2 3 4 5
e	In developing new knowledge which is relevant to my social and cultural setting	1 2 3 4 5
f	In going out to communities or areas with environmental problems to learn about environmental and sustainability issues	1 2 3 4 5
g	In identifying environmental issues and deciding possible solutions, take action and evaluate the action	1 2 3 4 5
g	In taking action to improve environmental and sustainability problems	1 2 3 4 5

6. Please rate your opinion on the following statements on the scale given.

Circle one number where:

1 Strongly Disagree 2. Disagree 3. Not sure 4. Agree 5. Strongly Agree

a	I think learning is effective when it is in harmony with a student's culture, beliefs and values	1 2 3 4 5
---	--	-----------

b	Indigenous/local knowledge can be used for environment and sustainability education	1 2 3 4 5
---	---	-----------

7. The following statements ask you to rate your opinion about your confidence about teaching in environment and sustainability education in primary schools? Circle one number where:

1. Very confident 2. Confident 3. Not Sure 4. Than confident 5. Not at all confident

a	Teaching environment and sustainability education in primary schools	1 2 3 4 5
b	Teaching the children how to participate in social and economic activities that contribute to the development of the local community	1 2 3 4 5
c	Teaching the children how to contribute to social and economic development of the province and nation	1 2 3 4 5
d	Teaching the children how to suggest changes to the government or industry that would lead to social and economic sustainability	1 2 3 4 5
e	Teaching the children to identify and describe influence of human beings on natural environments of the country	1 2 3 4 5
f	Helping the children the children to take appropriate action to help maintain and improve the natural environment	1 2 3 4 5
g	Helping the children to Identify, propose and practice sustainable use of the local environment and its resources	1 2 3 4 5
h	Helping the children to Identify and describe environmental issues of the nation and world, and their possible solutions	1 2 3 4 5

Open Ended Questions

Items 8 to 12 are open ended questions. Write your answers in the space provided.

8. What subjects/courses have you done at this college that taught you something about environment and sustainability education?

.....
.....
.....

9. Would you like to learn more about how to teach environment and sustainability? Why/why not?

.....
.....
.....

10. List the subjects in primary school that you think you can use to teach environment and sustainability

.....
.....
.....

11. Do you think you are ready to teach environment and sustainability education to the children in primary school? Why/ Why not?

.....
.....
.....

12. Any other things you want to say about environment and sustainability education

.....

Appendix Six. Student Questionnaire for Phase Two Study

UNIVERSITY OF WAIKATO - SCHOOL OF SCIENCE AND ENGINEERING
THE QUESTIONNAIRE REGARDING CURRENT ENVIRONMENTAL AND
SUSTAINABILITY EDUCATION PRACTICES IN PRE-SERVICES TEACHERS COLLEGE IN
PAPUA NEW GUINEA

This survey is being carried out to find out the perceptions of trainee teachers about environment and sustainability education practices in pre-service primary teachers college in Papua New Guinea.

- Here are 6 pairs of statements; each pair has two different points of view on a particular topic. Place your view along the scale by circling a number between 1 and 5, where 1 means you strongly agree with the statement on the left, 3 means your views are evenly balanced between the two statements and 5 means you strongly agree with the statement on the right**

A	Development in transport and communication have worsen the quality of life in PNG	1 2 3 4 5	Development in transport and communication have improved the quality of life in PNG
B	Social/cultural and economic development activities are affecting the natural environment	1 2 3 4 5	Social/cultural and economic activities do not affecting the natural environment
C	The use of advance technology in cities is causing environmental problems	1 2 3 4 5	The use of advance technology in cities is helping to solve environmental problems
D	People living in rural areas in PNG do not cause environmental problems	1 2 3 4 5	People living in rural areas in PNG do not cause environmental problems
E	People must learn to control and use the natural resources to improve the quality of their lives	1 2 3 4 5	People must learn to be connected to their environment, live in it and use it harmoniously
F	Economic growth should be given priority over environmental protection in PNG	1 2 3 4 5	Environmental protection should be given priority over economic growth in PNG

2. These are 6 pairs of statements; each pair has two different points of view on delivery of environment and sustainability education. Indicate your view by circling a number between 1 and 5, where: 1 means you strongly agree with the statement on the left, 3 means your views are evenly balanced between the two statements, and 5 means you strongly agree with the statement on the right

A	People's social and cultural background affects their behaviour towards the environment	1 2 3 4 5	People's social and cultural background does not affects their behaviour towards the environment
B	Students learn better when they work on learning activities that were identified and selected by the teacher	1 2 3 4 5	Students learn better when they work on learning activities that they themselves identified and selected were identified and selected.
C	Environment and sustainability education is effective if the teacher tells the students all about the issues related to the environment	1 2 3 4 5	Environment and sustainability education is effective if the learners are exposed to environmental issues and are allowed to take appropriate actions to solve them
D	Students learn better when they when they are engaged in seeking solutions for environment and sustainability problems	1 2 3 4 5	It is not the responsibility of the students to solve environment and sustainability problems
D	Traditional/local Knowledge, values and skills are useful for solving environmental problems PNG	1 2 3 4 5	Traditional/local Knowledge, values and skills are not useful for solving environmental problems PNG

3. Below are some environment and sustainability issues. You are to indicate whether you think these are issues experienced in Papua New Guinea by circling 1, 2, 3, 4 or 5 and then explain your choice of rating in the space provided, where:

- 1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree**

	Environmental issue	Rate	Describe it or explain your choice
A	Depletion of Biodiversity	1 2 3 4 5	
B	Deforestation	1 2 3 4 5	
C	Endangered Species	1 2 3 4 5	
D	Land ownership and degradation	1 2 3 4 5	
E	Water land air pollution	1 2 3 4 5	
F	Global warming and Climate change	1 2 3 4 5	
H	Mining	1 2 3 4 5	
I	Population Growth	1 2 3 4 5	
J	Poverty	1 2 3 4 5	
K	Unequal resource distribution	1 2 3 4 5	

4. Below are some statements related to learning strategies that are said to be appropriate for teaching environment and sustainability? You are to indicate if you strongly agree, agree, not sure, disagree or strongly disagree with the statement by circling 1, 2, 3, 4 or 5 and then explain your choice of rating in the space provided. Where:

1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree

	Item	Rate	Explain your choice of rating
a	Learners need to forget what they already know to learn new things	1 2 3 4 5	
b	Learning is dependent on or affected by the learner's social and cultural background	1 2 3 4 5	
c	Students can use their current and past experiences to develop new knowledge	1 2 3 4 5	
d	Learners develop knowledge by questioning and answering questions	1 2 3 4 5	
e	Learners learn best when given information by the teacher	1 2 3 4 5	
f	Learners learn better when they work and learn in small groups.	1 2 3 4 5	
g	Traditional teaching methods from the village are useful for teaching in schools	1 2 3 4 5	

5. Below are some statements related to the characteristics of environment and sustainability education. Please indicate if you strongly agree, agree, are not sure, disagree or strongly disagree with the statement by circling 1, 2, 3, 4 or 5 and then explain your choice of rating in the space provided. Where:
1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree

	Item	Rate	Explain your choice of rating
a	Environmental and sustainability issues should be taught through science subject in school	1 2 3 4 5	
b	People can deal with the effects of environment problems without knowing the causes of environmental problems	1 2 3 4 5	
c	Experiences in the environment are not necessary for learning about an environmental issues	1 2 3 4 5	
d	Understanding environmental and sustainability issues needs thinking about values	1 2 3 4 5	
e	Critical reflection about environmental and sustainability learning is necessary	1 2 3 4 5	
f	The quality of our future lives is dependent on today's environment and sustainability education	1 2 3 4 5	
g	Environment and sustainability education should be related to the culture of PNG and in line with PNG curriculum	1 2 3 4 5	

Open Ended Questions

Items 6 to 9 are open ended questions. Write your answers in the space provided.

6. Do you think it is important that primary school students are taught about environment and sustainability? Why/why not?

7. Which subjects in lower primary school do you think could include environment and sustainability education?

8. Describe what you know about how traditional knowledge about environment and sustainability is passed on? Who teaches it, where is it taught and how it is taught?

9. Do you have any other comments about environment and sustainability education?

Appendix Seven Lecturers' Interview Schedule for Phase One Study

UNIVERSITY OF WAIKATO - SCHOOL OF SCIENCE AND ENGINEERING THE INTERVIEW REGARDING CURRENT ENVIRONMENT AND SUSTAINABILITY EDUCATION PRACTICES IN PRE-SERVICES TEACHERS COLLEGE IN PAPUA NEW GUINEA

Lecturer Interview Schedule

This interview is being carried out to find out the views and experiences of lecturers in teaching about the environment and sustainability education in pre-service primary teachers college in Papua New Guinea.

1. **What do you think sustainability is?** What do you think are the main sustainability issues that PNG faces?
2. **Do you think it is important to teach the trainee teachers about environment and sustainability?** Why/why not?
3. **What topics, subtopics and concepts about environment and sustainability do you teach?** Why do you teach them? What else would you like to teach?
4. **How do you teach the topics and concepts?** What teaching and learning strategies do you use? What other teaching and learning strategies would you like to use? Do you use locally relevant cases to develop sustainable concepts?
5. **Do you provide opportunities for the trainee teachers to utilize and develop their traditional or local knowledge about the environment?** Why/Why not?
6. **Tell me about any teaching and learning activities that you provide for the students to develop and deepen their experiences with the environment and sustainability?** Do you use direct experiences on environment and factors related to the environment? If not, what sort of indirect experiences do you use to increase student's awareness and appreciation of the environment?
7. **Do you accept and use beliefs, values and perspectives of your students?** Do you consider them when teaching environment and sustainability education? How do you develop these further?
8. **What learning outcomes would you like your students to achieve from your teaching in environment and sustainability education?** What are some concepts, processes and skills you want them to be able to demonstrate?
9. **What assessment processes are you using to find out if these outcomes are being achieved?** What methods do you use to assess the students knowledge

skills and values about environment and sustainability? What other approach could you use?

10. **Do you think that trainees are well prepared to teach environment and sustainability when they graduate from Balob Teacher's College?** How could they be better prepared?

11. **What are some barrier you have when teaching environment and sustainability education at the college?** What can be done to address these barriers?

Appendix Eight. Interview Schedule for Student's Focus Group in Phase One Study

UNIVERSITY OF WAIKATO SCHOOL OF SCIENCE AND ENGINEERING

The interview regarding current environment and sustainability education practices in pre-services teachers college in Papua New Guinea

Please tell me about environment and sustainability education that you are involved in.

- 1. What are topics, subtopics and concepts did you learn?**
- 2. What type of teaching and learning strategies did your lecturer use to help you learn about environment and sustainability education?**
- 3. What subjects/courses have you done at the college that taught you something about environment and sustainability education?**
- 4. What assessment methods did your lectures use to assess your learning in environment and sustainability education at the college?**
- 5. Were you given the opportunity to utilize and develop your local and traditional knowledge about environment?**
- 6. I know you participated in your culture show you had different, was it recognised and discussed in science and social science classes, especially in natural and cultural environment?**
- 7. At the college do you think we should have these courses run in this semester and at the same time and also have the cultural show?**
- 8. Name the subjects in primary school that you think you can use to teach environment and sustainability**
- 9. Do you think you are ready to teach environment and sustainability education to the children in primary school?**
- 10. Are there any other things you want to say about environment and sustainability education?**

Appendix Nine. Interview Schedule Phase Two Study lecturer

Interview Schedule

UNIVERSITY OF WAIKATO

SCHOOL OF SCIENCE AND ENGINEERING

THE INTERVIEW REGARDING CURRENT ENVIRONMENT AND SUSTAINABILITY
EDUCATION PRACTICES IN PRE-SERVICES TEACHERS COLLEGE IN PAPUA NEW
GUINEA

Lecturer Interview Schedule

This interview is carried out to find out the views and experiences of lecturers in teaching environment and sustainability education in pre-service primary teachers college in Papua New Guinea before implementation.

Tell me about your experience teaching the course on EEfS

1. **What do you think sustainability is all about?** What is sustainable development? What are the main/key concepts of sustainability?
2. **Is sustainability an issue in PNG? What sustainability issues are important to you in PNG?**
3. **How should PNG address these issues?** Should education be used? How?
4. **Should we teach the trainee teachers about environment and sustainability.** If so, what do they need to learn? How should they learn it?
5. **Have you taught students about environment and sustainability at BTC?** If so, how and what have you taught?
6. **What learning outcomes would you want your students to achieve from your teaching in environment and sustainability education?** What are some concepts, processes and skills you want them to be able to demonstrate?
7. **How would you assess these learning outcomes?**
8. **Do you think traditional or local knowledge is important in teaching about environment and sustainability?**
9. **What are the challenges in delivering environment and sustainability education?**

Appendix Ten. Reflection journal Template for Phase Two Study

What was the lesson about?	
Did you learn anything new? If so what?	
How you might apply this learning in future	
Has this lesson influence your thinking about teaching and environment and sustainability	
Is there anything more you would like to know about Ideas raised in this lesson?	

Appendix Eleven. The Course overview for the intervention course implemented at the pre-service teachers college in PNG

Lecture Topic	Subtopics	Learning activity and approaches	Link with the Framework
1 Course on EEfS	Introduction to EEfS	The pre-intervention questionnaire was administered and students completed the questionnaires. Students answered questions related to prior knowledge and experience. Students read notes on characteristics of EEfS; and education about, in and for environment; and traditional knowledge system in their own time	There was some introduction in pre-service teachers knowledge about environmental issues in PNG; key concepts of EEfS; and education about, in and for environment; knowledge about pedagogies including EEfS pedagogies; and traditional knowledge system that is consistent with Lucas' education about environment. Finding student's prior knowledge and experience about the topic to create new knowledge is consistent with Tilbury's idea that EEfS should be relevant education.
2 EEfS frameworks	Characteristics of EEfS; Education about, in and for environment; and traditional Knowledge system.	Socio-cultural and cooperative learning approaches were used when pre-service teachers were involved in doing pair share, group, and class discussions learning about characteristic of EEfS; education about, in and for environment; and traditional knowledge system. Learning from lecturer and each other is sociocultural learning.	Students knowledge about characteristics of EEfS; education about, in and for environment; traditional knowledge system; and different types of student-centred learning was developed that is being consistent with Lucas' idea that EEfS should be about environment. Pre-service teachers learning about active learner centred learning approach is relevant and appropriate for delivering EEfS which is consistent with Tilbury's idea that EEfS should be relevant.

<p>3 Pedagogy for EEfS</p>	<p>Inquiry and problem based, experiential, sociocultural and cooperative learning</p>	<p>Teaching and assessing each student working and learning in small groups through cooperative learning; inquiry-based learning was developed through students asking and answering questions; students learning from each other and the lecturer involved sociocultural learning; and experiential learning through knowledge and methods developed becoming experience for future actions and lessons.</p>	<p>There was development in students' knowledge about different student-centred learning approaches including inquiry based, experiential, sociocultural and cooperative learning which is being consistent with Lucas' idea that EEfS should be about environment. The need to use appropriate and effective pedagogy is important for relevant, issue-based and action-oriented EEfS, as Tilbury (1995) suggested.</p>
<p>4 Biodiversity</p>	<p>Biodiversity, Living things, Lowland rainforest, mid-mountain forest and upper mountain forest</p>	<p>Lesson composed of simulation of a trip to three different types of rainforest. Constructivist and experiential learning occurred when the pre-service teachers imagined types of forests based on their past knowledge and experiences</p> <p>Cooperative, experiential, and inquiry based learning occurred when they answered questions, discussed, listed and explained to each other the use for different resources from the forest in groups.</p>	<p>There was development in students' knowledge about biodiversity, types of habitat or environment including lowland rainforest, mid-mountain forest and upper mountain forest, that is being consistent with Lucas' ideas about EEfS as education about and in environment</p> <p>The knowledge about biodiversity, type of cultural and natural environment, resources in the environment is relevant for the pre-service teachers, which is consistent with Tilbury' idea that EEfS should be relevant and value based.</p>

<p>5 Biodiversity</p>	<p>Take actual trip to rainforest habitat to see endangered and endemic species</p>	<p>Taking actual trip to rainforest habitat (zoo), completing worksheets at the site by answering the questions, and then critically reflecting on activities and lessons . The learning approaches employed are constructivist, experiential, and inquiry based learning.</p> <p>Sociocultural learning because they are seeing the lecturer modeling both learning activities and approaches.</p>	<p>Knowledge about endangered and endemic species and how to organize and take students on excursion has been developed and that is consistent with Lucas' idea that EEfS should be about and in the environment.</p> <p>Knowledge about endangered and endemic species and how to organize and take students on excursion is relevant which is consistent with Tilbury's idea that EEfS should be relevant, issue based, action oriented, and critical reflective learning.</p> <p>The fact that the students experienced observing an environmental issue, and felt and thought about the issue and its solution is expected to promote sustainable action, which is consistent with Lucas' that EEfS should be in, and for environment.</p>
<p>6. Ecology</p>	<p>Ecology, Ecosystems, habitats in PNG such as: Savannah grasslands, Low, mid and upper mountain forests, Lowland rainforests, Wetlands/Swamps and Mangrove forests</p>	<p>List living things in the local environment and listen to the lecturers; using teacher centred, constructivist, and experiential learning strategies</p>	<p>There was development in the preservice teachers knowledge about ecology, ecosystems, habitats in PNG and that is consistent with Lucas' idea that EEfS should be about environment.</p> <p>The knowledge about ecology, ecosystems, habitats in PNG is relevant for pre-service teachers , that is consistent with Tilbury's idea that EEfS should be relevant.</p>

7. Ecology	Forest , use of forest resources, carrying capacity of the forest, depletion of resources and deforestation, cause of deforestation and depletion of biodiversity, effects of deforestation, sustainable use of forest resources.	Cooperative, inquiry based and constructivist learning approach were used when pre-service teachers did think, pair share, and answered revision questions based on past knowledge and experiences. Experiential learning was used when pre-service teachers considered their past and present experiences including studying of big tree community.	<p>Knowledge about forest, use of forest resources, depletion of resources and deforestation, carrying capacity of the forest, cause of deforestation and depletion of biodiversity, effects of deforestation, sustainable use of forest resources. has been developed and that is being consistent with Lucas' idea that EEfS should be about environment.</p> <p>Knowledge about depletion of resources and deforestation is relevant to the pre-service teachers that is consistent with Tilbury's idea that EEfS should be relevant and issue based.</p>
8. Interdependence	EEfS as action oriented, issue based education; problem solving skills and sustainable actions, engaging learners in actions. Asked to read and learn about interdependence of ecological, social and economic systems,	Cooperative learning approach was used when the pre-service teachers shared with each other about the ideas related to EEfS as action oriented, issue based education; problem solving skills and sustainable actions, engaging learners in actions which they read about in the handout. Most of the time teacher centred and sociocultural learning approach was used to explain the importance of action in EEfS and in instructing and encouraging the pre-service teachers to take action to contribute to future sustainability	<p>Pre-service teachers knowledge was developed about EEfS as action oriented and issue based education; problem solving skills and sustainable actions, engaging learners in actions, action competency, model pedagogy, experience for future action. This is being consistent with Lucas' idea that education should be about and for the environment.</p> <p>The pre-service teachers were engaged in taking action to contribute to future sustainability is consistent with Tilbury's idea that EEfS should be issue based and action oriented.</p>

<p>9. Interdependence</p>	<p>Interdependence of ecological, issues affecting related systems including cultural, social and economic systems.</p> <p>Role play in EEfS lessons.</p>	<p>Sociocultural learning approach was used when the pre-service teachers learnt from lecturer modeling role play in EEfS lesson and when they learn from the ideas raised about natural and cultural environment in the role play dramatizing cultural, social and economic developments, effects of development activities, and decision making.</p> <p>Cooperative learning was used when the pre-service teachers completed activities in groups which includes role playing.</p> <p>Constructivist and experiential learning approach was utilized when the pre-service teachers used past and present knowledge and experience to create new knowledge and experience.</p>	<p>Pre-service teacher knowledge about interdependence of ecological, issues affecting related systems including cultural, social and economic systems was developed. That is consistent with Lucas' idea that education should be about environment. The knowledge about interdependence of ecological, issues affecting related systems including cultural, social and economic systems is relevant for pre-service teachers and it is consistent with Tilbury's idea that EEfS should be relevant, issue based, and holistic.</p>
<p>10. Topics in National Curriculum</p>	<p>National Curriculum Statement of PNG, environmental issues of PNG, EEfS concepts in NCS, ways of addressing environmental issues of PNG, Pedagogy for teaching EEfS in schools</p>	<p>Reading and answering questions related to NCS, environmental issues and EEfS is using inquiry based learning. Cooperative learning approach was used when they played Follow Me game with peers and seeing lecturer model the learning activity and approach is sociocultural learning approach.</p>	<p>The pre-service teachers knowledge about National Curriculum Statement of PNG, environmental issues of PNG, EEfS concepts in NCS, ways of addressing environmental issues of PNG, pedagogy for teaching EEfS in schools was developed. This is linked to developing relevant pedagogy for EEfS.</p>
<p>11. Topics in National Curriculum</p>	<p>Environmental issues, indicators, outcomes, Clustering learning outcome, Developing a Unit of Work,</p>	<p>Learning from each other and from the teacher is using cooperative and sociocultural learning approach. Actually practicing to develop unit of work is experiential learning approach.</p>	<p>The pre-service teachers knowledge about environmental issues of PNG, EEfS concepts in NCS, indicators, outcomes, clustering learning outcomes, and developing a Unit of Work, is in line with Lucas' idea that education should be about environment, Tilbury's idea that EEfS should be relevant education, and the development of appropriate pedagogy for EEfS.</p>

12. Earth Studies	Traditional Knowledge about earthquakes, sea level rise, moon, phases of moon, suns, solar system, planets and other bodies in the space.	Lecturer led discussion on how local traditional knowledge, values and skills are passed from one generation to another. Told and wrote stories, legends and myths about different concepts related to the environment including formation of earth, stars, moon, solar system, and phases of moon Pedagogies used include constructivist, experiential, cooperative, and sociocultural learning.	Pre-service teachers knowledge about local traditional knowledge about earthquakes, sea level rise, moon, phases of moon, suns, solar system, planets and other bodies in the space has developed that is in line with Tilbury's idea that EEfS should be relevant and value based education, and with the use of local traditional knowledge in EEfS.
13. Earth Studies	Mountains, valleys, trenches, volcanoes and earthquakes sea level rise Suns, solar system, planets and other bodies in the space and around the earth	Sociocultural learning approach was used when Self study KWL chart was Modeled to the student Used their prior knowledge and experiences to list what they knew, what they wanted to learn about. They then listed what they learnt through research and discussion etc when they have learnt. Constructivist, experiential and inquiry based learning are the pedagogies used in the lesson	Students knowledge about mountains, valleys, trenches, volcanoes and earthquakes sea level rise; and Suns, solar system, planets and other bodies in the space and around the earth was developed which is consistent with Lucas' idea of education about environment, and with Tilbury's idea that EEfS should be relevant education..
14. Social and Cultural environment	Traditional education system, teacher of traditional education, Venue of traditional education, time/period for delivering or offering traditional education	They used constructivist and experiential learning strategies when they utilized past knowledge and experiences to develop new knowledge. Cooperative learning approach was used when the students discussed as pairs and as class about teachers of traditional education, Venue of traditional education, time/period for delivering or offering traditional education.	Pre-service teachers knowledge of traditional education system was developed which is consistent with with Tilbury' idea that EEfS should be relevant and holistic education.

<p>15.</p> <p>Social Cultural Environment - Traditional lifestyle</p>	<p>Local traditional knowledge system; the beliefs and values about environments and its resources, specifically about fishing, hunting, gathering, gardening and cooking.</p>	<p>Sociocultural learning was used when the pre-service teachers discussed points raised in an article about the local traditional knowledge system; the beliefs and values about environments and its resources, specifically about fishing, hunting, gathering, gardening and cooking. Also sharing and learning from the lecturer and each other and about their social and cultural beliefs and values.</p> <p>Constructivist learning approach was used because the students came to the lesson with prior knowledge and experience on the topic and learnt some more about the topic.</p>	<p>Development of knowledge in line with Lucas' education about environment and Tilbury's critical reflective knowledge. Learning about local traditional knowledge which is in line with Tilbury's idea that EEfS should be value based and relevant education.</p>
<p>16</p> <p>Social and Cultural Environment- Modern Lifestyle</p>	<p>Change in lifestyle, improved lifestyle, development in transport system and its impact on quality of lifestyle, development in communication system and its impact on quality of lifestyle, use of advance tools or machines and their effects on the environment</p>	<p>Cooperative learning was used because they worked in small groups to complete their assessable task and gain marks as a group.</p> <p>Sociocultural learning because the students were learning about each other's culture, beliefs and values.</p>	<p>Pre-service teachers' development of Knowledge is in line with Lucas' education about the environment, and Tilbury's ideas about EEfS as value based.</p>

<p>17 Social and Cultural Environment - Traditional Lifestyle</p>	<p>Issues of utilizing local traditional knowledge and method</p>	<p>Cooperative and sociocultural learning strategies were employed when the students discussed as pairs and class, and learnt from each other and the lecturer respectively.</p> <p>Inquiry based learning strategy was employed when students read to discover information and answer questions related to the information on the handout.</p> <p>Constructivist learning was employed when students utilized their prior knowledge to develop new additional knowledge related to lifestyle choices and their positive and negative effects.</p>	<p>Development of knowledge about lifestyle choices and their positive and negative effects is consistent with Lucas' education about environment and Tilbury's critical reflective knowledge. Learning about local lifestyle choices and effects on the environment is being consistent with Tilbury's idea that EEfS should be value based and relevant education.</p>
<p>18. Social and Cultural Environment -Modern Life style</p>	<p>People's lifestyle choices and its effects on the environment including improved transport and communication systems and their impact on the environment Use of advance tools and machines and their impact on the environment</p>	<p>Cooperative and sociocultural learning strategies were employed when the students discussed as pairs and class, and learnt from each other and the lecturer respectively.</p> <p>Inquiry based learning strategy was employed when students read to discover information and answer questions related to the information on the handout.</p> <p>Constructivist learning was employed when students utilized their prior knowledge to develop new additional knowledge about lifestyle choices and their positive and negative effects.</p>	<p>Development of knowledge about improving transport and communication system and their positive and negative effects which is consistent with Lucas' education about the environment.</p> <p>The topics or concepts are relevant to the learners life which is consistent with Tilbury's idea that EEfS should be relevant and critically reflective.</p>

19. Land and land use	Customary land and ownership, value and beliefs. Land tenure, land uses, management and development, Customary land law and Mining law	<p>Inquiry based learning was used when the students read the handout, searched for the information and answered the questions related to the Customary land and ownership, value and belief.</p> <p>Cooperative learning was used when the pre-service teachers learnt from each other and their lecturer about customary land in PNG.</p>	Development of knowledge about Customary land and ownership, value and beliefs is consistent with Lucas' education about the environment. The topics or concepts are relevant to the learners life and national curriculum which is consistent with Tilbury's idea that EEfS should be relevant and value based.
20. Land and land use	Land problems, cause and effects of land problems, possible solutions to land problems, different types of actions	Cooperative and inquiry based learning approaches were used when the pre-service teachers worked in groups to identify land related issues, investigated its causes, effects and possible solutions.	Pre-service teachers knowledge about Land problems, cause and effects of land problems, possible solutions to land problems, different types of actions was developed. This is in line with Lucas' idea that education must be about environment. Pre-service teachers taking some actions to address land issues helped them developed competence which is in line with the ideas of action competence.
21. Population	Large families, reasons for having large families (Culture and religious values and beliefs), effects of population growth, Growth and density, Impact of population on the environment	Cooperative and sociocultural learning strategies were employed when the students discussed as pairs and class, and learnt from each other and the lecturer about effects or impact of population growth and density on the cultural and natural environment;and factors affecting family sizes and ways of addressing issue of rapid population growth.	Development of knowledge about effects or impact of population growth and density on the cultural and natural environment; factors affecting family sizes; and ways of addressing issue of rapid population growth is consistent with Lucas' education about environment. The topics or concepts are relevant to the learner's life and national curriculum which is consistent with Tilbury's idea that EEfS should be relevant and values based.

22. Population	Problems related to population including land shortage, low living standard, poverty, increasing law and order problem	Cooperative and sociocultural learning strategies were employed when the students discussed as pairs and class about problems related to population, including land shortage, low living standard, poverty, increasing law and order problems. Also the pre-service teachers taught each other about the functions/use, advantages and disadvantages of a family planning method and how to seek information about family planning methods.	Development of knowledge about problems related to population is consistent with Lucas' EEfS as education about environment, and with Tilbury's idea that EEfS should be relevant, values based and issue based education.
23-25 Presentation of students' action plans	EEfS as action oriented, issue based education; problem solving skills and sustainable actions, engaging learners in actions.	Sociocultural learning approach was used when pre-service teachers learnt from their peers presentations.	<p>Pre-service teachers knowledge was developed about EEfS as action oriented and issue based education; problem solving skills and sustainable actions, engaging learners in actions, and action competency while they were engaged in identifying local environmental issues, investigating their causes, effects and possible solutions. This is being consistent with Lucas' idea that education should be about, in and for environment.</p> <p>The pre-service teachers were engaged in planning action to contribute to future sustainability which is consistent with Tilbury's idea that EEfS should be issue based and action oriented, and with the development of action competence.</p>
26 Revision and evaluation time	All concepts	Finding out about the impact of the intervention on student's knowledge and experience after the intervention	The use of critical reflection on ideas.

27-28 Consultation Time, Revision and Examination	All concepts	Inquiry based learning occurs when students ask and answer questions by themselves. Sociocultural learning occurs when the pre-service teachers learn from each other and from their lecturers	
--	--------------	---	--

Appendix Twelve Lecturers Training Programme

Lecturers training programme

Day One

SESSION	TOPIC	SUBTOPIC	ACTIVITY
One	Prior knowledge and current practice	Importance of EEfS, pedagogy (especially student centered learning), modeling pedagogy, use of traditional knowledge in delivering environmental education	Small questionnaire to find out about lecturer's prior knowledge
	MORNING	COFFEE	
Two	New course EEfS World view Why is EEfS important?	<ul style="list-style-type: none"> • New Course • International policy, • National policy in the constitution, • Educational policy in NCS and TENCG and; • Current issues in PNG 	(1) Do a PowerPoint presentation on policies (2) Make comments to stress the important points
	LUNCH	LUNCH	
Three	Reorientation in EE Why is it important to change the approach?	Environmental problems as multidisciplinary problem; social and economic activities such as developments affect the environment; must be addressed by all disciplines and learning areas; and using all human faculties holistically. Education about, in and for environment are equally important	Each person given small paragraph to read and speak on Interdependence, Multidisciplinary, Holism in relation to environment and sustainability education.
	AFTERNOON	COFFEE	
Four	Evaluation	Oral and written evaluate the day's work	The lecturers evaluate the day's work by writing reflective journal

Day Two

SESSION	TOPIC	SUBTOPIC/ Concepts	ACTIVITY
Five	Education for environment and Sustainability	Interdependence, Social justice, future focused, Connectedness Environmental education for	(1) PowerPoint presentation on the pedagogies (2) Make comments to stress the important points about pedagogies
SIX	EEfS- Action oriented learning resulting in learner action competent or empowered.	sustainability that is: (a) Relevant (b) Holistic © Values-orientated (d) Issues-based (e) Action-orientated (f) Critical education	
	LUNCH	LUNCH	
Seven	Education about, in and for Environment and sustainability	Education in and for environment and sustainability, experiential learning, and Connectedness	Take the trip to the rainforest habitat Reflect on what the experience does for them
	AFTERNOON	COFFEE	
Eight	Evaluation	Oral and written evaluate the day's work	The lecturers evaluate the day's work by writing reflective journal

Day Three

SESSION	TOPIC	SUBTOPIC	ACTIVITY
Nine	Modeling pedagogy Why model the pedagogy?	Deliver the concept in a way the trainees will also do the same. Allow the students to reflect on the method used	(1) Let the lecturers share what they think about modeling the pedagogies. (2) Trainer explain to the lecturers why it is important in EEfS
	MORNING	COFFEE	
Ten	Traditional Knowledge Why traditional knowledge?	Who teaches the knowledge, skills and values? Where is the knowledge, skills and values delivered? How are the knowledge skills and values delivered?	(1) Allow them to answer the questions (2) Trainer explain why it is appropriate for delivering EEfS
	LUNCH	LUNCH	
Eleven	Lesson Plans – Other lessons	Peer teaching in group, simulation like the imaginary trip, Dramatize and defending their position/role, use of KWL chart, use of reflective journal for critical reflection	Group discussion led by trainer
	AFTERNOON	COFFEE	
Twelve	Evaluation	Oral and written evaluate for the whole training	The lecturers evaluate the training

Appendix Thirteen Sample Lesson Plan

Lesson: Four, Single Period

Week: 3

Date

Topic: Biodiversity – biodiversity of rainforest

Objectives: (1) Develop an understanding of the concept of biodiversity and discuss the incredible wealth PNG rainforest has in terms of flora and fauna in the different types of forests.
 (2) Experience the lesson approaches used in the lesson including use of KWL Chart.

Materials

Main Points	Lecturer	Student Activity
Introduction Feedback on formative peer assessment. Story of PNG forests.	1. Take roll check (3 min) 2. Ask the students to sit in a relaxed position with their eyes closed and you tell an imaginary story about a trip to the forest (10 min)	1. Participate in roll check (3 min) 2. Listen to the story while seated in a relaxed position with their eyes closed (10 min)
Body – key ideas <ul style="list-style-type: none"> • Indirect experience evokes feelings – a key aspect of EEfS • Use of prior knowledge and indigenous knowledge to make learning relevant • Biodiversity – (1) variety of living things found in a given area (2) provide, food , shelter and other services for each other – interdependence • Four types of forests in PNG • Much of what we eat 	3. Ask the students to share their feelings about the imaginary trip to the forest with someone next to them and also their knowledge about native plants in their home region (5 min) 4. Lead a discussion on the concept of biodiversity and types of forests in PNG and encourage the students to share their experiences and knowledge of them: A. What are main types of plants found in lowland rainforest, low mountain forest and mid mountain forest?	3. Students share feelings and knowledge with their partner (5 min) 4. Participate in class discussion on biodiversity and forests (12 Min)

<p>and use comes directly and indirectly from the rainforests.</p> <ul style="list-style-type: none"> • Rainforest – relatively un-explored and so more needs to be discovered, unfortunately, many plant and animals species are disappearing before scientists have the chance to identify them 	<p>B. What does rainforest provide for animals? C. What does rainforest provide for people? (12 Min)</p> <p>5. Ask the students to study items on the list (below) and share with class possible substitutes from the forest, using their knowledge: Imported apples, Crunchy nut mix, Bowl/plate, Antibiotic, Spices, Ropes, Aspirin, Candle for lighting, Charcoal for cooking, Insect repellent, Pills to prevent Malaria (10 Min)</p> <p>6. Lead a discussion on the importance of using resources from the environment sustainably</p>	<p>5. Study the items on the list and share the possible substitutes from the forest (10 Min)</p> <p>6. Participate in the discussion on sustainable use of resources from the environment</p>
<p>Conclusion/Homework</p>	<p>7. Ask students to write in their reflective journals about the lesson as part of their homework</p>	<p>7. Critically reflect on the whole lesson (5 Min)</p>

Lesson Evaluation

.....

Imaginary Stories

“As part of your study for EEfS you were told, you would be taken to Mount Kaindi at Wau, on Friday morning and return on Saturday evening, to study plants in lowland rainforests, Low Mountain forest and mid mountain forests. You have packed your backpacks and left as early as 5 am in college bus with a lecturer driver. Your First Aid kit and the food are being transported in another vehicle. At 9 am you are now at the end of the highway where the lowland rainforest meets the low mountain forest. You are ready and excited to see the four different forest types and their vegetation. Suddenly you are told that your first aid kit and the food on the other vehicle have been stolen. You have two alternatives: return to the college and come on the trip another

time; or continue regardless of the fact that you do not have food and a medical kit. You and your lecturer decide to stay on and complete the field study using food and medicine from the forest. You are at the end of lowland rainforest what type trees did you drive past? You are entering the forest and walk through the low mountain forest, what type of trees can you see? What can you see on the tree trunks? Can you see or hear some animals? What can you smell? Now you are in the mid mountain forest. Look at the big trees, what can you see on their trunks, their branches, and their leaves? What can you see, hear, and smell? You are at the end of low mountain forest and walking through mid mountain forests, what type of trees cans you see? What can you see on the tree trunks? Can you see or hear some animals? What can you smell? Now you are in the mid mountain forest. Look at the big trees, what can you see on their trunks, their branches, and their leaves? What can you see, hear, and smell? You can open your eyes now.

Questions for discussions

1. What plant or animal from the forest can you use instead of the items listed below?
 - Bowl/plate
 - Imported Apples
 - Crunchy nut mix,
 - Antibiotic
 - Spices
 - Ropes
 - Aspirin /Pain killer
 - Candle for lighting
 - Pot for cooking
 - Charcoal for cooking
 - Insect repellent
 - Pill to prevent malaria

2. Why is sustainable use of resources from the forest very important for people in PNG?

Appendix Fourteen Sample Lesson Plan

Lesson: Thirteen **week:** 7 **Date:**

Topic: Earth Studies

Objectives: (1) Revise or develop basic knowledge about the Earth and the other planets and their satellites, (2) Utilize prior and traditional knowledge when learning, (3) Involve students in deciding what to learn and how to learn, (4) Experience the lesson approaches used in the lesson.

Ref/Materials

PASTEP modules on Earth studies and Earth in the space

Article on traditional Knowledge- homework

Main Points	Lecturer	Student Activity
<p>Introduction</p> <p>Lesson cover (1) prior learning, (2) utilizing traditional knowledge, (3) Student learns what he or she has chosen to learn</p>	<ol style="list-style-type: none"> 1. Take attendance record and give overview of the lesson (2 min) 2. Ask the students to move into groups of five (3 min) 	<ol style="list-style-type: none"> 1. Participate in taking attendance record and listen to the lecturer (2 min) 2. Move into the groups of five to share with their friends (3 min)
<p>Body</p> <ul style="list-style-type: none"> • Prior knowledge can either facilitate or hinder learning and so is important that it is understood. It should be checked before introducing the new idea or knowledge. • In everything learners have prior knowledge and experience which can affect the construction of new knowledge. • Learning is affected in many ways by the people's 	<ol style="list-style-type: none"> 3. Ask the students to share with each other the legends, myths and stories about how Earth, Moon, Sun, stars and Solar system were formed. Including ways in which the planets and stars are used in traditional societies of PNG e.g. using the Sun's position as a clock (10 min) 4. Then ask volunteers to share with the class the legends, myths or stories about formation of Earth, Moon, Sun, 	<ol style="list-style-type: none"> 3. Share with each other the legends, myths and stories about how Earth, Moon, Sun, stars and Solar system were formed (10 min) 4. Volunteer and share in the class discussion(10 min) 5. Listen and try to understand KWL, its purpose, how,

<p>culture, especially the social and survival activities in which they have participated.</p> <ul style="list-style-type: none"> • Traditionally people in PNG use heavenly bodies as a clock, calendar or indicators to guide seasons and events. Many of them are still very useful today. • Students learn to decide what to learn and how to learn what they want to learn. 	<p>stars and Solar system (10 min)</p> <p>5. Explain KWL to students, its purpose, how, when and where it can be used (5 min)</p> <p>6. Allow the students to answer questions on the handout and create a KWL chart and list what they know about astronomy and geology in column K and record what they want to learn about astronomy and geology in W column. They should list what they know and what they want to know till they run out of ideas or questions (10 min).</p>	<p>when and where it can be used (5 min).</p> <p>6. Create a KWL chart and list the things they know about astronomy and record them in the K column of their charts and list what they want to learn about geology and astronomy in the W column (10 Min)</p>
<p>Conclusion/Homework</p> <p>KWL chart is a table used to help learning. The letters KWL are an acronym for "what we/I know", what we/I want to know, and "what we/I learned". A KWL table is typically divided into three columns titled Know, Want and Learned. It is a good strategy for addressing prior knowledge and self-learning.</p>	<p>7. Check what they know and what they want to know and tell them that column L will be filled after they read more about the topic in the module or after they look up the information on the topic which will be checked in the next lesson (10 Min)</p>	<p>7. Check what they know and what they want to know and in column L and make note of what they want to learn as their homework (10 min).</p>

Lesson Evaluation

.....

.....

.....

.....

KWL chart Learning Strategies

We know that successful learners link prior knowledge to new information, then reorganize it to create their own meaning and learning. A KWL table, or KWL chart is a graphical organizer designed to help in learning by providing a framework that students can use to construct meaning from new material. It activates prior knowledge and is completely student centered. It is a literacy strategy that teachers can easily modify to meet students' learning needs at

any level and in any content area. It can be used for all subjects in a whole group or small group atmosphere.

The letters KWL are an acronym for "what we **know**", what we **want** to know, and "what we **learned**". A KWL table is typically divided into three columns titled Know, Want and Learned. The table comes in various different forms as some have modified it to include or exclude information.

The teacher divides a piece of chart paper into three columns. The first column, 'K', is for what the students already **know** about a topic. This step is to be completed before the reading. The next column, 'W', is for students to list what they **want** to learn about the topic during the reading. This step is also to be completed before the reading. The third column, 'L', is for what the students **learned** from the reading or studying the topic. This step, of course, is done after finishing the reading.

K	W	L
What I KNOW Write the information about what the students know in this space.	What I WANT to Know/learn Write the information about what the students know in this space.	What I LEARNED After the completion of the lesson or unit, write the information that the students learned in this space.

Students begin by brainstorming everything they *Know* about a topic. This information is recorded in the *K* column of a KWL chart. Students then generate a list of questions about what they *Want to Know* about the topic. These questions are listed in the *W* column of the chart. During or after reading, students answer the questions that are in the *W* column. This new information that they have *learnt* is recorded in the *L* column of the KWL chart.

Purpose of using KWL

A teacher has many reasons for using KWL charts in the classroom. First, a KWL chart activates students' prior knowledge of the text or topic to be studied. By asking students what they already know, students are thinking about prior experiences or knowledge about the topic. Next, KWL charts set a purpose for

the unit. Students are able to add their input to the topic by asking them what they want to know. Students then have a purpose for participating and engaging in the topic. Also, using a KWL chart allows students to expand their ideas beyond the text used in the classroom. By being aware of students' interests, the teacher has the ability to create projects and assignments that the students will enjoy. A KWL chart is a great tool that can be used to drive instruction.

Steps are;

- a. Create a KWL chart. You as the teacher should create a chart on the blackboard or on an overhead transparency. In addition, the students should have their own chart on which to record information. (Above is an example of a KWL chart).
- b. Ask students to brainstorm words, terms, or phrases they associate with a topic. The teacher and students record these associations in the K column of their charts. This is done until students run out of ideas. Engage students in a discussion about what they wrote in the K column.
- c. Ask students what they want to learn about the topic. The teacher and students record these questions in the W column of their charts. This is done until students run out of ideas for questions. If students respond with statements, turn them into questions before recording them in the W column.
- d. Have students read the text and fill out the L column of their charts. Students should look for the answers to the questions in their W column while they are reading. Students can fill out their L columns either during or after reading. Especially the new things they learnt during.
- e. Discuss the information that students recorded in the L column.
- f. Encourage students to research any questions in the W column that were not answered by the text.

Questions

1. What does K stand for when using through KWL chart?
.....
2. What does W stand for using through KWL chart?
.....
3. What does L stand for using through KWL chart?
.....
4. What learning strategies are used when learning through KWL chart?
.....
5. What are some things learners should be encouraged to do to learn what they want to learn?

