THE NATURE AND MEASUREMENT OF ENVIRONMENTAL LITERACY FOR SUSTAINABILITY

by

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DECLARATION

I declare that "THE NATURE AND MEASUREMENT OF ENVIRONMENTAL LITERACY FOR SUSTAINABILITY" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

.... 29-11-2000

SIGNATURE DATE

SUMMARY

This study begins with a discussion of environmental education. Various definitions, aims objectives and guiding principles for effective environmental education are included. The term environmental literacy is introduced with its definitions and three levels of environmental literacy (nominal, functional and operational). The study also provides an overview of the definitions, aims, principles and goals of sustainable development. The relationship between environmental education, environmental literacy, environmentally responsible behaviour, and education for sustainability is outlined.

It appears that many teachers are not well informed about environmental concerns. Therefore, in this study an attempt is made to develop and standardize an instrument to measure the level of environmental literacy of teachers, from both primary and high schools. Ten concepts related to environmental literacy were developed. A questionnaire was developed using these identified concepts. Content validity was established before the questionnaire was presented to the teachers. An item analysis was carried out for each aspect of environmental literacy as well as for the questionnaire as a whole. It was determined that the questionnaire could be considered as both a reliable and valid instrument to measure the level of environmental literacy of teachers.

An important finding from this study is that there is a significant difference between environmental literacy of teachers who received training in environmental education and teachers who did not receive any training in environmental education. It was also found that there is a significant difference between environmental literacy of teachers teaching in the different learning areas.

The instrument developed for this study can be used as a baseline to improve the pre-service and in-service training of teachers in environmental education. The study concludes with

recommendations for teacher education and empowerment of local communities through environmental education. Possible further research is also highlighted.

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CHAPTER 1

RATIONALE FOR THE STUDY

1.1 Introduction

The right to a clean and healthy environment is protected in the Constitution of the Republic of South Africa (RSA) (RSA, 1996:16). This right is also highlighted in the goals of the Reconstruction and Development Programme (RDP), for example, to meet the basic needs of the people (African National Congress, 1994:40). The establishment of such a clean and healthy environment depends on the provision of quality education (Firth, 1995; Orr, 1992; Schreuder, 1995). Seemingly, much of the "environmental degradation that continues to occur today is the result of the failure of our society and its educational systems to provide citizens with the basic understandings and skills needed to make informed choices about interactions and interrelationships in the environment" (Roth, 1992:1). Provision of quality education is expected to empower communities to act on environmental issues and to promote an environmental ethic (African National Congress, 1994:40) so that they can take part in the wise use of natural resources and good management of the environment. It is doubtful whether it is possible to improve or maintain a healthy environment by the same kind of content-oriented education offered by the previous education departments in the RSA.

In addition to the provision of education, a healthy environment is also influenced by the behavioural patterns of people (Grieve & van Staden, 1985:135). Plant (1995:26) quoted Orr (1994) who said that environmental problems Ais first a crisis of mind that makes it a crisis for those institutions that purport to improve minds. This is a crisis of education in general and environmental education in particular. Subbarini (1998:242) reached similar conclusions and contends that environmental crises are crises of environmental education. According to Cortese (1991:32) "the diverse nature of human activities, which are causing environmental transformation and degradation, requires that we use every possible means to change the behaviour of individuals". This will mean that the solution to environmental problems can be achieved by an alteration of human behaviour. Hungerford & Volk (1990:8) also mention that the ultimate aim of education is to shape human behaviour, that is, to develop citizens who will behave in desirable ways. Models of responsible human behaviour towards the environment will be provided in paragraph 2.4. However, to Newhouse (1990:31) it is very difficult to change behaviour without changing people's motivation to behave in desirable ways to meet the needs of the present and future generations. Education for sustainability may provide the motivation to shape behaviour so that actions are more consistent with sustainable development. Seemingly, education for sustainability may enable citizens to make wise use of the environment and its resources.

Apart from the behavioural patterns of people, a healthy environment is affected by the attitude of people towards the environment. It was noted by Firth (1995:59) that education should aim to engage students in the exploration and resolution of environmental issues and to foster environmental and ethical awareness, values and actions to promote lifestyles that are compatible with the sustainable and equitable use of resources within democratic societies. It implies inter alia the generation of favourable public attitudes to environmental movements.

Besides desirable attitudes and behaviour patterns toward the environment, a particular knowledge of ecology is also necessary to maintain a healthy environment. According to Rockcastle (1989:8) the vast majority of people are unaware of the most basic interactions between humans and the environment. It must be noted that unawareness of a person can lead to destruction, as unawareness does not mean that a person is neutral. Schaefer (1992) shares the same opinion and mentioned that the biosphere as a whole will be changed or even destroyed, unless people act now. In this regard, Orr (1992) proposed an education for ecological literacy - a key to repair the damage of our earth caused by modern tragedy, too much power, and too little knowledge. An awareness of the environment can be achieved through "planned learning programmes which impart knowledge, skills and values in order to develop responsible lifestyles in harmony with the environment" (Firth, 1995:58).

The quality of the environment is also affected by the nature of control and power exercised by human beings on the environment. According to Plant (1995:26) the more power man exercises over nature, the less predictable and resilient nature has become. In view of the increasingly serious global impacts resulting from the control and power by humans, it is important that all individuals need to understand that environments change, and all individuals need to understand the general principles to find solutions to specific environmental problems.

It seems that environmental problems will increase unless all are educated with an environmental ethic, an ethic that assumes that all persons, present and future, are entitled to equal respect and a share of the benefits of the environment (Firth, 1995:58). Seemingly, an improvement in student learning can lead to an improvement in the quality of the environment and quality of life for all. Firth (1995:58) stressed the need for an education system that can "transform materialistic values and empower people to participate in environmental improvement and protection". The need to empower people to participate in environmental improvement and protection is a key aspect of the RDP. Therefore, an environmental ethic must be of top priority for environmental education. The need to create an informed decision-making public to deal with environmental issues demands an urgency for education for the environment. This is because children of today will be making decisions about the country in the future. Children must understand how important the environment is in order to make the right decisions at the right time. It is also important that they know about actions that might be detrimental to the environment. It is doubtful whether the present education system provides children with the education needed to face the global ecological crisis and to make sound decisions in a technocratic and consumer oriented culture.

A clean and healthy environment is also dependent on the environmental literacy of people. According to O'Neal & Skeleton (1991/92:158) "environmental literacy is a crucial component of knowledge if citizens are to make sound decisions on the environment". It must be noted that the environmental literacy of the public could increase the pressure which would slow the pace of environmental change. Shongwe (1997:3) also agrees that there is a need for "an aware, articulate, and activated citizenry who are willing to donate time, energy, and resources towards the solution of environmental problems confronting modern society". Seemingly, environmental literacy has the potential to achieve a sustainable future for all so that the present and future generations can share the resources of the environment. It implies that there is an urgent need to encourage citizens to become environmentally literate.

It seems the provision of education, knowledge of ecology, attitude, behaviour patterns, environmental literacy, an environmental ethic as well as the control and power exercised by man over nature, are some of the factors that affect the quality of the environment. It seems the present curricula of schools and teacher education are not able to engage students and student-teachers in different aspects of environmental education. In the recent past, environmental education was not included in the curricula of all teacher education institutions (Irwin, 1993; Loubser, 1994). According to Hungerford, Peyton & Wilke (1980:43) "environmental education can help citizens in becoming environmentally knowledgeable, skilled and dedicated citizens who are willing to work, individually and collectively to improve or maintain the quality of the environment". Therefore, there is an urgent need for innovations in the content of environmental education programmes at all levels of the education system, and that also implies a need for well-trained teachers in environmental education.

1.2 Analysis of the Problem

The major problems discussed in the following paragraphs include inadequate professional development of teachers in environmental education and the level of environmental literacy of teachers in the RSA.

1.2.1 Professional Development of Teachers in Environmental Education

It appears that the effectiveness of teaching in the classroom is influenced by the background knowledge of the teacher (Prawat, 1992:356) which gives meaning and direction to classroom practice (Ballantyne & Tooth-Aston, 1987:3; Beatties, 1995:59). It is obvious that teachers are the ones who select the ways in which EE goals and objectives are met (Shuman & Ham, 1997:25). Many researchers noted that teachers lack the necessary skills, knowledge, and confidence to teach environmental education (Braus, 1995:47; Myburgh, 1994:7; Shongwe, 1992:9; Simmons, 1993:8). The main reasons for this were that

(a) environmental education never received strong emphasis in pre- and in-service teacher training (Hurry, 1982:2; Irwin, 1982:271; Loubser, 1994:36; Richards, 1985:3; Schreuder, 1995:2; Shongwe, 1992:1).

(b) environmental education requires a degree of expertise and knowledge that teachers feel they do not possess (Kuiper, 1995:43; Pettus, 1982:181; Simmons, 1989:16).

(c) there are not enough teacher educators trained in environmental education (Kuiper, 1995:43; Pettus, 1982:181; Simmons, 1989:16).

(d) many teachers have not yet made efforts to incorporate appropriate teaching methods and strategies that will directly and significantly enhance the goals of environmental education (Blignaut, 1992:254).

(e) there was teacher resistance to change (Irwin, 1993:20; Papadimitriou, 1995:88-89; Schreuder, 1995:2).

It is therefore, difficult for teachers to understand and gain insight into environmental matters. Teachers cannot help their students to become environmentally literate if they themselves lack environmental literacy. Therefore, there is a need for the professional development of all teachers in environmental education as this is necessary to develop students as the most precious resource in environmental education.

It is important to note that innovations in any curriculum are largely dependent on the knowledge, skills and commitment of teachers (Simmons, 1993:8; Stone, 1990:43) as teachers are believed to be the real tools of change (Prawat, 1992:354; Schreuder, 1995:13). Schulze (1994:165) quoted Sterling (1987:13) who pointed out that "the key to school commitment to environmental education lies with teachers". It seems most curriculum innovative efforts require the teacher to improve the subject knowledge and methods of teaching that are different from those of the traditional classroom. According to Schreuder (1994:37) "curriculum innovation poses a threat to the identity of the teacher and imposes the burden of incompetence on the teacher". The teaching approaches of environmental education are in conflict with the established traditions and structures with the tight, centrally organised and book-centred education system. Teachers feel safe when working in traditional ways as no one can blame them for interrupting the fixed school timetable. Teachers are also concerned that children might fail their examinations (Papadimitriou, 1995:88-89; Tyldesely, 1990:23) if time is wasted using new methods of teaching.

Buethe & Smallwood (1987:39) quoted Richardson & Johnson (1980) who said that "teachers at all levels and in all subjects influence their students' environmental attitudes". Moreover, what students learn at an early age will have a strong influence upon their attitudes, decisions, and ways of solving problems. The amount of environmental knowledge of a teacher can affect the environmental values and attitudes of the students. Irwin (1993:3) noted that "teachers can, by virtue of their status in society and their position to influence thousands of students during their professional careers, play a crucial role in environmental education". If teachers do not have positive attitudes towards teaching environmental education, then it would seem that little instruction in this approach would occur in their classrooms. The students would, therefore, have little opportunity to achieve the major goals of environmental education. The first step towards achieving these goals is to produce teachers who are willing to teach environmental education in their classrooms. Therefore, teachers must be knowledgeable about environmental topics that are important to the future of the students. There is a need to motivate teachers to participate in environmental education programmes. This is because, without the participation of teachers, environmental education will be severely hindered.

It may be assumed that most teachers are not trained to deal with different approaches in environmental education (Adams, Biddle & Thomas, 1988:19; Ballantyne & Oelofse, 1989:8; Ballantyne & Tooth-Aston, 1987:3; Blignaut, 1992:254; Braus, 1995:46; Papadimitriou, 1995:88-89; Schreuder, 1995:2). This is because the training of teachers in environmental education is a relatively new venture in South Africa and not many teachers will have undergone pre-service or in-service training in environmental education (Loubser, 1994:36). Therefore, there is an urgent need for well-trained teachers in environmental education.

The professional development of teachers in environmental education is also affected by other problems. It appears that environmental educators themselves do not yet know the kinds of teaching that are most effective in eliciting environmentally responsible behaviour (Yambert & Donow, 1986:13). At the same time, there are very few environmental education centres and lack of training programmes for teachers (Braus, 1995:46).

These barriers deprive the students of the opportunities to explore, create, hypothesise, manipulate materials, and predict. It is believed that in many schools, aspects of environmental education are not taught or at least not taught effectively. The teachers do not look for, nor teach, interrelationships beyond those that are immediately obvious either within the subject or between subjects. The major problem is that due to inadequate professional development of teachers in environmental education and conceptual, logistical, educational, and attitudinal factors, effective integration of environmental education is not practised in schools in the RSA.

1.2.2 Environmental Literacy of Teachers

Environmental literacy refers to the basic level of understanding an individual should possess to make intelligent decisions about managing the environment. According to Roth (1992:7), "environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems. It involves the possession of basic skills, feelings, and understandings for the man/environment relationship". A literature review on definitions and the three levels of environmental literacy (nominal, functional and operational) will be provided in paragraph 2.3.

In order to develop environmentally literate people, there is a need for better informed teachers. A well-trained teaching force may be necessary to educate students in such a way that they could provide solutions to environmental problems from what they learn at school. The question arises whether teachers are trained to help students to provide these solutions and who are comfortable about teaching environmental values. It seems there is a need to scrutinize the teacher education curriculum in order to ensure that present and future citizens will understand the interrelationship between science, technology, society and the impact of human actions upon the Earth. It must be understood that teachers need to carry an attitude of appreciation and respect for nature to the many people they will influence during their lives. If, then, the major goal of environmental education is to produce an active and informed citizenry, environmental educators should know the kinds of learning experiences which produces such persons.

A study conducted by Buethe & Smallwood (1987:40) among teachers in Indiana, United States of America (USA), indicated that environmental literacy of Indiana teachers is far from optimal. The major problem is the low level of environmental literacy of teachers.

This may be because environmental education is not a priority for many people and programs (Braus, 1995:46; Singletary, 1992:35). Do environmental educators, curriculum planners in pre-service and in-service education of teachers have an understanding of the level of environmental literacy of teachers? The low level of environmental literacy of teachers is a situation that may be applicable to all the nine provinces in the RSA. It was noted that there are not enough well trained teachers in environmental education. Despite the important role teachers play in educating students, research into teachers' level of environmental literacy has been extremely limited. Review of literature does not reveal much research that focuses on teachers' level of environmental literacy. This is mainly because most of the researches in environmental education has involved students as subjects. An understanding of the level of environmental literacy of teachers is very essential to help students become responsible adults who may be willing to maintain a healthy environment. It is then that we can build on the level of environmental literacy of teachers, for example, by in-service education. It seems that relatively little attention has been paid to assess the level of environmental literacy of teachers. At the time of writing this work, no study on environmental literacy of teachers in the RSA was known to the researcher. Therefore, this study will concentrate on the development and standardization of an instrument to measure environmental literacy of teachers in the RSA.

1.3 Formulation of the Research Problem

The purpose of environmental education is to develop in all citizens responsible personal life styles in harmony with the environment. This is mainly because much of the "environmental degradation that continues to occur today is the result of the failure of our society and its educational systems to provide citizens with the basic understandings and skills needed to make informed choices about interactions and interrelationships in the environment " (Roth, 1992:1). This implies that environmental education should develop environmentally literate persons with the basic understandings and skills required to make informed decisions in matters affecting the environment, and whose personal life styles support sustainable development. Arguably, teachers with an inadequate level of environmental literacy may hinder the efforts to achieve environmental literacy for sustainability.

It must be noted that environmental literacy can provide a valuable resource for sustainable development, if it can be passed on to the students in schools. According to Rockcastle (1989:22) environmental literacy may be realised "when education has environmental relevance for students, when students become convinced of the consequences of their actions, and when students value what they are in danger of losing". It seems environmental literacy can best be achieved by optimal exposure of individuals to their environments (Schreuder, 1994:1). Therefore, it is the responsibility of teachers to prepare productive and responsible citizens in our society by providing optimal exposure of individuals to their environments. However, doubts exist whether teachers with an inadequate level of environmental literacy can prepare students to solve unanticipated environmental problems or to generate new ideas in environmental education.

It was noted in paragraph 1.2 that the success of environmental education will be determined by well-trained teachers and their level of environmental literacy. It was also noted that there are not enough well trained teachers in environmental education. The question is whether teachers are equipped with the expertise to transmit environmental ideas to students in a way that will stimulate them to think about the environment holistically and to develop a regional and global outlook, instead of treating each subject or topic as an isolated discrete entity? Teachers cannot be expected to impart competencies to their students, if the teachers themselves do not possess the competencies. According to Hooper (1988:15) teachers have inadequate levels of environmental knowledge. If teachers have inadequate levels of environmental knowledge and low environmental literacy, they may be perpetuating misconceptions to the students during their teaching career. It is imperative that all teacher training institutions should train teachers to be able to teach in an environmentally directed way. However, the current status of environmental education in teacher education remains at an unsatisfactory level. Prior to writing this work, the majority of the Colleges of Education and other institutions of higher learning (as noted in paragraph 1.2) in the RSA did not offer environmental education as an approach (Loubser, 1994). Therefore, it may be hypothesised that the majority of teachers are nominally environmentally literate. The nominal environmental literacy of teachers (mainly due to inadequate teacher training) may hinder the implementation of environmental education within the classroom. This state of affairs will have very serious implications on achieving environmental literacy for sustainability. If teachers are not trained in environmental education or not convinced that teaching environmental education is their responsibility, what are the chances that students will be exposed to environmental education on a regular basis in the classroom? Therefore, it may be necessary to assess the level of environmental literacy of teachers as the majority of the teachers have not received any formal training in environmental education.

What are the factors that contribute to the inadequate level of environmental literacy of teachers? The level of environmental literacy of teachers may be affected by factors such as gender, age, marital status, location of the work place and residence, education, years of teaching experience and subjects taught, membership of environmental education organizations, and exposure to environmental education programmes. What is the nature of the relationship between these factors and the level of environmental literacy of teachers? It appears that a mature, married, male secondary school science teacher is more environmentally literate (Buethe & Smallwood, 1987:41). According to Buethe & Smallwood (1987:41) teachers with nonscience majors are least prepared to deal with the content knowledge in environmental education. It seems most of the existing instruments only assess certain aspects such as attitudes, concern, and knowledge. Various researchers, for example, noted that place of residence (Arcury & Christianson, 1990:387; Arcury & Christianson, 1993:24; Freudenburg, 1991:167; Grieve & Van Staden, 1985:135; Lowe & Pinhey, 1982:114; Samdahl & Robertson, 1989:78; Willers, 1996:1), exposure to environmental education programmes (Willers, 1996:1), home language (Grieve & Van Staden, 1985:135; Willers, 1996:1), age group (Grieve & Van Staden, 1985:135; van Liere & Dunlap, 1980:192; Willers, 1996:1), gender (Arcury, Scollay, &

Johnson, 1987:463; Blocker & Eckberg, 1989:586; Grieve & Van Staden, 1985:135; Mcstay & Dunlap, 1983:291; Schahn & Holzer, 1990:767; Willers, 1996:1), educational qualifications (Arcury & Christianson, 1993:24; Grieve & Van Staden, 1985:135; van Liere & Dunlap, 1980:192; Willers, 1996:1), occupation (Buttel, 1979:250) career in science and watching science programmes on television (Samdahl & Robertson, 1989:78), socioeconomic status, religious beliefs, and political ideology (Buttel & Flinn, 1978:445; Samdahl & Robertson, 1989:78; van Liere & Dunlap, 1980:192), membership of organizations which aim to promote awareness of and care for the natural environment, hobbies, leisure, and sporting activities (Grieve & Van Staden, 1985:135), social norms (Lowe & Pinhey, 1982:114), social class and income (Arcury & Christianson, 1993:24; Samdahl & Robertson, 1989:78) are variables in the prediction of environmental concern. At the same time, empirical evidence on the direction of the relationship between environmental attitudes, concern and knowledge are conflicting and ambiguous. For example, some of the studies have found that environmental concerns of urban residents is significantly greater than that of rural residents, but the actual differences are not large (Arcury & Christianson, 1993:19). There is insufficient literature which deals with the direction of relationship between different variables in the prediction of environmental literacy of teachers. Therefore, the important question is whether it is possible to measure the nature and direction of the relationship between environmental literacy and factors such as gender, age, marital status, location of the work place and residence, education, years of teaching experience and subjects taught, membership of environmental education organizations, and exposure to environmental education programmes.

According to the analysis of the problem, the following research problems can be formulated:

(1) What does environmental literacy entail?

(2) What is sustainable development and education for sustainability?

(3) Is it possible to develop an instrument to measure the level of environmental literacy of teachers?

(4) Is the level of environmental literacy of teachers in general adequate?

(5) What can be done to enhance the level of environmental literacy of teachers?

(6) What is the relationship between certain identified factors and the level of environmental literacy of teachers?

The major problem, as mentioned in paragraph 1.2 suggest that the level of environmental literacy of teachers in the RSA should be low due to inappropriate professional development of teachers in environmental education. At the same time, research into teachers' level of environmental literacy has been extremely limited. Therefore, this study intends developing and standardizing an instrument to measure the level of environmental literacy of teachers in the RSA.

1.4 Aims of the Study

The major concerns highlighted in the previous paragraphs was the inadequate level of environmental literacy of teachers and whether it is possible to develop and standardize an instrument to measure the level of environmental literacy of teachers. It may be hypothesised that, at present, most teachers are not equipped with the expertise to promote environmental education in institutions of learning. That is, the present level of environmental literacy is mainly due to lack of training in environmental education.

The aims of this study are as follows:

(1) To make a study of the concepts environmental education and environmental literacy.

(2) To provide an overview of sustainable development and education for sustainability with the view to formulate concepts which are important for environmental literacy for sustainability.

(3) To develop an instrument to measure the level of environmental literacy of teachers.

(4) To ascertain whether this instrument is suitable to measure the level of environmental literacy of teachers.

(5) To investigate the nature and direction of the relationship between environmental

literacy of teachers and certain identified factors.

(6) To make recommendations of ways to enhance the level of environmental literacy for sustainability.

1.5 Study Programme

In chapter 2 an attempt will be made to look at what environmental education and environmental literacy entail. Various view points on the definitions, aims and objectives of environmental education as well as the guiding principles for effective environmental education will be considered. Discussions will also be based on the definitions of environmental literacy, the three levels of environmental literacy: nominal, functional and operational, and the characteristics of an environmentally literate person and on responsible environmental behaviour.

Chapter 3 will provide a definition of sustainable development, outline the basic principles and objectives of sustainable development, and an overview of the potential of environmental literacy as a vehicle to realize the educational agenda of sustainable development.

In chapter 4, a study of concepts in general and formulation of the concepts which are important for environmental education and environmental literacy will be made.

Chapter 5 will focus on the selection of a measuring technique for measurement of environmental literacy, the development of an instrument for this purpose. The research design regarding the standardization of the instrument to measure the level of environmental literacy of teachers will also be outlined. Information on the process of data analysis will also be provided.

In chapter 6 an investigation into the level of environmental literacy of teachers in three provinces (Northern Province, Mpumalanga Province, and North West Province) in the

RSA will be made from an analysis of data obtained from the responses to the questionnaire, by teachers selected for this study.

Chapter 7 will, apart from concluding statements, contain a critical evaluation of the research findings to form a useful baseline to establish continued teacher assistance and also in the curriculum development for pre-service and in-service teacher education, the need to generalise the findings in similar environmental settings in the RSA and the need for further research.

CHAPTER 2

ENVIRONMENTAL EDUCATION AND ENVIRONMENTAL LITERACY

2.1 Introduction

The main aim of this study is to develop and standardize an instrument to measure the level of environmental literacy of teachers in three provinces (Northern Province, Mpumalanga Province, and North West Province) in the Republic of South Africa (RSA). This is in line with the aim of environmental education to develop environmental literacy as indicated in paragraph 1.4. Another aim of this study (aim 1) is to make a study of the concepts environmental education and environmental literacy as mentioned in paragraph 1.4. Researchers such as Hungerford & Volk (1990) and Sia, Hungerford & Tomera (1985/86) have indicated the interrelationship between the concepts environmental education, environmental literacy and responsible environmental behaviour. At the same time, it is possible that the understanding of these concepts have broadened and there is a lack of understanding among environmental educators about the meanings and definitions of these concepts. Hence, a section on environmental education, environmental literacy and responsible environmental behaviour is provided in order to understand the relationship between these concepts and also to develop working definitions for these concepts. An understanding of the relationship between these concepts can provide increased support for curriculum development in teacher education (both in-service and pre-service) in environmental education. Hence, an improvement in student learning can be expected to lead to an improvement in the quality of the environment and quality of life for all.

In the following paragraphs, definition of the concept 'environment', definitions, aims, objectives and guiding principles of environmental education as well as on environmental literacy (definition, levels of environmental literacy, environmentally literate person and environmentally literate society) is outlined. Discussions on responsible environmental behaviour will also be provided as it seems the root cause of environmental problems lies in maladaptive behaviour.

2.2 Environment and Environmental Education

There is no worldwide consensus about the meaning of the concepts 'environment' and 'environmental education'. Seemingly, an understanding of 'environment' could lead to a better understanding of environmental education. For this reason, an attempt will be made to explain the concepts 'environment' and 'environmental education'.

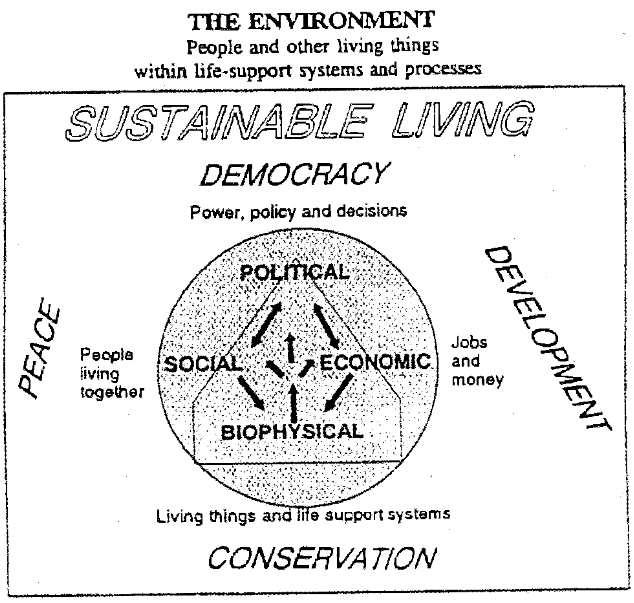
(a) The Concept 'Environment'

From the experience of the researcher, the concept 'environment' means different things to different people. For many people, 'environment' include 'green' issues such as the destruction of rainforests, threats to biodiversity, accelerating rates of land degradation and desertification (Mabogunje, 1995). For some others, 'environment' means the biophysical environment – plants and animals and other natural resources (Irwin, 1993). Some problems of definition are due to the fact that author's from many fields use the term in different contexts and also depends on his or her view or perception of the environment. In this regard, some of these definitions will be examined to see how one author emphasises certain aspects of the environment while another author emphasises others.

The term 'environment' is drawn from the verb 'to environ', which means to form a circle or ring around. The Webster's Collegiate Dictionary (1977:334) describes the environment "as an aggregate of all surrounding things, the external conditions and influences affecting the life and development of an organism; ...the state of being environed".

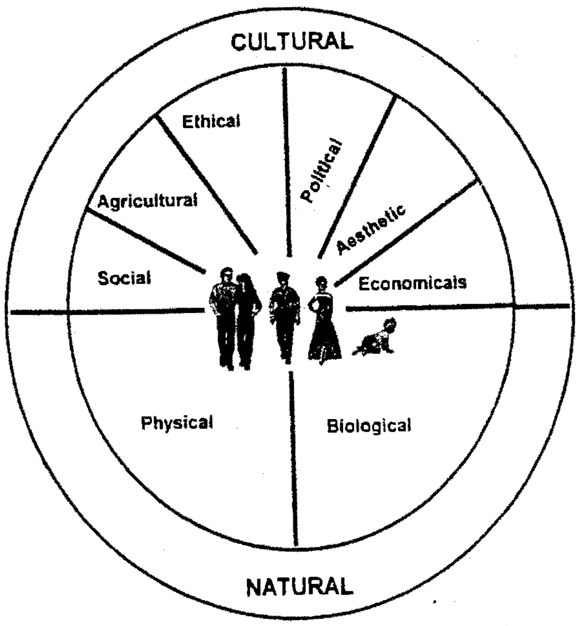
Loubser, Le Roux & Dreyer (1996:4-6) mentioned two holistic models of the environment. The first model (Figure: 1), reflect a holistic view of the environment, which emphasise sustainable management, use of life support systems and which develop action strategies to solve and prevent environmental issues. These environmental issues arise from the political, economic and social aspects of our lives. They are related to the bio-physical support systems – soil, water, air, plants, animals and the ecosystems in which they interact. The centre of figure 1 shows the environment as interacting social, economic and political dimensions, resting upon a base of biophysical life support systems. It also shows the interrelationships between socio-political, socio-economic and socio-ecological concerns, all of which influences sustainable living. This perspective thus expands the scope of environmental education to include conservation, development, peace and democracy. Seemingly, there is a growing realisation that environmental problems can be better understood with reference to social, economic, environmental values and lifestyle choices.

Figure 1: A Diagrammatic Representation of the Environment (Loubser et al., 1996:5)



In the second model (Figure: 2), people are placed at the centre of all environmental concerns. This model recognises the natural (physical and biological) and cultural (social, agricultural, ethical, political, aesthetic and economic) origins of environmental problems. In essence, environmental problems are linked to all surrounding things, conditions and influences.

Figure 2: A Holistic Representation of the Environment (Loubser et al.,1996:6)



There are similarities and differences between the two models (Figure 1 and Figure 2). Both models place emphasis on the bio-physical, economic, political and social factors as part of the environment. The first model, demands the communities to practice conservation, development, peace and democracy for sustainable living. In the second model, the ethical, aesthetic and agricultural aspects are included. This may mean that the environment includes more than just nature. In essence, everything around us is part of the environment. For example, the bio-physical, economic, political and social factors. To many people the word 'environment' means "something to do with plants" and fails to convey its social, economic, political and cultural components. The two models outlined above also indicate that the environment is a broad concept that may difficult to define.

For purposes of this study, the environment is defined as the sum total of surrounding things, conditions and all the influences (including the natural, cultural and socio-political) affecting the life and development of an organism. This view will be reflected in the design of the items of the planned questionnaire.

(b) The Concept Environmental Education

The term environmental education emerged as a response to escalating environmental problems such as atmospheric warming and climate change, the destruction of rainforests and threats to biodiversity, accelerating rates of land degradation and desertification, erosion and siltation of rivers, population- resource imbalances, nuclear accidents, the disposal of toxic wastes, ozone depletion, pollution, and a range of others which affects the quality of life and sustainability of the ecosystems (Mabogunje, 1995). However, after several decades, environmental education remains difficult to define in terms acceptable to environmental educators mainly owing to the nature of its content, diversity of approaches and attitudes among environmental educators. Two views on environmental education provided in the following paragraphs indicate that environmental education is education for the environment, for sustainable development and to develop informed and skilled citizens who are willing to take action to resolve environmental issues.

According to Fien (1993:12) environmental education

* is a critical tool to help people understand and deal with environmental problems and help create a sustainable society.
* involves the intellectual tasks of a critical appraisal of environmental (and political) situations and the formulation of a moral code concerning such issues.
* involves the development of a commitment to act on one's values by providing opportunities to participate actively in environmental improvement.

Therefore, environmental education is a means to develop in people understanding, awareness, values, commitment and skills necessary to manage environmental problems and issues consistent with sustainable development.

Ramsey, Hungerford & Volk (1992:37) asserted that environmental education must prepare individuals to be "responsive to a rapidly changing technological world, to understand contemporary world problems, and to provide skills needed to play an effective role in the improvement and maintenance of the environment". In other words, individuals who are not educated about society's modern advances and their impacts will be ill-prepared for citizenship in the 21st century. According to Papadimitriou (1995:86) the benefits of environmental education will be invaluable for the whole context of schooling. To this end, 'environmental education is important as it provides opportunities for relevant and meaningful learning, and links what is learned in the classroom to what actually happens around us'. Therefore, it can be assumed that environmental education will contribute greatly to the development of environmental literacy as environmental education can guide individuals and groups in making wise decisions in maintaining the quality of environment and quality of life. In the following paragraphs, a brief overview of the definitions, aims, objectives and guiding principles of environmental education is made.

2.2.1 Definitions of Environmental Education

Many attempts have been made over the years to define environmental education. There is not a single, adequate definition of environmental education. According to Van Rensburg (1995:62) the concept environmental education is confusing to young environmental educators as well as to those who have been working in the field of environmental education for many years. It has been difficult to define environmental education since its inception as there are many interpretations of environmental education (Singletary, 1992:35). There is a lack of agreement on the nature and purpose of environmental education between many environmental educators. Therefore, it seems there are major problems with the definitions of environmental education. The researcher, however, feels that there is a need to establish a clear definition of environmental education, because a lack of such a clear definition may hinder decisions about the aims, objectives, guiding principles, curriculum development and resulting actions for effective environmental education.

There can be as many similarities and differences in defining environmental education as there are people. In order to understand the different approaches to environmental education the definitions by IUCN (1971), Nightingale (1977), Stapp & Cox (1979), Hurry (1982), Irwin (1993) and Hooper (1988) are provided.

The definition of environmental education of the International Union for the Protection of Nature and Natural Resources (IUCN) states that "environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision making and self-formulation of a code of behaviour about issues concerning environmental quality" (IUCN, 1971:2; Neal & Palmer, 1990:2).

According to Nightingale (1977:6) environmental education "is a study of the factors influencing ecosystems, mental and physical health, living and working conditions, decaying cities, and population pressures. Environmental education is intended to promote among citizens the awareness and understanding of the environment, our relationship to it and the concern and responsible action necessary to assure our survival and to improve our quality of life".

Stapp & Cox (1979:3) defined environmental education as a "process aimed at developing a world population that is aware of, and concerned about, the total environment and its associated problems, and has the knowledge, attitudes, motivation, commitments and skills to work individually and collectively towards solutions of current problems and the prevention of new ones".

According to Hurry (1982:39) environmental education is a "process leading to the acquisition of environmental knowledge and the development of attitudes, values and patterns of behaviour which reflect a concern for the health of the total environment as well as for the quality of life of all its inhabitants".

Irwin (1993:21) noted that environmental education is a "sophisticated and holistic concept embracing ecological knowledge and understanding, total people-environment relationships, ethics, politics, psychology, sociology and public participation in decision making. It aims primarily at educating about human interaction with the environment".

Hooper (1988:15) defined environmental education as a "multidisciplinary approach to teach the interrelationship between people and their natural and man-made environments".

The definitions of environmental education outlined above are compared in Table 1. A comparison would help to understand the key aspects in each definition. These aspects include the interaction between people and their environments, awareness of the environment, understanding of the environment, development of a code of behaviour, development of skills, attitudes, values, ecological/environmental knowledge, motivation, concern, improvement of quality of life, and action.

Table 1: Definitions of Environmental Education

Concepts	IUCN 1971	Nightingale 1977	Stapp & Cox 1979	Hurry 1982	Irwin 1993	Hooper 1988
Awareness of the environment	Yes	Yes	Yes	No	No	No
Understanding of the environment	Yes	Yes	Yes	Yes	Yes	No
Interrelatedness between man & his environment	Yes	Yes	No	No	Yes	Yes
Concern for a healthy environment	Yes	No	Yes	Yes	No	No
Improvement of quality of life	Yes	Yes	Yes	Yes	No	No
Development of attitudes	Yes	No	Yes	Yes	No	No
Development of values	Yes	No	No	Yes	No	No
Development of skills	Yes	No	Yes	Yes	No	No
Development of a code of behaviour	Yes	No	Yes	Yes	Yes	No
Motivation	Yes	Yes	Yes	Yes	Yes	No
Action	Yes	Yes	Yes	Yes	Yes	No
Knowledge	Yes	Yes	Yes	Yes	Yes	Yes

There are similarities between these definitions, in that all of them refer to ecological/ environmental knowledge and most of them refer to the interaction between people and their environments, understanding of the environment, development of a code of behaviour, development of skills, motivation, and action, etc. They stress the holistic nature. According to these definitions environmental education is a process. However, a problem associated with these definitions is that they do not provide enough information on the methodology to be used by teachers. They are different as they reflect different views on environmental problems and their solutions. There is a lack of clarity on definition of the concept environmental education. For example, Irwin (1993) highlighted the importance of "politics and public participation in decision making on matters affecting human relationships with the environment". According to Jickling (1997:88) the concept "environmental education does not mean the same thing, and its intended meaning depends on how, and where, we use the term". The IUCN definition which is widely accepted, for example, views environmental problems as a lack of knowledge, poor decision making skills and an inappropriate code of behaviour. It is clear from the definitions that an understanding of the relationship between awareness, knowledge, attitudes, values, behaviour, motivation, skills and action are all important in environmental education. It is expected of the individual to develop and implement solutions to environmental problems. Jickling (1997:88) argued for a "rethinking of how we define environmental education, which will entail reconceiving the role of practitioners and practitioners in training". This should make a difference in the lives of the people and contribute to a healthier environment. It is therefore important to explore ways in which to move from rhetoric to action.

In short, environmental education is a holistic approach and involves the cognitive, the affective and the psychomotor domains of human development in order to identify problems, find solutions and prevent new ones. From the above definitions, the following working definition can be provided. That is, environmental education is an educational approach intended to foster awareness, sensitivity, knowledge, values, attitudes, motivation, skills, and the commitment needed to take actions towards a sustainable future. If environmental education is to make progress, any working definition of environmental education should be operational, open to interpretation and less loaded with particular environmental values. Such a definition can be used to formulate the aims of environmental education. In the following paragraphs the aims of environmental education are outlined.

2.2.2 Aims of Environmental Education

There are several aims of environmental education. One of the aims is to "assist students to become environmentally knowledgeable, skilled, dedicated citizens who are willing to work, individually and collectively, towards achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment" (Wisconsin Department of Public Instruction, 1991:5). Environmental education is also expected to prepare individuals to be responsive to a rapidly changing technological world, to understand contemporary world problems, and to provide the skills needed to play a productive role in improving and protecting the environment (Ramsey, Hungerford & Volk, 1992:37; Wisconsin Department of Public Instruction, 1991:4). Environmental education must therefore consider all aspects of the environment - natural and built, technological, social, economical, political, cultural, and aesthetic - and acknowledge their interdependence. Environmental education should develop knowledge, skills, attitude, commitment and a concern for actions to improve and maintain the quality of the environment.

Neal & Palmer (1990:7-8) noted 11 aims of environmental education. That is,

* To develop a coherent body of knowledge about the environment, both built and rural, sufficient to recognise actual and potential problems,
* To be able to gather information from or about the environment independently or as part of co-operative activity,
* To be able to consider different opinions related to environmental issues and to arrive at a balanced judgement,

* To appreciate the ways in which environmental issues are interrelated so that one factor affects others,
* To be able to evaluate information about the environment from different sources and to try to resolve environmental problems,
* To be able to understand and to know how to use the mechanisms available in society for cause of environmental change,
* To develop an appreciation of the environment and critical awareness of the natural and built environment,
* To develop an attitude of concern for environmental matters and a wish to improve environmental understanding,
* To be critical of one's own environmental attitudes and to take steps to change one's own behaviour and actions,
* To have a desire to participate in initiatives to care for or improve the environment,
* To wish to participate in environmental decision making and to make opinions known publicly.

Considering the above, the ultimate aim of environmental education should be to develop knowledge, gather information, consider different opinions and make judgements, appreciate interrelatedness in nature, evaluate information, solve problems, develop an attitude of concern, cultivate responsible behaviour, take positive actions and to develop a desire to participate in decision making. To bring about a fundamental change in human attitudes and actions towards the environment will depend upon changes in personal values, life style choices and development. This requires a move away from the manner in which we use natural resources to satisfy our basic needs and wants. To this end, it may be necessary to help people to understand the nature of environmental problems and the need for responsible environmental behaviour. The challenge, therefore, lies in educating people how to live more consistently with basic essentials than on reaching higher standards of living. The aims seek to enable people to behave in an environmentally responsible manner as it seems that environmental problems are caused by maladaptive human behaviour.

From the above the researcher feels that the aims of environmental education should be:

* To develop a coherent knowledge about the environment, sufficient to recognise actual and potential environmental problems,
* To enable one to gather and evaluate information from various sources to solve environmental problems,
* To help one to consider different opinions related to environmental issues and ultimately reach a balanced judgement,
* To develop appreciation and awareness of the environment,
* To develop a desire to care for and improve the environment,
* To change attitudes and behaviour patterns and enable people to act and react wisely in situations affecting quality of life and quality of the environment.
* To produce environmentally literate citizens who are committed to take actions towards a sustainable future for all, present and future generations and to share resources of the environment.

These aims of environmental education stated above can foster awareness, knowledge, sensitivity, appreciation, values, attitudes, behaviour patterns, skills, and motivation to identify and solve environmental problems. Hence, they are important for environmental education. Therefore, environmental education should develop citizens who have the ability to analyse environmental problems and have a critical attitude to one's environment leading to change in one's behaviour and actions.

The aims of environmental education embody the characteristics of an environmentally literate citizen as outlined in paragraph 2.3.1. Therefore, it may be mentioned that a crucial aim of environmental education is to produce environmentally literate citizens. The aims of environmental education can be translated into objectives that can be used to develop environmentally responsible behaviour of the entire society towards the biosphere. Considering the close relationship between aims, goals and objectives, an explanation on the goals of environmental education will not be provided. By definition, aims are general statements representing aspirations, goals describe the actual destination or what is to be envisaged in general terms but goals are considered to be vague and difficult to evaluate. On the other hand, objectives are specific, operational, can be readily attained and evaluated. In the following paragraph, an attempt is made to highlight the objectives of environmental education.

2.2.3 Objectives of Environmental Education

Translation of the aims of environmental education to objectives is necessary for the effective implementation of environmental education at all levels of education. In order to achieve the aims of environmental education, a comprehensive set of objectives for environmental education was set out by the United Nations Educational, Scientific and Cultural Organization (UNESCO) at the Belgrade Workshop (1975) and endorsed by the Tbilisi Conference (1977). These objectives are summarised as follows:

* To foster clear awareness of and concern about economic, social, political and ecological interdependence in urban and rural areas;
* To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment;
* To create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

An important objective of environmental education is to develop environmentally literate citizens who have the awareness, knowledge, values, attitudes, commitment, skills and responsible environmental behaviour to improve and maintain the quality of the environment. Environmental education is a process that fosters greater understanding of environmental problems to stimulate action that would lead to sound management of the available natural resources.

The following are the five categories of environmental education objectives as outlined by the Tbilisi Conference (1977):

* Awareness: Helping students to acquire an awareness and sensitivity to the total environment and its problems; develop the ability to perceive and discriminate among the stimuli; process, refine, and extend these perceptions; and use this new ability in a variety of contexts.
* Knowledge: Helping students acquire a basic understanding of how the environment functions, how people interact with the environment, and how issues and problems dealing with the environment arise and how they can be solved.
* Attitudes: Helping students acquire a set of values and feelings of concern for the environment and the motivation and commitment to participate in environmental maintenance and improvement.
* Skills: Helping students acquire the skills needed to identify, investigate, and contribute to the resolution of environmental issues and problems.
* Participation: Helping students to acquire experience in using their acquired knowledge and skills in taking thoughtful, positive action towards the resolution of environmental issues and problems (Hungerford & Volk, 1990: 8-9).

Based on the five categories of environmental education objectives as outlined by the Tbilisi Conference (1977), the following objectives that will assist teachers of environmental education are suggested.

(a) Awareness

Teachers should be able to help learners to:

* recognise actual and potential environmental problems.
* demonstrate that they are sensitive to the total environment and its problems.
* perceive and discriminate among the stimuli in a variety of contexts.
* process, refine, and extend their perceptions of the stimuli.
* use the ability to process, refine, and extend their perceptions of the stimuli in a variety of contexts.

(b) Knowledge

Teachers should be able to help learners to:

* explain how the environment functions.
* describe how people interact with the environment.
* identify environmental issues or problems as they arise.
* solve environmental issues or problems as they arise.

(c) Attitude

Teachers should be able to help learners to:

* demonstrate a commitment to maintain and improve the quality of the environment.
* demonstrate positive values for the environment.
* display feelings of concern for the environment.
* volunteer to participate in environmental maintenance and improvement.

(d) Skill

Teachers should be able to help learners to:

* exhibit the necessary skills to identify, investigate, and contribute to the resolution of environmental problems and issues.
* gather information from various sources to solve environmental problems.
* analyse different opinions related to environmental issues or problems.
* evaluate information gathered from various sources to solve environmental issues or problems.

(e) Participation

Teachers should be able to help learners to:

* participate in thoughtful and positive action towards the resolution of

environmental problems and issues.

* use their knowledge and skills to solve environmental problems.
* initiate a project to enhance the quality of the environment.
* make a balanced judgement in situations affecting the quality of life and quality of the environment for the present and future generations.

The five categories of objectives of environmental education stated above provide a well-built foundation to support environmental education and focus on responsible environmental behaviour. This behaviour is synonymous with environmental literacy as mentioned in paragraph 2.3. This is because the aspects of environmental literacy such as awareness, knowledge, attitude, participation and prevention coincide with the five categories of objectives of environmental education. It is expected that the variables (such as knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and sense of responsibility) that would predict responsible environmental behaviour would foster environmental literacy (Hines, Hungerford & Tomera, 1986/ 87: 1; Sia, Hungerford & Tomera, 1985/86:31). Discussions on responsible environmental behaviour will be provided in paragraph 2.4, as it seems the root cause of environmental problems lies in human behaviour.

The objectives indicate that the aspirations of environmental education go beyond developing students' knowledge and awareness of environmental concerns to active involvement to resolve environmental issues. The focus should be on an awareness of the total environment and its problems; the gaining of a sound knowledge and understanding of how the environment functions; the establishment of positive attitudes towards the environment; the acquisition of skills needed to identify, investigate, and contribute to the resolution of environmental issues and problems; and the participation in thoughtful, positive action regarding the environment. These objectives can give a better direction for environmental education, provided they are relevant, clearly formulated, achievable and evaluable. It must be noted that distinctions between the objectives (awareness, knowledge, attitude, skills, and participation) of environmental education are sometimes more artificial than real. It seems that many of the aims and objectives of environmental education are very difficult to be achieved without guiding principles for effective environmental education. Therefore, in the following paragraph discussions will be based on the guiding principles for effective environmental education as adopted in Tbilisi Conference (1977). The principles of environmental education for equitable and sustainable societies (International Council for Adult Education, UNCED, 1992) will also be outlined.

2.2.4 Guiding Principles of Environmental Education

The Tbilisi Conference (1977) produced a refined statement of needs, goals, objective categories and guiding principles for environmental education. The Tbilisi Conference recommended the incorporation of environmental education into the national education system of countries. The guiding principles of effective environmental education were accepted at Tbilisi in order to accomplish the aims and objectives of environmental education. The world's first intergovernmental conference on environmental education was organised by UNESCO and was held at Tbilisi, Georgia, USSR in 1977 and led to a declaration of 12 guiding principles for effective environmental education. According to this, environmental education should:

* consider the environment in its totality - natural and built, technological and social (economic, political, cultural, historical, moral, aesthetic);
* explicitly consider environmental aspects in plans for development and growth;
* be a continuous lifelong process, beginning at pre-school level and continuing through all formal and non-formal stages;
* be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;
* examine major environmental issues from local, national, regional and international points of view so that students receive insights into environmental conditions in other geographical areas;
* focus on current and potential environmental situations while taking into account

the historical perspective;

* promote the value and necessity of local, national and international co-operation in the prevention and solution of environmental problems;
* enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences;
* relate environmental sensitivity, knowledge, problem solving skills and value clarification at every age, but with special emphasis on environmental sensitivity to the learners own community in early years;
* help learners discover the symptoms and real causes of environmental problems;
* emphasise the complexity of environmental problems and thus the need to develop critical thinking and problem solving skills;
* utilise diverse learning environments and a broad array of educational approaches to teaching/ learning about and from the environment with due stress on practical activities and first-hand experience (Wisconsin Department of Public Instruction, 1991:77).

The guiding principles for effective environmental education as adopted at the Tbilisi Conference (1977) offer a broad and neutral approach to environmental issues. The guiding principles should emphasise enquiry and discovery methods, provide a range of learning experiences including outdoor learning experiences with a provision for group work, involve students in the planning to identify and solve problems, encourage integration of school subjects, promote values, and emphasise a commitment to maintaining and improving the quality of the environment.

The International Council for Adult Education, Rio de Janeiro (1992) adopted 16 principles of environmental education for equitable and sustainable societies. According to this:

* Education is the right of all; we are learners and teachers.
* Environmental education:
  - should be grounded in critical and innovative thinking, promoting the

transformation and construction of society.

- is both individual and collective. It aims to develop local and global citizenship with respect for self-determination and the sovereignty of nations.
- is not neutral but is value-based. It is an act for social transformation.
- must involve a holistic approach and thus an inter-disciplinary focus in the relation between human beings, nature and the universe.
- must stimulate solidarity, equality and respect for human rights involving democratic strategies and an open climate of cultural interchange.
- it should treat critical global issues, their causes and inter-relationship in a systemic approach and within their social and historical contexts. Fundamental issues in relation to development and the environment should be perceived in this manner.
- must facilitate equal partnerships in the processes of decision making at all levels and stages.
- must recover, recognise, respect, reflect and utilise indigenous history and local cultures, as well as promote cultural, linguistic and ecological diversity. This implies acknowledging the historical perspective of native peoples as a way to change ethnocentric approaches, as well as the encouragement of bilingual education.
- should empower all peoples and promote opportunities for grassroots level democratic change and participation (communities must regain control of their own destinies).
- values all different forms of knowledge. Knowledge is diverse, cumulative and socially produced.
- must be designed to enable people to manage conflicts in just and human ways.
- must stimulate dialogue and cooperation among individuals and institutions in order to create new lifestyles which are based on meeting everyone's basic needs regardless of ethnic, gender, age, religion, class, physical, or mental differences.
- requires a democratisation of the mass media and its commitment to the interests

of all sectors of society.

- must integrate knowledge, skills, values, attitudes and actions. It should convert every opportunity into an educational experience for sustainable societies.

* Education must develop an ethical awareness of all forms of life with which humans share this planet, respect all life cycles and impose limits on human's exploitation of other forms of life (UNESCO/DEA&T, 2000:46).

The above guiding principles for effective environmental education are stated in a lengthy way. It is suggested that the guiding principles should be reduced in number and should be stated clearly in order to make it easier for implementation by teachers. According to Loubser (1992:93) the following guiding principles can be selected for environmental education in schools in the RSA.

* follow a holistic approach,
* be interdisciplinary in its approach,
* be a lifelong process,
* address man and his total environment, and
* be aimed at changing peoples' attitudes towards the environment.

For the purposes of this study, the above five guiding principles can be accepted for environmental education in schools in the RSA. This is because the five guiding principles are clearly stated, reduced in number when compared to the Tbilisi principles (1977) and principles of environmental education for equitable and sustainable societies (1992), and is relevant for environmental education in schools in the RSA.

The guiding principles can be used to empower people and develop a sense of ownership and responsibility to improve the capacity for people to address environmental problems and issues. These guiding principles can be used to achieve the goals of RDP to meet the basic needs of all in the RSA. Therefore, environmental education should be a lifelong process, a holistic approach, a crosscurricular approach, rooted in direct experience of local environmental problems which should develop critical thinking and problem solving skills to develop knowledge, sensitivity, values, skills, commitment in learners to take proactive actions for the total environment. The guiding principles should guide in the selection of content and methodology for teacher education programmes in environmental education. There has been some confusion and disagreement about the definition, aims, and objectives of environmental education. The guiding principles were accepted at Tbilisi in order to accomplish the aims and objectives of environmental education to develop knowledgeable, concerned, competent, and participating citizens, i.e. environmentally literate citizens. As environmental literacy is of central importance in environmental education, in the following paragraphs discussions will be made on environmental literacy.

2.3 Environmental Literacy

Environmental education is rooted in a philosophy that the quality of life and the quality of the environment are directly related and that each citizen is responsible for maintaining the quality of the environment (Wisconsin Department of Public Instruction, 1991:5). According to Disinger & Roth (1992:165) the creation of an environmentally literate citizenry is an important aim of environmental education. They further noted "environmental literacy as a prerequisite to maintain and improve the quality of the environment". Therefore, there is a need for a "citizenry that is competent to take action on critical environmental issues and willing to take action" (Volk, Hungerford & Tomera, 1984:10). In order to establish a legacy which we will be proud to pass on to future generations, it is necessary for educators to help students develop an awareness and sensitivity to their environment - to help them to understand how the environment functions, how people interact with it, and how environmental issues and problems arise and how they can be solved. Therefore, "the development and fostering of environmental literacy need to be a key objective of any general education program" (Roth, 1992:2). The basic assumption is that environmental literacy is crucial if citizens are to make sound decisions to improve the quality of life and the quality of the environment.

The first general reference of the concept "environmental literacy" appeared in an article by Charles. E. Roth in Massachusetts Audubon in 1969 (Roth, 1992:ix). The concept environmental literacy came after general references to environmental illiteracy. Since then, the concept environmental literacy crept into environmental education and has resulted in refinements of its definition. In the following paragraphs an effort will be made to look at the definition and levels of environmental literacy.

According to Roth (1992:1) environmental literacy is essentially the "capacity to perceive and interpret the relative health of the environmental systems and take appropriate action to maintain, restore, or improve the health of those systems". To be environmentally literate, a sound knowledge about the threats to our environment is essential. Roth (1992:1) further noted that stewardship of our environment requires knowledge, attitudes and skills which are based on a commitment to shape the world in which we live through thoughtful and active participation. It calls for a perspective which acknowledges that each of our actions has an effect on the entire global ecosystem. It seems environmental literacy involves the development of an ecological conscience, a responsible commitment, attitudes, values and ethic, knowledge and skills important in solving environmental problems for the survival of the ecosystems. Therefore, it can be said that environmental literacy is in accordance with the five categories of objectives (awareness, knowledge, attitude, skills, and participation) of environmental education and the guiding principles of environmental education as outlined in paragraphs 2.2.3 and 2.2.4 respectively. The five aspects of environmental literacy (awareness, knowledge, attitude, participation and prevention) are outlined in paragraph 2.3.3.

It was noted that the concept environmental literacy came after general references to environmental illiteracy. It is doubtful whether the term environmental literacy means the same to everyone. Problems exist in defining environmental literacy, as is the case with the definitions of environmental education as explained in paragraph 2.2.1. It may be possible that an understanding about an environmentally literate person and an environmentally literate society can provide a clear definition of environmental literacy. It seems a sustainable society is dependent upon the degree of environmental literacy of its citizens. Therefore, in the following paragraphs discussions will be based on the definitions of an environmentally literate person and an environmentally literate society.

2.3.1 Environmentally Literate Person

Environmental literacy is important for all individuals because through choice of personal life style, they make decisions which may affect their own environment daily. According to Roth (1992:2) the ability to make choices in a fashion that will permit a sustainable human society is dependent upon the degree of environmental literacy of each citizen. An improvement in the degree of environmental literacy is required in order to reverse the present destructive trends caused by choice of personal life styles which has resulted in the deterioration of the quality of the environment and a threat to continued existence of life. This is because environmental literacy addresses the need to learn how people can live in harmony with the environment. This learning involves understanding natural systems and how human beings relate to them and acquire basic skills and an ethic that will prepare people to deal effectively with environmental problems and issues. It is important to note that sustainable development is dependent upon the degree of environmental literacy of each citizen. In order to understand the different views of an environmentally literate person, definitions according to Clacherty (1992), Harvey (1976), Hurry (1982), Roth (1992) and Subbarini (1998) are provided in the following paragraphs.

Clacherty (1992:26) suggested that an environmentally literate person will have a critical awareness of social, economic, and political forces in society. They can be related to environmental quality and the quality of life.

According to Harvey (1976:76) an environmentally literate person is one who possesses basic skills, understandings, and feelings for the man/environment relationship.

According to Hurry (1982:44) a person who is environmentally literate:

* is aware of the natural resources upon which he is directly or indirectly dependent, and that he has some understanding of finite and renewable resources;
* is aware of the natural and man-made environment of which he is part of, and ..... sees his places of work, residence and recreation as part of the fabric of his own ecosystem. He sees himself as a living part of, and interacting with, his ecosystem;
* has a conviction of his individual responsibility for the health of the land, where health is the capacity of the land for self-renewal;
* has been committed to caring for his environmental actions in his daily life. He is committed to caring for his environment and its resources, in no matter how small a manner; and
* is concerned with developing or maintaining a quality of life which is not only acceptable to the majority, but which is also in harmony with the capabilities of the environment.

Roth (1992:8-9) recognised an environmentally literate citizen as one who:

* recognises environmental problems when they arise;
* thinks before acting;
* rejects short-term gains when they threaten long-term benefits;
* takes action to correct environmental imbalances;
* continues to gather information about environmental issues throughout his life;
* is humane;
* has a keen sense of stewardship;
* demonstrates willingness to curtail some individual privileges;
* consciously limits the size of the family;
* works to maintain diversity in the total environment; and
* is continually examining and re-examining the values of his or her culture in terms of new knowledge about humankind and resources.

According to Subbarini (1998:245), an environmentally literate person:

* communicates and applies major ecological concepts and principles;
* understands how man's activities influence the environment from an ecological perspective;
* demonstrates the ability to identify and investigate environmental issues and alternate solutions; and
* assimilates environmental values needed for rational and responsible use of environmental resources.

The characteristics of an environmentally literate person outlined above suggest that an environmentally literate person should have a sound knowledge about the environment. An environmentally literate person is able to understand, appreciate and enjoy the world, to make personal choices, to contribute to his local environment, and to effectively care for the planet and work to improve it. Moreover, an environmentally literate person, is aware of the environment and its resources, has some understanding of renewable resources, has feelings for the interrelationship in nature, is sensitive towards environmental problems, has positive attitudes and values, is committed to caring for the environment, gathers information as environmental problems arise, investigates environmental issues, finds solutions to basic environmental problems, is willing to sacrifice individual privileges, possess basic skills, takes part in active and thoughtful action. These characteristics are needed to take appropriate actions to improve the quality of life and quality of the environment. The characteristics of an environmentally literate person will be used in the development of the instrument to assess the level of environmental literacy of teachers.

2.3.2 Environmentally Literate Society

Environmental literacy is important to society because it is through the political process, that the public decides how the environment and its resources should be used to meet their basic needs and how it should be economically developed. As environmental literacy of the society is important in the decision making process, various aspects of an environmentally literate society is outlined in the following paragraphs.

According to Nickerson (1991/92:170), the fundamental knowledge, skills, and attitudes for an environmentally literate society should include the following:

* Basic understanding of the biosphere- the air, water, and land - as the life support systems on which all living organisms depend for habitability and survival.
* An ecological perspective of nature and human beings, including concepts of carrying capacity, adaptation and evolution.
* Historical perspective on environmental changes caused by nature and human society with special emphasis on the rapid changes brought about by industrialisation, urbanisation, and population growth.
* Exploration of how culture, and social and political organizations, and the stages of development of groups of people contribute to these effects.
* Understanding the difference between hazard and risk and between actual, potential, and perceived risks from contamination and destruction of the environment and natural resource consumption.
* Basic understanding of how the ways in which we organise ourselves as family, community, and national entities, and how the activities we choose to meet human needs and wants affect health, the environment, and quality of life.
* Exploration of ethical issues involved in environmental protection and management.
* Exploration of decision making on environmental issues in scientific, economic, legal, social, and political context.
* Awareness of how individual decisions affect the health and quality of life of other people and living species, and actions that individuals can take to protect the environment and public health.

An environmentally literate society has an awareness of the effect of individual actions, a basic understanding of the biosphere, consumption of natural resources, knowledge of ecological concepts, knowledge of environmental changes caused by humans, knowledge of cultural, social, political, ethical, scientific, economic, and legal context involved in actions that will lead to environmental protection. To be environmentally literate, a sound knowledge about the environment is essential. Even though both the environmental literacy of a person and society should have a sound knowledge about the environment to take appropriate actions to improve the quality of life and quality of the environment, the level or the degree of environmental literacy of a person or a society is not the same everywhere. The level of environmental literacy of a person or a society can be dependent on cultural, social and political context as well as on education. It is expected that the knowledge of an environmentally literate person and an environmentally literate society shed some light on the degree or level of environmental literacy.

2.3.3 Levels of Environmental Literacy

As noted in paragraph 1.1, the vast majority of people are unaware of the most basic interactions between humans and the environment. It may be argued that everyone has some awareness and an understanding of the basic relationships in the environment. Therefore, it is an oversimplification to assume that an individual is either totally literate or illiterate about environmental issues. That is, there is a broad spectrum of environmental literacy, from total ignorance or unawareness to deep, thorough understanding and concern. Therefore, there is a need to distinguish levels of environmental literacy. The level of environmental literacy can be determined by observable behaviours (Roth, 1992:15). That is, people should be able to demonstrate in an observable form a continuum of competencies such as understandings, skills, and actions. The levels of environmental literacy is generally assumed to exist, but are often not well defined. According to Roth (1992:16) environmental literacy is a continuum of competencies ranging from zero competency to very high competency that can be functionally divided into three working levels: nominal, functional and operational.

(a) Nominal Environmental Literacy

It indicates a person able to recognise many of the basic terms used in communicating about the environment and able to provide rough, if unsophisticated, working definitions of their meanings. Persons at the nominal level are developing an awareness and sensitivity towards the environment along with an attitude of respect for natural systems and concern for the nature and magnitude of human impacts on them (Disinger & Roth, 1992:166-167; Roth, 1992:16). Nominal environmental literacy implies basic awareness and understanding of the total environment.

(b) Functional Environmental Literacy

It indicates a person with a broader knowledge and understanding of the nature and interactions between human social systems and other natural systems. They are aware and concerned about the negive interaction between these systems in terms of at least one or more issues and have developed the skills to analyse, synthesise, and evaluate information about them using primary and secondary sources. They evaluate a selected problem on the basis of sound evidence, personal values and ethics. They communicate their findings and feelings to others. On issues of particular concern to them, they may evidence a personal investment and motivation to work toward remediation using their knowledge of basic strategies for initiating and implementing social or technological change (Disinger & Roth, 1992:166-167; Roth, 1992:16). Functional environmental literacy implies narrowly focussed issue application in matters affecting the environment.

(c) Operational Environmental Literacy

It indicates that a person who has moved beyond functional literacy in both the breadth and depth of understandings and skills who routinely evaluate the impacts and consequences or actions; gathering and synthesising pertinent information, choosing between alternatives and advocating action, positions and taking actions that work to sustain or enhance a healthy environment. People at the operational level also demonstrate a strong, on-going sense of investment in and responsibility for preventing or remediating environmental degradation both personally and collectively, and are likely to be acting at several levels from local to global in so doing. They are routinely engaged in dealing with the world at large (Disinger & Roth, 1992:166-167; Roth, 1992:16). Operational environmental literacy implies broad application in daily life.

For the purpose of this study, the definition of the three levels of environmental literacy will be as follows:

* Nominal environmental literacy indicates the ability to recognize many of the basic terms used in communicating about the environment and to provide their meanings.
* Functional environmental literacy indicates a broader knowledge and understanding of the nature and interaction between human social systems and other natural systems.
* Operational environmental literacy indicates progress beyond functional literacy in both the breadth and depth of understandings and skills.

According to Disinger & Roth (1992:167), environmental literacy derives its focus from four basic aspects which take it well beyond the traditional disciplines. That is,

* the interrelationship between natural and social systems;
* the unity of humankind with nature;
* technology and the making of choices; and
* developmental learning throughout the human life cycle (Disinger & Roth, 1992: 167).

From the four basic aspects mentioned above it must be understood that environmental literacy draws upon six major areas: environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement (Disinger &

Roth, 1992:167). From the six major areas, Roth (1992:8) created four strands - knowledge, skills, affect and behaviour to be addressed in education for environmental literacy. Roth (1992:8) grouped environmental sensitivity, attitudes and values as "affects", while personal investment and responsibility, and active involvement as "behaviour". The four strands have been defined as follows:

* Knowledge "should be construed to encompass all the cognitive understandings about the working of the natural world and human interactions and interrelationships with it".
* Skills "should be construed to encompass the cognitive, affective and psychomotor abilities which can be developed, refined and applied, and which are associated with the environment. It's allied problems and issues or solutions to such problems and issues".
* Affect "should be construed to encompass all emotional traits and dispositions which appear to be potentially or actually associated with the environment and people's relationship to it".
* Behaviour "should be construed to encompass all psychomotor activities intended to maintain and improve the quality of the environment and which deal responsibly with concerns pertaining to the quality of life" (Disinger & Roth, 1992:167).

The six major areas (environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement) and the four strands (knowledge, skills, affect and behaviour) is in line with the objectives and guiding principles of environmental education outlined in paragraphs 2.2.3 and 2.2.4 respectively. They should help to accomplish one of the aims of environmental education, for example, to develop knowledgeable, concerned, competent, and participating citizens, i.e. environmentally literate citizens.

For the purposes of this study, the following definition of environmental literacy will be used. Environmental literacy is the ability to be aware of the environment; it enriches one with the knowledge to realize the imbalances and threat the environment faces both directly and indirectly; it enables one to form positive attitudes towards it with the aim of developing skills to resolve and prevent environmental problems and urge to protect and improve the environment for the present and future generations by active participation. In short, the five aspects of environmental literacy are awareness, knowledge, attitude, participation and prevention.

Definitions of the five aspects of environmental literacy will be useful in the development of the instrument to measure environmental literacy of teachers in paragraph 5.3. Therefore, definition of the terms - awareness, knowledge, attitude, participation and prevention is provided below.

Awareness: awareness and sensitivity to the environment, environmental issues, and environmental problems.

Knowledge: understandings about the working of the natural world, human interactions and interrelationships with it.

Attitude: emotional traits and dispositions (values and feelings) which are associated with the environment and people's relationship to it.

Participation: psychomotor activities intended to maintain and improve the quality of the environment.

Prevention: personal investment, personal responsibility, and skills for identifying and solving environmental problems.

The four strands created from the six major areas and the aspects of environmental literacy are all closely linked to make a strong contribution to develop environmental literacy. The focus is mainly on awareness, knowledge, skills and action to prevent environmental problems and to protect and improve the environment for the present and future generations.

It was noted in paragraph 1.1 that quality of life and quality of the environment is influenced by the behavioural patterns of people. It seems environmental education can possibly help to build a system of values, attitudes and skills that can lead to responsible environmental behaviour patterns in people. Therefore, in the following paragraphs discussions on responsible environmental behaviour will be provided.

2.4 Responsible Environmental Behaviour

Researchers such as Hungerford & Volk (1990) and Sia, Hungerford & Tomera (1985/86) have indicated the interrelationship between the concepts environmental education, environmental literacy and responsible environmental behaviour. At the same time, it is possible that understanding of these concepts has broadened over the years and there is a lack of understanding among environmental educators about the meanings and definitions of these concepts. An understanding of the relationship between these concepts can provide increased support for curriculum development in teacher education in environmental education. Hence, an improvement in student learning can lead to an improvement in the quality of the environment and quality of life for all. Therefore, within the scope of this study, in the following paragraphs, discussions on responsible environmental behaviour and models of responsible environmental behaviour will be provided.

Several studies have explored the development of environmentally responsible behaviour and associated variables (Hines, Hungerford & Tomera, 1986/87; Hungerford & Volk, 1990; Neal & Palmer, 1990; Sia, Hungerford & Tomera, 1985/86). According to Neal & Palmer (1990:13) environmental education is about promoting changes in behaviour that will help to solve existing problems relating to the environment and to avoid creation of new ones. Therefore, Palmer (1998:11) stressed the need for "new patterns of behaviour of individuals, groups and society as a whole towards the environment". It is important to note that an "aim of education is shaping human behaviour" (Hungerford & Volk, 1990:8) and that of "environmental education is the acquisition of responsible environmental behaviour" (Howe & Disinger, 1991:5; Hungerford & Volk, 1990:8-21; Ramsey, 1993:31; Sia, Hungerford & Tomera, 1985/86:31). Education should encourage learners to think positively about the environment, as our future is dependent on the environment and its resources. It must be noted that responsible environmental behaviour is synonymous with the levels of environmental literacy outlined in paragraph 2.3.3. It seems the five categories of objectives (awareness, sensitivity, attitudes, skills and participation) and aspects of environmental literacy provide a well-built foundation for environmental education as these objectives focus on responsible environmental behaviour. This opinion is shared by Sia, Hungerford & Tomera (1985/86:32). It is expected that the variables (such as knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and sense of responsibility) that would predict responsible environmental behaviour would foster environmental literacy (Hines, Hungerford & Tomera, 1986/87:1; Sia, Hungerford & Tomera, 1985/86:31; Willers & van Staden, 1998:31).

The five categories of objectives of environmental education indicate that the aspirations of environmental education go beyond developing students' knowledge and awareness of environmental concerns to active involvement to resolve environmental issues. According to Stevenson (1993:5) active involvement requires that students develop a position on specific policies or proposed actions by questioning, examining, and building rationales or justifications for their positions or policy judgements. According to Van Staden (1996:3) the guiding rationale behind environmental education programmes is that "information will lead to greater environmental awareness, skills and motivation, causing changes in attitudes and ultimately in behaviour patterns resulting in the solution of environmental problems". It seems that solutions to environmental problems can be achieved by an alteration of human behaviour. It is possible that increased knowledge enhance a positive attitude making it more likely that a person would engage in environmentally responsible behaviour.

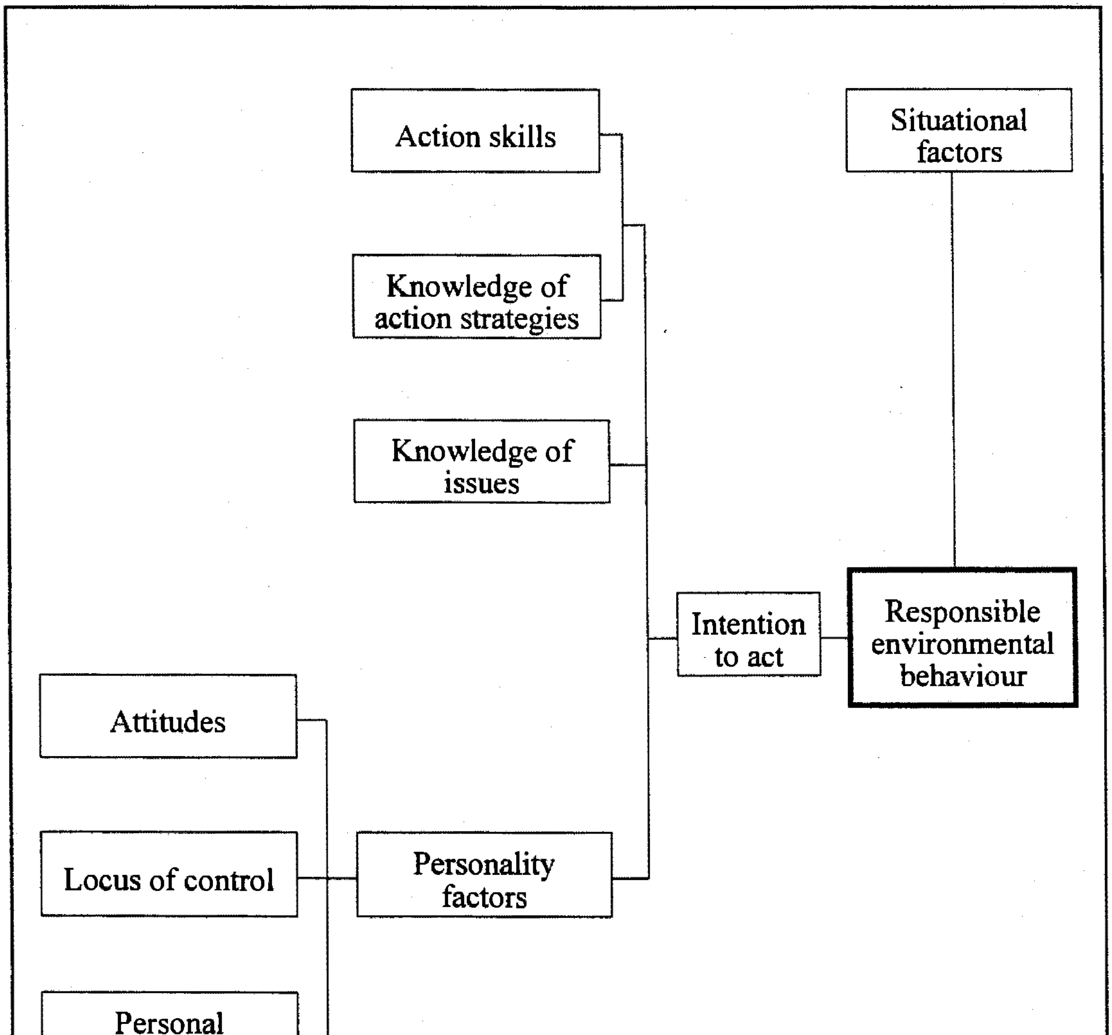
Traditional thinking in the field of environmental education has been that one can change behaviour by making human beings more knowledgeable about the environment and its associated issues. Findings from a study by Cottrell & Graefe (1997:24) suggest that knowledge predicts behaviour in both general and specific- issue situations. Arbuthnot & Lingg (1975:280) noted, "knowledge acts as a mediating variable between attitudes and behaviour". The assumption is that "increased knowledge leads to awareness and favourable attitudes, which in turn motivates to act towards the environment in more responsible ways"(Hungerford & Volk, 1990:9). Therefore, responsible environmental behaviour can be associated with knowledge, awareness, attitudes and action. Hines, Hungerford & Tomera (1986/87) proposed that responsible environmental behaviour is a learned response or action and is dependent upon several variables interacting with one another. Researchers such as Hines, Hungerford & Tomera (1986/87) and Hungerford & Volk (1990:9) have investigated a variety of variables associated with responsible environmental behaviour. The following variables were found to be associated with responsible environmental behaviour: knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and an individual's sense of responsibility (Hines, Hungerford & Tomera, 1986/87:1). It is likely that a person would demonstrate environmentally responsible behaviour, with an increase in cognitive and behavioural inputs.

2.4.1 Models of Environmentally Responsible Behaviour

In following paragraphs, models of Responsible Environmental Behaviour (adapted from Hines, Hungerford & Tomera (1986/87) and an expanded model of environmental behaviour suggested by Hungerford & Volk (1990) are outlined.

Hines, Hungerford & Tomera (1986/87:6) noted that the prediction of environmental behaviour is not a simple process. They further pointed out that knowledge about the environment does not always lead to increased awareness of environmental problems and increased motivation. The Hines Model of Responsible Environmental Behaviour (adapted from Hines, Hungerford & Tomera (1986/87:6) is provided in Figure 3.

Figure 3: The Hines Model of Responsible Environmental Behaviour



Adapted from Hines et al. (1986/87).

According to the model proposed by Hines et al (1986/87) environmental education programmes should be designed to influence the attitudes and behaviours of human beings as part of the environment, to make them aware of environmental problems, and a feeling of concern for the environment. It was further noted that the feelings of concern for the environment will lead to behavioural change and contribute to active participation in improvement and protection of the environment. Hines et al (1986/87:7) also noted that situational factors, such as economic constraints, social pressures and opportunities to choose different actions may counteract or strengthen the variables in the model.

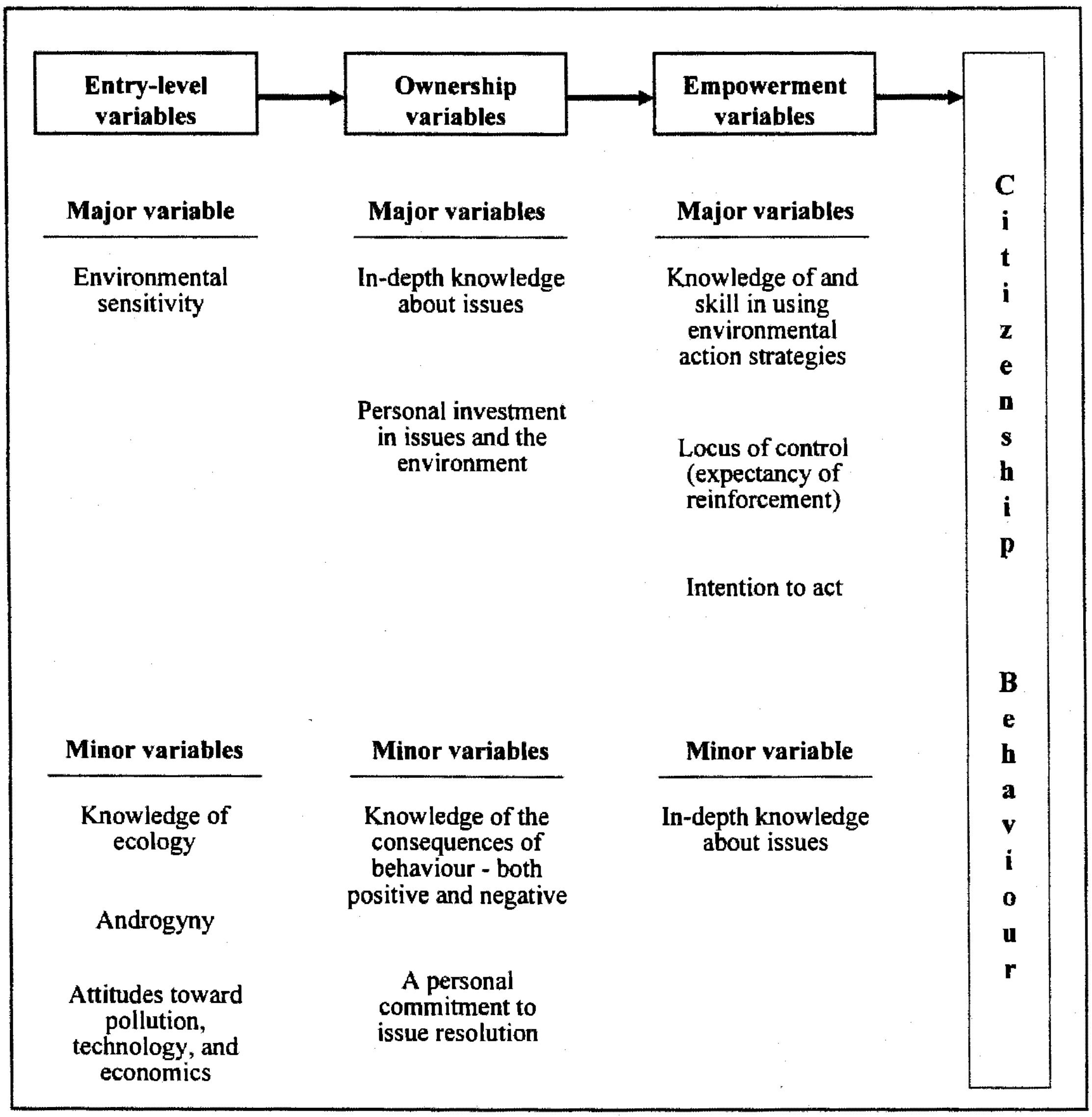
Responsible environmental behaviour is associated with such components as personality factors (attitudes, locus of control, perception, personal responsibility); knowledge of issues; knowledge of action strategies and action skills; intention to act; and situational factors (constraints and opportunities). In essence, the various goals establish a process through which knowledge, attitudes, skills, commitment, and motivation play important roles to ensure that environmentally sound behaviour can be met.

2.4.2. Responsible Citizenship Behaviour

Based on the model proposed by Hines et al (1986/87) and drawing from additional research, Hungerford & Volk (1990) suggested an expanded model of environmental behaviour. According to this research three categories of variables contribute to responsible citizenship behaviour. The variable categories (entry- level, ownership, and empowerment variables) are hypothesized to act in a more or less linear fashion, albeit a complex one. The model proposed by Hungerford and Volk (1990) uses seven key indicator variables to predict the level of environmental behaviour. Entry level variables function as prerequisites for environmentally responsible behaviour by providing the foundation for pro-environment attitudes and decision making. Ownership variables personalize environmental issues through expanded understanding and investment. Empowerment variables represent environmental problem solving skills. According to the model, an individual who exhibits development of many of these variables is more likely to behave responsibly toward the environment.

Hungerford & Volk (1990:10-11) believes that a set of major variables (environmental sensitivity, in-depth knowledge about issues, personal investment in issues, knowledge of and skill in using action strategies, locus of control, and intention to act) and minor variables (knowledge of ecology, androgyny, attitudes, knowledge of the consequences of behaviour, and a personal commitment to issue resolution) contribute to responsible environmental behaviour. The major and minor variables adapted from Hungerford & Volk (1990:11) are indicated in Figure 4.

Figure 4: Major and Minor Variables Involved in Environmental Citizenship Behaviour



The models described in figure 3 and 4 are in line with the set of guiding principles of environmental education as mentioned in paragraph 2.2.4. For example, to foster clear awareness of, and concern about economic, social, political and ecological interdependence in urban an rural areas; to provide every person with opportunities to acquire knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; to create new patterns of behaviour of individuals, groups and society as a whole towards the environment. The guiding principles of effective environmental education were accepted at Tbilisi in order to accomplish categories of environmental education objectives (awareness, knowledge, attitude, skills and participation). There is a close relationship between objectives and guiding principles of environmental education. Hines model (Figure 3) shows that knowledge of issues, knowledge of action strategy, action skills, personality factors (attitudes, locus of control and personal responsibility) and situational factors are indicators of the intention to act towards a responsible environmental behaviour. In the model described by Hungerford & Volk (Figure 4), entry level, ownership and empowerment variables highlight environmental sensitivity, knowledge of issues, skills and personal investment and attitudes that lead to citizenship behaviour. The studies indicated above seem to suggest a number of variables that may be linked to responsible environmental behaviour and these variables interact with one another. From an analysis of research findings, Howe & Disinger (1992:6) indicated that individuals who exhibit responsible behaviour on a broad range of environmental problems have: knowledge of relevant concepts; knowledge of environmental problems and issues; concern for the *quality* of the environment; knowledge of action strategies that may be used for resolving an issue; belief that their action can make a difference; commitment to take action; and experience in action - based activities. Environmentally responsible behaviour calls for knowledge, understanding, concern, commitment and self-belief to accomplish positive results, and skills in identifying and implementing action strategies.

Many educators have noted that knowledge alone cannot influence the protection of the environment (Hungerford & Volk, 1990; Iozzi, 1989; Hewitt, 1997:35; Tomsen & Disinger, 1998). Iozzi (1989:4) noted that "it is important to possess knowledge to improve the quality of the environment, possessing such knowledge certainly does not ensure that one will be motivated to take action". It was noted in paragraph 1.1 that ecological crisis is caused by the disruption of ecological systems. This reflects "a prior disorder in the thought, perception, imagination, intellectual priorities, and loyalties in the industrial mind"(Orr, 1996:7) and is a crisis of education. Therefore, the major causes of environmental problems lie in human behaviour.

There is lack of knowledge and data available to help in the understanding, predicting, and modifying of responsible environmental behaviour. An examination of environmental education research and curricular materials indicates that the objective of environmental education to develop responsible environmental behaviour is not given the emphasis it deserves. According to Carlson & Mkandla (1998:8) environmental education has not fully managed to reach into people's minds and change attitudes and behaviour. One conclusive finding of research on responsible environmental behaviour is that "there is no single all-potent experience that produces environmentally informed and active citizens, but many together" (Chawla, 1998:19). The danger is that "when environmental education concentrates primarily on a manipulation of behaviour, the development of critical thinking skills in students is diminished" (Emmons, 1997:36). Maloney & Ward (1973:585) noted that most persons have a relatively high degree of verbal commitment and affect, with lower levels of actual commitment and knowledge. This means that most people say they are willing to do a great deal to help curb, for example, pollution, and are emotional about it, but they actually do little and know even less. It must be noted that attitudes and behaviour are not always consistent. Ultimately, it is necessary to transform the attitudes and behaviour of entire societies towards the biosphere. Therefore, the challenge for the teacher is to translate the aims, objectives and guiding principles of environmental education into the instructional situation. The characteristics associated with environmentally responsible behaviour include empathy toward the environment, identification with specific environmental issues, awareness of ways to maintain environmental quality and a sense of empowerment for achieving desired outcomes. Therefore, environmental education should be directed at changing people's attitudes towards their responsibility for improving the environment.

2.5 Conclusion

Many attempts have been made to define environmental education. It has been difficult to define environmental education since its inception. There is a need to establish a clear definition of environmental education. This is because the lack of a clear definition may hinder decisions about the aims, objectives and guiding principles for effective environmental education. Environmental education is a holistic approach and involves the cognitive, the affective and the psychomotor domains of human development in order to identify problems, find solutions and prevent new ones. Environmental education can be referred to as an educational approach intended to foster awareness, sensitivity, knowledge, values, attitudes, motivation, skills, and commitment needed to take actions for sustainable development.

The ultimate aim of environmental education for each school leaver is to have formulated a responsible attitude towards the sustainable development, an appreciation of the beauty of nature and an assumption of an environmental ethic. The focus is on an awareness of the total environment and its problems; the gaining of a sound knowledge and understanding of how the environment functions; the establishment of positive attitudes towards the environment; the acquisition of skills needed to identify, investigate, and contribute to the resolution of environmental issues and problems; and the participation in thoughtful, positive action regarding the environment. The guiding principles should guide in the selection of content and methodology for in-service and pre-service teacher education programmes in environmental education.

Environmental literacy is the ability to be aware of one's environment. It enriches one with the knowledge to realize the imbalances and threats the environment faces and enables one to form positive attitudes towards it with the aim of developing skills to resolve and prevent environmental problems and urge to protect and improve the environment for the present and future generations by active participation. There is a broad spectrum of environmental literacy, from unawareness to deep, thorough understanding and concern.

Environmental literacy is a continuum of competencies ranging from zero competency to very high competency that can be functionally divided into three working levels: nominal, functional and operational.

To encourage responsible environmental behaviour, knowledge of issues, knowledge of natural systems, problem-solving skills, attitudes, and the development of self-esteem should be included in any programme. Responsible environmental behaviour overlaps the aims, objectives and guiding principles of environmental education. In the long run, nothing significant will happen to reduce threats to the environment unless widespread public awareness is aroused concerning the essential links between environmental quality and the continued satisfaction of human needs. Therefore, it is important that everyone becomes environmentally literate. Information on environmental education, environmental literacy and responsible environmental behaviour from this chapter will be used in the formulation of concepts which are important for environmental education and environmental literacy.

Chapter 3 will provide a definition of sustainable development, outline the basic principles and objectives of sustainable development, and an overview of the potential of environmental literacy as a vehicle to realize the educational agenda of sustainable development.

CHAPTER 3

ENVIRONMENTAL LITERACY AND SUSTAINABLE DEVELOPMENT

3.1 Introduction

The main purpose of this chapter is to provide an overview of sustainable development and education for sustainability (aim 2 as indicated in paragraph 1.4) and the role that environmental education and environmental literacy can play towards education for sustainability. It seems developing environmental literacy is a step towards education for sustainability. Environmental literacy can provide the elementary knowledge, skills and motivation for people to participate in the solution, and anticipation of environmental problems, and so make their contribution to sustainable development. In this context, an understanding of the terms such as sustainability, sustainable society, sustainable development, and education for sustainability and their relationship with environmental education and environmental literacy can be useful in the development of an instrument to measure the level of environmental literacy of teachers in this study.

In chapter 2, it has been indicated that an important function of environmental education is to develop the necessary awareness, knowledge, ethics, values, attitudes, skills, and commitment to allow people to become environmentally literate. It can be expected that an "environmentally literate citizen has the capacity to perceive and understand the relative health of the environment and take appropriate decisions and actions to maintain, restore or improve the health of the environment in a sustainable way" (Roth, 1992:2). As noted in paragraph 2.3, development of environmental literacy is a step towards the maintenance of environmental quality and the quality of life. In the context of sustainable development, development of environmental literacy is perhaps the most important influence to meet the needs of the present and future generations. It can be expected that an understanding of sustainable development can lead to an improvement in the quality of the environment and quality of life for all. It can be assumed that there is a relationship between environmental literacy and sustainable development and will be explained in paragraph 3.3.

In the following paragraphs, an attempt will be made to outline the concept sustainable development and also show its relationship with education.

3.2 Sustainable Development

Before starting to outline the various dimensions of sustainable development, it is necessary to define the term sustainable development.

3.2.1 The Term Sustainable Development

Sustainable development was first discussed in the 1960s with the advent of the green movement (McMinn, 1997:136). During the 1980s the concept of sustainable development emerged as one of the key concerns about the management of natural resources and were accepted as a policy by the World Commission on Environment and Development (WCED) (Basiago, 1995:109; Lele, 1991: 610; Slocombe & Van Bers, 1991:11). Key concepts, namely, sustainability, sustainable society and sustainable development are explained in the following paragraphs.

(a) Sustainability

The term sustainability is drawn from the verb 'to sustain', whose dictionary definitions include 'to support, to endure, to hold valid' (The Oxford English Dictionary, 1989:326-327). The word 'sustain' has an Indo-Aryan etymological origin and means to hold together with tension - not coercion, but tension (Fricker, 1998:566). According to Basiago (1995:109) the notion of sustainability emerged in "The Ecologist's: A Blueprint for Survival", in 1972. Sustainability is a concept originating from ecology, referring to the conditions necessary for ecosystems to be sustained in the long-term (Naess, 1995: 121) making things last, making them permanent and durable (Pearce, 1988:598).

According to Norgaard (1988:617) sustainability implies that the "overall level of diversity and overall productivity of components and relations in systems are maintained". It implies that those existing traits are deliberately maintained as options until after new ones have proven superior. Sustainability, according to Disinger (1990:3) is a "rational approach to the resolution of the dilemmas created by the interactions of humans and the world in which they live, to manage the environment and its resource base in such a manner that their reasonable use can be continued without diminishment into the indefinite future".

Biologists, economists, sociologists, planners and others define sustainability differently. For example, in biology, sustainability has come to be associated with the protection of biodiversity (Basiago, 1995:111). They all refer to the wise use of the environment and its natural resources.

The word 'sustainable' is used in several combinations, such as sustainable growth, sustainable use, sustainable economy, sustainable living, sustainable society, sustainable agriculture, sustainable development, education for sustainable development, education for sustainability, sustainable industry, sustainable resource development, sustainable economic development, ecologically sustainable development, environmentally sound development and successful development. Their meanings are not the same. For example, sustainable growth is a contradiction in relation to economic growth and human needs. Sustainable use is applicable only to renewable resources; it means using them at rates within their capacity for renewal. A sustainable economy is the product of sustainable development. Sustainable living describes the life style of an individual who feels the obligation to care for nature and for every individual, and who acts accordingly (UNEP, 1992:29-30). It seems that there is a need to develop a more caring approach towards the environment.

Sustainability means that the environment should be protected and maintained to give an equal opportunity to future generations. Sustainability refers to the wise use of the environment and the available resources.

(b) Sustainable Society

A sustainable society is expected to have the ability to maintain, and further improve upon, the quality of life of all its citizens by living within its own resource means (Govindan, 1996:952). It is important that all live by the principles of a sustainable society, as these principles are crucial for sustainable development. According to the UNEP (1992) the principles of a sustainable society include the following:

* respect and care for the community of life;
* improve the quality of life;
* conserve the earth's vitality and diversity;
* minimise the depletion of non-renewable resources;
* keep within the earth carrying capacity;
* change personal attitudes and practices;
* enable communities to care for their own environments;
* provide a national framework for integrating development and conservation; and
* create a global alliance (UNEP, 1992:29-30).

In a sustainable society, environmental protection, economic objectives, and social justice (social equity) should be linked in harmony (US Government, 1996:1). Seemingly, there is no clearly agreed understanding as to what is to be sustained. Sometimes it is assumed that it is the resource base, sometimes the livelihoods which are derived from the resource base, others still refer to the sustainability of current production levels. A society is only sustainable if quality of life is equally distributed among all people, and if the biosphere as a resource base is not over-exploited by people.

(c) Sustainable Development

In the literature, there are many definitions, descriptions, and interpretations for sustainable development. These definitions of sustainable development in the literature serve particular social, economic and environmental (ecological) interests, and core values. Some of the definitions, descriptions, and interpretations for sustainable development are provided in the following paragraphs.

Sustainable development can be interpreted and understood as a continuous process of change (Jokinen, Malaska & Kaivo-oja, 1998: 492; Lele, 1991:609). In many instances, sustainable development would simply mean development that can be continued either indefinitely or for a definite period.

According to Vinke (1992: 40) the underlying idea of sustainable development is that "economic growth must continue, at rates that are even faster than population growth, without leading to higher demands for natural resources and increased pressures on the environment". Sustainable development suggests the need to live within ecological limits without avoiding the idea of progress. According to Blowers (1992:133) sustainable development can "promote the enhancement of the natural and built environment in ways that are compatible with the requirement to conserve natural resources and with the need to achieve greater social equality without imposing added costs or risks on future generations". According to Fien (1993:7) sustainable development demands "a move from a situation of wasteful consumption and pollution to one of conservation, and from one of privilege and protectionism to one of fair and equitable chances open to all". All definitions address the sustainability of changing interactions between people, their environment and the resources over a period of time.

A common definition is that of the World Commission on Environment and Development (WCED) which defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Fien, 1993:8). Sustainable development entails the principle of futurity, equity, democracy and participation. There is also an element of ethics included in the term, both across generations and between the same generation (Cole, 1999:90; Govindan, 1996:948; Naess, 1995:121; Plant, 1995: 258). Implicit in the WCED definition of 'sustainable development' is the task of handing down to future generations at least the life-sustaining resources that are needed by them.

In the literature, there are several reasons for not accepting the WCED definition of sustainable development. According to Khan (1995:64), the WCED definition of sustainable development does not adequately articulate the functions of different branches of social, natural and biophysical sciences in a manner which will demonstrate their separate functions and reveal their integrating roles to constitute what is being termed sustainable development. It refers to the need for reconciliation between economic development and environmental conservation, the need to place any understanding of environmental concerns within a socio-economic and political context and the need to combine environment and development concerns.

The WCED definition of sustainable development implies that needs are separate from development and can be arrived at independently. Sustainable development invokes the concept of 'need' in the context of 'development' to meet problems of resource allocation between present and future generations. It can be assumed that needs are different things to different people. From a historical perspective, each society defines needs in its own way. The knowledge we have of needs changes over time and is linked to our ability to satisfy them. It is unlikely that the needs of a culture or society can be measured in terms of some set criteria over a period of time. Therefore, how needs are defined depends on who is doing the defining and when. Instead of addressing these issues, attention has been focussed on the future costs of development to our own societies, as if satisfaction of our future needs is more important than the way we currently satisfy our needs.

An important question is 'what future generations may require?'. Beckerman (1992) identified the dilemma in trying to assess the needs of future generations. "In the absence of any knowledge of future preference patterns and technological possibilities, it is impossible to know what substitutions would permit the same level of welfare to be obtained from different combinations of assets. .... For simply, we have no basis for judging what the tradeoffs would be in the future between, say work and leisure, certain forms of economic activity and others, economic welfare versus the non-economic welfare, one may obtain from the environment and so on" (Beckerman, 1992:492). What is considered important today may not be so valuable to generations yet unborn. There is a hope and an expectation that technology can play a major part in the reduction of environmental problems (Thom, 1996:347). In this context, Lele (1991:614) noted that any discussion of sustainability must first answer the questions such as "what is to be sustained? For whom? How long?" It seems there is no easy answer to such questions.

The concept sustainable development is ambiguous (Plant, 1995:254), emotive, flexible, has a misleading appearance of simplicity (Horlings, 1994:193) and is difficult to define (Gibbs, 1994:183; Khan, 1995:64). This is because when people define an activity as 'sustainable', it is on the basis of what they know at the time. Gibbs (1994:183) stressed the need to resolve contradictions between economic development and environmental protection before a clear definition of sustainable development can be provided. Otherwise, the definition of sustainable development will be used universally but as a misapplied term. This lack of a consensus probably reflects different interpretations of the term sustainable development.

One general meaning of sustainable development might be to continually satisfy the basic human needs such as food, water, shelter as well as social and cultural necessities such as security, freedom, education, employment and recreation. Another meaning might be to ensure the continued productivity as well as efficient functioning of ecosystems. The term 'sustainable development' has implications for environmental (ecological), social and economic systems. In simple terms, sustainable development requires that the needs of the present generation are met without prejudicing those of future generations.

3.2.2 The Conceptual Pillars of Sustainable Development

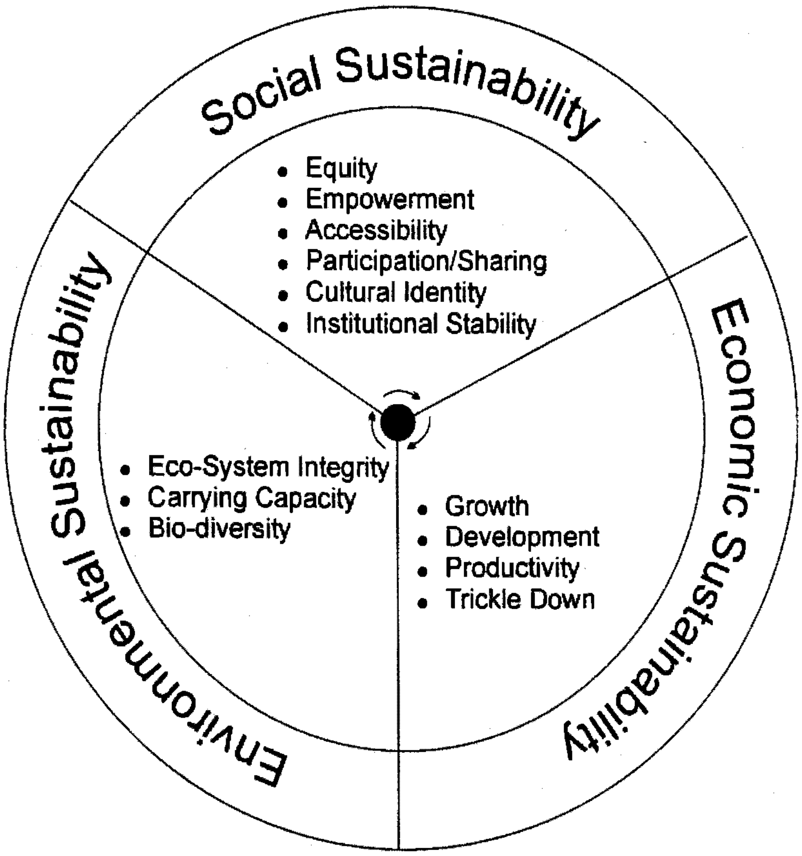
Sustainable development as described in Agenda 21 rests on three conceptual pillars (Khan, 1995:64-65). These three conceptual pillars (Figure 5), economic sustainability, social sustainability and environmental sustainability respectively, are outlined in the following paragraphs.

(a) Economic sustainability

Economic sustainability by way of growth, development and productivity, has guided conventional development. Allocation of resources, sustained levels of growth and consumption, an assumption that natural resources are unlimited and a belief that economic growth trickles down to the poor, have been its hallmarks. Sustainable development expands development's concern with monetary capital to consider natural, social and human capital. Restraint upon economic growth and consumption which deplete these is favoured (Khan, 1995:64-65).

The major elements are growth, development and productivity. The view is that if economic development is to be sustainable, the ecological systems on which economic production ultimately relies also need to be sustainable. It is believed that economic growth would lead to an improvement in the quality of life.

Figure 5: The Paradigm of Sustainable Development in Agenda 21 (Khan, 1995:65)



(b) Social sustainability

Social sustainability encompasses notions of equity, empowerment, accessibility, participation, sharing, cultural identity, and institutional stability. It seeks to preserve the environment through economic growth and the alleviation of poverty (Khan, 1995:64-65).

There is a concern for the welfare of the poor and disadvantaged, fair sharing of economic benefits within and between generations, and the need for individuals to participate in decisions affecting them.

(c) Environmental sustainability

Environmental sustainability involves ecosystem integrity, carrying capacity and biodiversity. It requires that natural capital be maintained as a source of economic inputs and as a sink for wastes. Resources must be harvested no faster than they can be regenerated. Wastes must be emitted no faster than they can be assimilated by the environment (Khan, 1995:64-65).

There is a need to maintain the integrity of ecological processes and systems, and to live within the carrying capacity of supporting ecosystems. A distinction needs to be made between renewable and non-renewable resources, as well as ecological processes that are crucial to the well being of all forms of life.

The theoretical framework elaborated by Khan (1995) posits that social, economic and environmental sustainability must be integrated and interlinked. This may mean that sustainable development needs specific environmental, economic and social goals and necessitates 'policy integration and planning'. Agenda 21 is a blueprint on how to make development socially, economically and environmentally sustainable. It seems one major goal is to improve the quality of life in a sustainable way. In brief, the term 'sustainable development' has implications for economic, social and environmental systems.

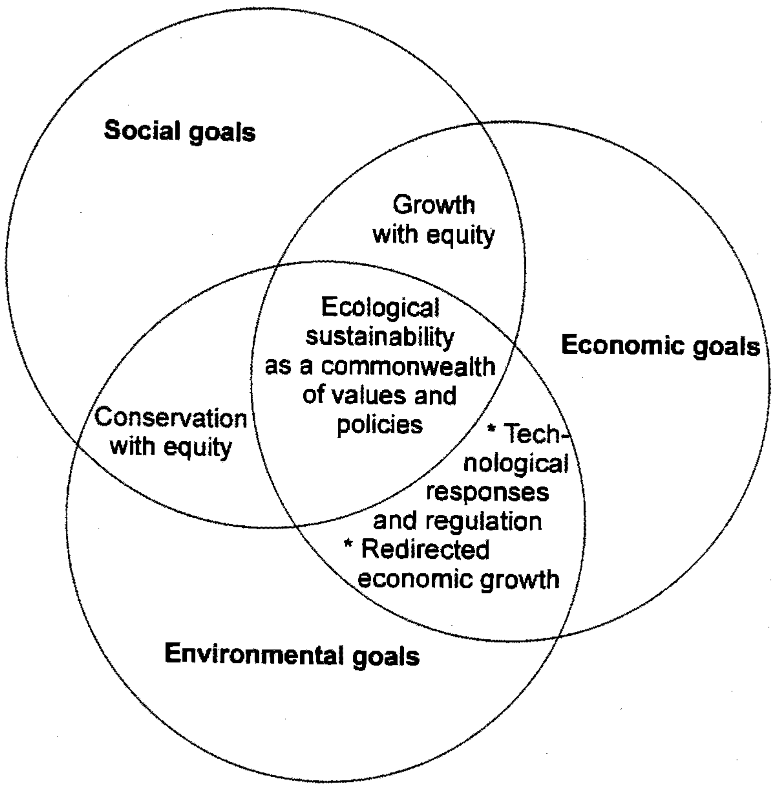
A fourth dimension (ecological sustainability) may be added to social, economic and environmental sustainability.

(d) Ecological sustainability

An ecological view of sustainable development (ecological sustainability) sees it as a "process which requires that the use of environments and resources by one group of people does not jeopardise the environments and well-being of people in other parts of the world or destroy the capacities of future generations to satisfy their reasonable needs and wants" (Fien, 1993:10). The ecological dimension of the 'Gandhian model' of social reconstruction is based on the ecological values of harmony between population, energy and technology secured through organisations complying with the laws of nature (Unnithan, 1991:152). It may be assumed that development without concern for the environment can only be short-term development. At the same time, development at the cost of the environment can take place only up to a certain point, it will be like a foolish man who tries to cut the very branch of the tree on which he would be seated.

According to Fien & Trainer (1993:34-35), ecological sustainability represents social, economic and environmental goals in which environmental, economic and justice imperatives equally define the parameters of sustainable development (Figure: 6).

Figure 6: The Nature of Ecological Sustainability: The Sustainable Development Mode (Fien & Trainer, 1993: 35)



There is an integration of the three goals, for example, of social and economic goals (growth with equity); economic and environmental goals (technological response and regulation and redirected economic growth); environmental and social goals (conservation with equity). These three goals of sustainable development could lead to ecological sustainability as a commonwealth of values and policies. It seems that the necessary preconditions for achieving sustainable development are environmental (ecological) security, economic efficiency and social equity. These preconditions may be necessary for improving the quality of life while living within the carrying capacity of supporting ecosystems. The importance of an environmental ethic cannot be overemphasised. As stated in Agenda 21, the document produced by the 1992 United Nations Conference on the Environment and Development, education is "critical for promoting sustainable development". Understanding the principles of sustainability and the interdependence of the environment, the economy, and social systems can help us to make the changes necessary to become effective stewards of natural resources and the environment. Seemingly, education is the key in responding to this need.

In the following paragraphs, the basic principles, goals and objectives of sustainable development will be outlined.

3.2.3 Principles, Goals and Objectives of Sustainable Development

Underlying the concept 'sustainable development' there are a number of principles, goals and objectives which are fundamental to the use of natural resources.

(a) Principles of Sustainable Development

Knowledge of the principles of sustainable development is important for the present and future generations. The principles of sustainable development, for example, can guide the management of resources and protect the integrity of ecosystems. In the following paragraphs, the principles of sustainable development from authors namely, Basiago

(1995), Dunlop (1992) and Palmer, Cooper & van der Vorst (1997) are outlined to provide a basis for education for sustainability.

According to Basiago (1995:118) sustainability is embodied in four principles:

* futurity (a concern for the welfare of future generations),
* equity (the fair sharing of economic benefits and burdens within and between generations);
* global environmentalism (a recognition of the global dimension of ecological problems associated with use or depletion of natural capital by one or some at the cost of others); and
* biodiversity (the maintenance of the integrity of ecological processes and systems).

According to Dunlop (1992:92), the five main principles that underlie the concept 'sustainable development' are the following:

* The need to take a long rather than short-term perspective of development;
* The management and maintenance of resources are as equally important as their utilisation;
* The recognition of the strong interdependence between economic activity and the natural environment;
* Individuals and communities have the right and duty to influence the way in which natural resources are utilised, developed and managed; and
* Promote awareness and understanding of environmental issues by educational processes within and outside the formal education system.

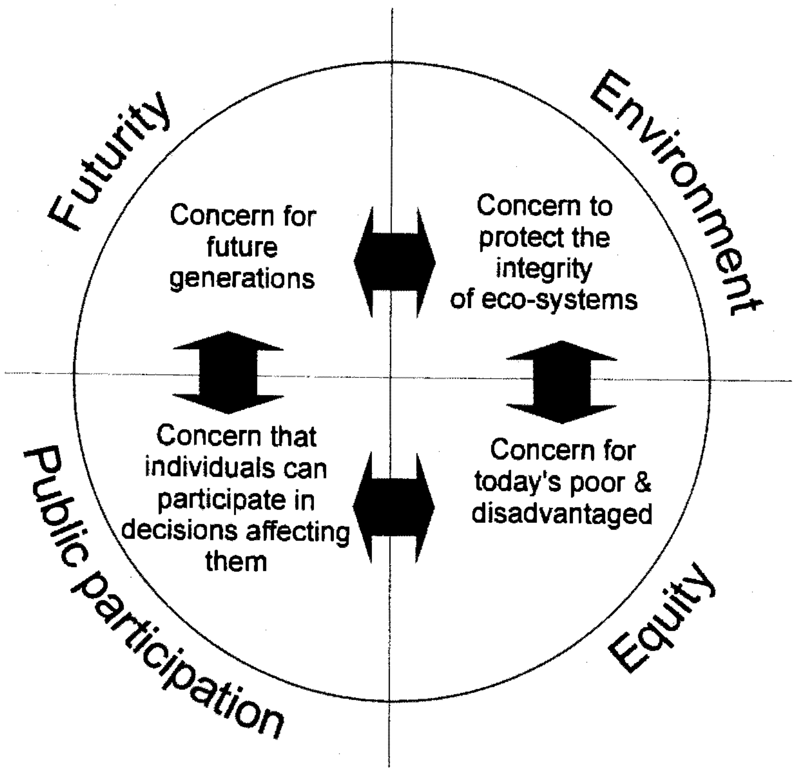
Palmer, Cooper & van der Vorst (1997:88-91) outlined four main principles that underlie sustainability (Figure 7). The principles underlying sustainable development are

* futurity (concern for future generations);
* environment (concern to protect the integrity of ecosystems);
* public participation (concern that individuals can participate in decisions affecting them); and

*   equity (concern for today's poor and disadvantaged).

As shown in Figure 7, these four principles are closely interrelated.

Figure 7: The Principles Underlying Sustainable Development (Palmer et al, 1997:88)



Palmer, Cooper & van der Vorst (1997) noted those concerns regarding environmental quality and the resources available to future generations are a concern for equity. Unfortunately, not everyone values the environment and the needs of others today of for future generations in the same way. It is important to note that the concept of sustainable development is relatively simple to state in theoretical terms but highly complex on a practical level.

Sustainable development is a philosophy in which principles of futurity, equity, global environmentalism and biodiversity must guide in the management and maintenance of resources in the environment and assist in the provision of resources for the present and future generations. There is the recognition of the need for public participation in matters affecting the environment and to develop an ethical awareness and commitment towards the sustainable use of natural resources.

(b) Goals of Sustainable Development

There are several goals for sustainable development. In the following paragraphs, the goals of sustainable development from authors namely, Blowers (1992), Lele (1991), and Pearce (1988) are outlined.

Blowers (1992:133) identified conservation, balanced development, environmental quality, political participation, and social equality as the five goals of sustainable development.

According to Lele (1991:611) sustainable development seeks to respond to five broad requirements:

* integration of conservation and development,
* satisfaction of basic human needs,
* achievement of equity and social justice,
* provision of social self-determination and cultural diversity, and
* maintenance of ecological integrity.

Pearce (1988:599) outlined sustainable development as a means to achieve:

* justice in respect of the socially disadvantaged;
* justice to future generations;
* justice to nature; and
* aversion to risk arising from:
  - our ignorance about the nature of the interactions between environment, economy and society; and
  - the social and economic damage arising from low margins of resilience to external shock.

An important goal of sustainable development should be to pass on to future generations an environment which is at least as productive as that which the present generation inherited. The major goals of sustainable development may include justice to nature, future generations (within and between generations) and the disadvantaged; balanced economic development; satisfaction of basic human needs; and maintenance of environmental quality and quality of life through public participation in conservation programmes.

(c) Objectives of Sustainable Development

Arising from the principles and goals of sustainable development are a set of objectives. One of the basic objectives of sustainable development, as stated by the World Commission on Environment and Development (WCED), is to bring economic growth and the environment into harmony (Basiago, 1995:111). In addition, human needs and social welfare can be linked to this approach. The critical objectives which follow from the concept sustainable development are:

* to revive growth;
* to change the quality of growth;
* to meet essential needs for jobs, food, energy, water, and sanitation;
* to ensure a sustainable level of population;
* to conserve and enhance the resource base;
* to reorient technology and manage risk;
* to merge environment and economics in decision making;
* to reorient international economic relations; and
* to make development participatory (Lele, 1991:611).

It seems sustainable development can achieve inter alia, the conservation of resources, maintaining a sustainable level of population and participation in decision making in matters relating to the environment and economic development. Sustainable development is important for the long-term maintenance of the natural systems that support life on earth. In this context, seeking sustainability means redesigning society so that human activities do not have long-term negative impacts, on either the environment or on society.

The principles, goals and objectives outlined above are very closely interrelated and are critical in balanced development. They encompass the notions such as futurity (welfare of future generations), equity (within and between generations, and to nature), environment (global environmentalism and biodiversity), integration of conservation and development, justice (to nature, future generations and the disadvantaged) and public participation in decision-making. Added to these notions is an element of an environmental ethic. It seems humanity has the ability to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. However, this does not mean that future generations will have the same options and choices as the present generations. This is because not all resources are renewable. It is vital to identify those aspects of sustainable development that caters for diverse interests which can aid the development of our understanding of sustainable development. This should include aspects such as economic, environmental (ecological), social, technological, justice, moral, and cultural which include value and belief systems. In essence, sustainable development should be a rational approach to the management of natural resources. It has the aim of safeguarding and satisfactorily meeting human needs, not only in the present but also in the future.

3.2.4 Towards 'Education for Sustainability'

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil from 3 to 14 June 1992, is an important milestone for education in general and environmental education in particular. One of the results of the Rio conference was to redirect environmental education towards sustainable development. The Rio conference action plan in Chapter 36 states that education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. . . and is critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective public participation in decision making (Quarrie, 1992:221). An important agreement of the Rio Conference was Agenda 21 which provides a plan to make development socially, economically and environmentally sustainable. This aims to establish education for sustainability as the major goal of environmental education. Seemingly, there is a growing realisation that environmental problems can be better understood with reference to social, economic, environmental values and lifestyle choices.

In the following paragraphs, the aims and pedagogy of education for sustainability are outlined.

(a) Education for Sustainability

As stated in Agenda 21, education is critical for promoting sustainable development. It can be assumed that education for sustainability provides an opportunity to understand the principles related to sustainable development and encourages personal action to achieve sustainable development. According to Slocombe & Van Bers (1991:14), "education for sustainability can encourage the generation of creative solutions and can help identify possibilities for sustainable development". They further noted that giving substance to sustainable development and giving it an educational relevance and importance is a critical part of turning the idea of sustainable development into the reality of sustainable societies. Education for sustainability demands a clear commitment to change attitudes and practices so that actions are more consistent with sustainable development.

Education for sustainability aims to:

* clarify the concept sustainable development;
* develop understandings of ecological and economic principles;
* promote critical analysis of the relationship between ecological and economic principles which relate to sustainable development;
* include positive models and successful case studies of sustainable development in

action;

* promote values and personal actions which are integral to the achievement of sustainable development;
* encourage active participation in decision making regarding sustainable development (Reid, 1996: 169-171).

Education for sustainability is a process to build relationships between individuals, groups and their environment. Fien (1995:26) argued that education for sustainability is a process which:

* enables people to understand the interdependence of all life on this planet, and the repercussions that their actions and decisions may have both now and in the future on resources, on the global community, local one, and on the total environment.
* increases people's awareness, of the economic, political, social, cultural, technological, and environmental forces which foster or impede sustainable development.
* develops people's awareness, competence, attitudes and values, enabling them to be effectively involved in sustainable development at local, national and international level, and helping them to work towards a more equitable and sustainable future. In particular, it helps people to integrate environmental and economic decision-making.
* affirms the validity of the different approaches contributed by environmental education and development education and the need for the further development and integration of the concepts of sustainability in these and other related cross-disciplinary educational approaches, as well as in established disciplines.

As sustainable development focuses on the quality of peoples' lives, it must become central to education in general and environmental education in particular. Education for sustainability should:

* enable an understanding of the interdependence of life forms and the consequence

of actions and choices on resources in the long and short term;

* increase awareness of individuals and groups to environmental, economic, social and cultural forces which contribute to sustainable development;
* provide everyone with the opportunity to acquire awareness, knowledge, skills, attitudes, values and commitment in order to protect and improve the environment;
* create environmentally friendly behaviour patterns;
* develop an environmental ethic;
* foster environmental literacy for all; and
* improve the quality of life.

Education for sustainability is a "continuous learning process based on respect for life, affirms values and actions which contribute to human and social transformation, and ecological preservation. It fosters ecologically sound and equitable societies that live together in interdependence and diversity" (Plant, 1995:261). This means that education for sustainability will develop and mature in the future as environmental, economic and social forces undergo change. Therefore, the philosophical principle that sustainability is a process will need to be reaffirmed continually along the path to sustainability. As outlined in *education for sustainability: an agenda for action* (US Government, 1996), successful efforts for implementing education for sustainability depend on six core themes. They are lifelong learning, interdisciplinary approaches, systems thinking, partnerships, multicultural perspectives, and empowerment (US Government, 1996:3). Collectively, these themes outline a course of action to educate for sustainability.

Education for sustainability can provide a vehicle for engendering responsible citizenship utilizing a variety of instructional models and guidelines that have been long accepted in the field of education (US Government, 1996:6). It requires an understanding of the interdependence and interconnections of humans and the environment. Its elements include knowledge of global socio-geopolitical disciplines, biological and physical sciences, and human socio-economic systems (US Government, 1996:6). Education for sustainability is essentially process-driven, participative, empowering, liberatory, continuous and is necessitated by the possibilities and dangers presented by an emerging post-modern world.

Education for sustainability is consistent with "think globally and act locally" (Dippo, 1998: 328). It is "problem-centred, inquiry-based and takes as fundamental the relation between thinking and acting, theory and practice. It resists cynicism and despair and insists as well on an appreciation of the value of concerted and collective action" (Dippo, 1998:328). The programmes for education for sustainability ought to acknowledge and address questions such as "what kind of development is to be sustained?" "Is it economic growth? Quality of life? Ecosystem integrity? What is our moral obligation to the future generations? What should be the criteria for progress?" (Plant, 1995:253). It must also explore the meaning of sustainable development from different perspectives such as economic, social, environmental and ethical. Education for sustainability should also encompass an appreciation of diverse cultural perspectives.

Although, the literature is replete with suggestions as to how sustainable development ought to be practised, no coherent articulation of the theory and no easily implementable method of achieving it can be found. Govindan (1996:941) argued that "rather than following a metaphysical approach of postulating *a priori* how sustainable development ought to be practised, it is better to follow a practically reflexive approach of looking for a paradigmatic case of a state or society that has some characteristic features of what might be deemed sustainable development". The idea then is to propose ways to improve that prototype to bring it closer to the ideational content of the concept sustainable development, and then explicate ways to replicate it elsewhere.

However, there are certain limitations of education for sustainability. The question is "is it educationally justifiable to speak of education *for* sustainability?". While acknowledging that sustainability is a useful term that has the capacity to capture important issues and inspire imagination, Jickling (1992) expressed his concerns about education *for* sustainability. Seemingly, education *for* sustainability is seen as indoctrination as it involves the advancement of a particular agenda. This means that education 'for something' is inconsistent with the criterion of education to enable students to think for themselves. The use of the word 'for' suggests a predetermined way of thinking to which the students are expected to behave. The assumption is that education can be used to achieve pre-determined goals.

Is it the job of teachers to make students behave in a particular way towards the environment? Jickling (1999:110) argued that the teachers' job is to teach students "how to think, not what to think". According to Jickling (1999:112) students should be "exposed to a diversity of ideas, creating possibilities, but not defining future for our students". Education is concerned with enabling students to think for themselves. Jickling (1992:8) further argued that "we should not educate for sustainable development," but "we must enable students to debate, evaluate, and judge for themselves the relative merits of contesting positions". This will lead to the development of skills such as critical thinking and problem-solving in students. The present school curriculum (Curriculum 2005 based on Outcomes-Based Education) demands the provision of developing such skills.

The aims of education for sustainability can be achieved by providing opportunities to:

* practise a number of learning and teaching strategies that promote education for sustainability. In particular, values clarification, group discussion and evaluation activities.
* develop an understanding of the concept of sustainable development by examining the value base behind a range of interpretations of the concept and clarifying their own values.
* develop an understanding of the objectives of education for sustainability, and
* plan teaching units which incorporate the aims, knowledge, processes, skills and values inherent in education for sustainability.

It is imperative that education for sustainability should aim at the development of awareness, knowledge, attitudes, values and skills in environmental decision making and problem solving so that the world will be a better place now and also in the future. Education for sustainability should be open to informed debate and should not be taught as an ideology or as a goal, but rather as an ongoing process; not as a set of irrevocable answers, but as a way of continually asking better questions. This should enable learners to think positively about the environment as our future is dependent on the environment and its resources. This will enable students to judge for themselves the relative merits of contesting positions and to make responsible environmental decisions. Education for sustainability is a life long learning process that leads to an informed and involved citizenry having the creative problem-solving skills, scientific and social literacy, and commitment to engage in responsible individual and collective actions. These actions will help ensure an environmentally sound and economically prosperous future for all.

(b) Education for Sustainability in the Republic of South Africa

In the Republic of South Africa (RSA), the need for sustainable development has been emphasised in documents such as the constitution (RSA, 1996), the Reconstruction and Development Programme (RDP: 1994), White Paper on Education and Training (RSA, 1995), and the National Environmental Management Act (Department of Environmental Affairs & Tourism, 1999).

The constitution of the Republic of South Africa, for example, stresses the importance of conservation and recognises the right of each person to an environment that is not harmful to the health and well being. This is reinforced in the constitution by the guaranty of "the right to have a protected environment, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development" (RSA, 1996:11).

The right to a decent quality of life through sustainable use of natural resources is a goal of the Reconstruction and Development Programme (RDP) put into practice by the democratic Government of National Unity (RDP, 1994) and is documented in the White Paper on Education and Training (RSA, 1995) and in the National Environmental Management Act (Department of Environmental Affairs & Tourism, 1999). Agenda 21 promotes sustainable development in terms of meeting the basic needs of the present generation in such a way that the environment will be able to meet the needs of future generations. In this way the Reconstruction and Development Programme (RDP) is similar to Agenda 21. The Reconstruction and Development Programme (RDP) advocates "programmes to rekindle our people's love of the land, to increase environmental consciousness amongst our youth, to coordinate environmental education with education policy at all levels, and to empower communities to act on environmental issues and to promote an environmental ethic" (RDP, 1994:40). The White Paper on Education and Training (RSA, 1995) advocates "environmental education, involving an interdisciplinary, integrated and active approach to learning, must be a vital element of all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources". The National Environmental Management Act (DEA&T, 1999) identified the importance of Environmental Education and stated that community well being and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means. This demonstrates the desire of the government to ensure that today's development seeks to improve the quality of life and quality of the environment, without having a negative effect on future generations.

The present curriculum, Curriculum 2005 (C2005), which is an example of Outcomes-Based Education (OBE), demands that the learner should be able to demonstrate responsibility towards the environment. This means there should be provision for developing and exercising skills such as problem solving, conflict resolution, consensus building, information management, interpersonal expression, and critical and creative thinking skills. The provision of many of these skills can be an exemplary vehicle for education for sustainability. Therefore, education for sustainability presents an opportunity to meet the goals of the current reforms in the education system in the RSA.

(c) Education for Sustainability in Outcomes-Based Education

In Outcomes-Based Education (OBE) and Curriculum 2005, for example, learners should be able to demonstrate their ability to use science and technology effectively and critically showing responsibility towards the environment and the health of others (Department of Education, 1997a; Environmental Education Curriculum Initiative, 1996). Of particular importance is the emphasis of environmental concerns across learning areas. For example, 'the environment' is one of the 'phase organisers' in General Education and Training (GET). Some of the specific outcomes in Curriculum 2005 (Senior Phase) which may improve the level of environmental literacy and contributes to sustainable development from the learning areas (indicated in brackets) are the following:
Learners will be able to:

* Participate actively in promoting a just, democratic and equitable society (Human & Social Sciences).
* Make sound judgements about the development, management and utilisation of resources (Human & Social Sciences).
* Critically understand the role of technology in social development (Human & Social Sciences).
* Demonstrate an understanding of interrelationships between society and the natural environment (Human & Social Sciences).
* Address social and environmental issues in order to promote development and social justice (Human & Social Sciences).
* Understand and apply the technological process to solve problems and satisfy needs and wants (Technology).
* Demonstrate an understanding of how scientific knowledge and skills contribute to

the management, development and utilisation of natural and other resources (Natural Sciences).

* Demonstrate a personal role in economic development (Economic and Management Sciences).
* Demonstrate actions which advance sustained economic growth, reconstruction and development in South Africa (Economic and Management Sciences).
* Evaluate the interrelationships between economic growth and other environments (Economic and Management Sciences).
* Demonstrate the values and attitudes necessary for a healthy and a balanced lifestyle (Life Orientation) (Department of Education, 1997b).

These specific outcomes must be fully integrated into teaching as the environment provides the basis for life and is a major determinant of the quality of life of all. Integrating environmental concerns into specific outcomes of the eight learning areas could become a possible approach to learning programme development. Then, each specific outcome in the learning programme should be investigated for environmental orientations. For example, a specific outcome in the learning area Human & Social Sciences is to participate actively in promoting a just, democratic and equitable society. This outcome can contribute to the concept of sustainability mainly because participating actively in promoting a just, democratic and equitable society is fundamental to the development of a sustainable society as these values are integral to sustainable living practices. Some of the possible interpretations of this specific outcome are the following:

* Give examples of unsustainable practices (overproduction of waste, pollution, poverty, violence, etc.).
* Mention how these unsustainable practices affect the quality of life in different contexts.
* Respond to identified unsustainable practices (issues of social justice) through participation in projects.
* Recognise the relationship between resource use and social justice.

Teachers have an important role to play in introducing learners to the concept of environmental literacy (Paragraph 2.3) and sustainability as well as to assist learners to better understand how to develop more sustainable life styles. Education for sustainability of which many other disciplines are indispensable components, will engage partners from all arenas. Working together, we can make education for sustainability a critical part of a lifelong learning process. Therefore, developing environmental literacy is a step towards achieving sustainability across the learning areas at the different phases. However, it was noted in paragraph 1.3 that what teachers teach in environmental education is perhaps greatly influenced by their own environmental literacy. An important question is whether we have the teachers who can translate the specific outcomes in the different learning areas into classroom practice? One thing that is clear is the importance of education and the central role of educators in the range of initiatives that aim to establish sustainability as a viable framework for thinking about and acting upon a range of increasingly urgent and complex social, economic, and environmental problems.

(d) Education for Sustainability in Teacher Education

Education for sustainability will be dependent upon the ability of teacher education to provide opportunities for students to practise strategies founded on values which support sustainability in schools and within their own institutions of teacher training (Shallcross & Wilkinson, 1998:251). In the Republic of South Africa (RSA), the Committee on Teacher Education Policy (COTEP) document - *Norms and standards for teacher education* regards environmental education as an important aspect of teacher education. For example, teacher education should develop various forms of knowledge including knowledge of environmental issues, both locally and globally; to develop skills such as the ability to develop a sense of environmental responsibility in students; and to develop those values, attitudes and dispositions which advance environmental awareness and a knowledge of ecology and natural systems (Committee on Teacher Education Policy, 1996: 6-12). It requires that all teacher education institutions should train teachers to be able to teach in an environmentally directed way.

It was noted in Chapter 1 that teachers have a crucial role to play in helping to bring about the changes needed to improve the level of environmental literacy. Teachers also have an important role to play in helping to bring about the changes needed for sustainable development. The norms and standards in the COTEP document is an effort towards providing 'education for sustainability'. This can, to a great extent, lead to the development of environmentally literate citizens. From what is outlined in paragraph 3.2.3, it seems a major priority in the RSA is to reorient education towards sustainable development and an acknowledgement that environmental education is the "key to sustainability". Institutions of teacher education must establish structures which will enable students "to engage in constructivist, participatory and process-based approaches before they enter the profession as newly qualified teachers" (Shallcross & Wilkinson, 1998:253). Seemingly, very few academic programmes are involved in developing environmental literacy and in encouraging students to study sustainable development. Therefore, in teacher education, provision should be made for education for sustainability.

The inclusion of 'the environment' as a 'phase organiser' in C2005, indicates the need to develop environmental education learning programmes in teacher education that will prepare teachers to:

* mediate learning to address social, political, economic, and environmental issues.
* design learning programmes which integrate environmental concerns and which promote sustainable living.
* identify community environmental issues – to promote development and social justice and prevent further environmental degradation (UNESCO/DEA&T, 2000:2).

In 1995, in order to accomplish government policy and legislation, as mentioned earlier, the South African Qualifications Authority (SAQA) was established by the SAQA Act. The main task of SAQA is to implement National Qualifications Framework (NQF). Another function of SAQA is to legally establish the structures that approve and develop new qualifications in all 12 organising fields of learning (including Education, Training and Development – the field that includes teacher education). They are doing this through the establishment three types of structures:

* National Standard Bodies (NSBs)
* Standard Generating Bodies (SGBs)
* Education and Training Quality Assurance Bodies (ETQAs) (UNESCO/DEA&T, 2000:28).

Department of Environmental Affairs and Tourism (DEA&T) together with the Environmental Education Curriculum Initiative (EECI) are supporting the teachers and learners to address environmental issues and problems, prevent environmental damage, and develop sustainable living patterns. One of the initiatives of EECI is to support the growth of environmental education processes in teacher education. In 1996, an EECI Teacher Education Working Group (TEWG) was established to support teacher educators to interpret current policy changes and develop curricula to facilitate environmental learning in teacher education (UNESCO/DEA&T, 2000: 1-2). The main output of EECI is the development of the document: *Enabling Environmental Education Processes in Teacher Education* (UNESCO/DEA & T: 2000). This document intends to support all the educators to understand what is required of them in the new system that is currently undergoing transformation and restructuring. It attempts to explain:

* Why the environment has become such an important component of the present education system.
* How and why the education system is changing.
* What the format for qualifications in the new system should be.
* How concerns for the environment can be included in qualifications for educators.

(UNESCO/DEA&T, 2000:2). This document provides some guidelines on how to develop educators' programmes with an environmental orientation.

However, educators have identified a number of obstacles that are impeding the integration of information about environmental education in formal learning settings (Refer paragraph 1.3). In the context of education for sustainability, one obstacle is that the interdisciplinary content of education for sustainability does not easily fit into a discipline oriented educational process. Other obstacles are the lack of general agreement among professional educators that education for sustainability is a priority and there is insufficient professional preparation for teaching the core content of sustainability issues. Still another challenge for educators is finding ways to incorporate diverse cultural perspectives. There is also a decline in fiscal support that limits efforts to advance education for sustainability. In this context, Shallcross & Wilkinson (1998:243) argued that "without teachers who are confident in the practice of education for sustainability and are committed to value systems which support this approach, education for sustainability is unlikely to materialise in schools". New approaches to learning may offer significant benefits if the benefits of teaching education for sustainability are understood. Professional training is needed to enable teachers to introduce new curricula and methods into the classroom.

In the following paragraphs, an overview of the potential of environmental literacy as a vehicle to realize the educational agenda of sustainable development is provided.

3.3 Environmental Literacy and Education for Sustainability

As outlined in paragraph 2.2.1, environmental education is a process in which individuals gain awareness of their environment and acquire the knowledge, values, skills, experiences and also the determination which will enable them to act individually and collectively to solve present and future environmental problems. Many definitions of environmental education also stress the holistic nature of the environment, encompassing the cultural, socio-economic, and biophysical aspects. Environmental education is also regarded as human centred, concerned with changing attitudes and values and to develop the skills necessary to manage the environment and improve the relationship between human society and the environment in an integrated and sustainable way. If environmental education is considered as the key to sustainability, how can prevention be effective without the essential elements of environmental education (awareness, knowledge, skills and the determination to act)? Environmental education can play a major role in this learning process.

An awareness and appreciation of natural and built environment; knowledge of natural systems and ecological concepts; understanding of the range of current environmental issues; and the ability to use investigative, critical thinking, and problem solving skills towards the resolution of environmental issues can be considered as the key to environmental literacy. In essence, environmental literacy can provide the elementary knowledge, skills, and motivation for people to participate in the solution, and anticipation of environmental problems, and so make their own contribution to sustainable development. There are strong similarities between definitions of environmental education (paragraph 2.2.1), environmental literacy (paragraph 2.3) and sustainable development. In the paradigm of sustainable development one would have to add to the definition ... as well as to meet their needs without compromising those of future generations.

The sustainable use of resources will depend greatly on citizens who are environmentally literate are able to use and manage resources effectively, and who can make decisions wisely. As noted in paragraph 2.3, development of environmental literacy is a step towards the maintenance of environmental quality and the quality of life. Environmental literacy is perhaps the most important influence in providing awareness, knowledge and skills, changing attitudes and behaviour in raising the quality of life through positive action. Arguably, sustainable development may not be achieved without the essential elements of environmental literacy namely, awareness, knowledge, attitude, skill, and determination to act. Seemingly, developing environmental literacy is an essential prerequisite for improving environmental quality and the quality of life.

It was noted in paragraph 2.4 that environmental literacy can have a positive effect on the behavioural patterns of humans and contribute to an improved environment. This view is supported by Hungerford & Volk (1990). There remains a considerable lack of awareness of the interrelatedness of all human activities and the environment, due to inaccurate or insufficient information. For example, how many people understand the devastation of the earth's ozone layer by chemicals such as chlorofluorocarbons (CFCs)? The assumption is 'not many people'. Yet, ozone depletion is one of the most serious environmental threats. Without accurate information, people will have difficulty in understanding how a hole in the atmosphere (kilometres away), could affect their lives. In this context, public sensitivity to environment and development problems must be increased, along with a sense of personal responsibility and greater motivation and commitment towards sustainable development.

Environmental Education has an important role to play in motivating and empowering people to participate in environmental improvement and protection. Environmental Education is vital to ensure that people learn, accept and live by the principle that living sustainably depends on accepting a duty to seek harmony with other people and with nature. It was noted by UNESCO/UNEP (1988:3) that there is "no greater contribution or more essential ingredient for the long-term environmental strategies for environmentally sound, sustainable development ... than environmental education and training of successive generations". Many aspects of environmental education and environmental literacy contribute to education for sustainability. Environmental education has been recognized as crucial to creating awareness to sustainable development. It was also noted that developing environmental literacy may be the right step "for the greatest good, for the largest number, for the longer time" (Sarkar, 1997:97). Environmental literacy is needed to ensure that all have a chance to develop awareness, knowledge, understanding, attitude, skills, ethic and commitment to allow them to guide their own behaviour towards the environment in a responsible manner required by the principles of sustainable development.

An important assumption is that environmental literacy should improve and sustain quality of life and quality of the environment. It may be for these reasons that some environmental educators (Schreuder, le Grange & Reddy, 1999:127) have redefined environmental education in the 1990s as education for sustainability. This is because environmental education is seen as one of the "cornerstones for education for sustainability" (Shallcross

& Wilkinson, 1998: 243). According to Shallcross & Wilkinson (1998) "environmental education for sustainability as an approach not only seeks immediate environmental improvement but also aims for sustainable development in the long term".

Tilbury (1995:209) outlined the six components of environmental education for sustainability. That is, relevance, holism, values education, issue-based approach, participation and action, and critical education. These components are based on the guiding principles of environmental education as outlined in Chapter 2. Tilbury (1995:206-207) further outlined a threefold approach and a futures dimension to the study of environment and development problems. According to Tilbury (1995:206-207; 1998:135) environmental education for sustainability requires a threefold approach to the study of environmental concerns - education *about / in / for* the environment.

The integration of the threefold approach (Tilbury, 1995) and the cross-curricular model (Shallcross & Wilkinson, 1998) may contribute to the education of the whole person and hence should become part of education for sustainability. Therefore, it is imperative to ensure that learning programmes should include developing environmental awareness, knowledge, values, concern, responsibility and action. Such learning programmes should be cross-curricular and should be a whole school approach. Ideally, courses with social, economic and environmental content should be accompanied by interdisciplinary subject matter on sustainability, which draws from a number of content disciplines. To the possible extent, the curricula should reflect the interconnections among disciplines that are central to sustainable development. The benefit of this approach is that sustainable development is an ideal organising theme for encouraging integrative thinking. To support this kind of experience, existing education standards may need to be revisited to embrace the major elements of sustainable development.

There is a strong relationship between environmental literacy and sustainable development. There are possibilities for including some important concepts based on the aims, goals and principles of sustainable development in the development of the questionnaire to measure the environmental literacy of teachers in this study.

3.4 Conclusion

Environmental education can be seen to consist of the incorporation of the principles of sustainable development in the teaching/learning situation. Environmental education constitutes both a precondition and a tool in effective implementation of sustainable development. The relationship between sustainability and development is complex and contradictory. The meaning ascribed to the concept sustainable development by different professionals varies a great deal. Sustainable development can be defined as a process of economic growth and other activities that do not deplete natural resources upon which the present as well as the future economic growth depends. In essence, sustainable development means raising the standard of living of the people without incurring uncompensated costs to future generations.

For sustainable development to be effective there must be appropriate environmental education strategies which provide people with the necessary knowledge, attitudes and skills which will enable them to use and manage their natural resources, at the same time maintaining environmental quality in such a way as to provide for future generations. Without the development of environmental literacy, resources will continue to be used unsustainably. Through education for sustainability better lifestyles can be achieved; respect and responsibility for the environment and for each other could be learned; natural resources for sustainable living could be protected and preserved; and all the people can work together to increase the quality of life for our generation and the generations to come. The well-being of all future generations depend on the skill and effectiveness with which we inform and inspire the knowledge base and values of those students currently in our education system. Therefore, a sustainable society is entirely dependent on having a generation of environmentally literate and responsible citizens. If sustainability is to be achieved, educators should take a leadership role, breaking new ground to prepare a society for an age of accelerating change in a world of increasingly diverse and growing population, an expanding economy, and changing global environments.

In chapter 4, an attempt is made to explain the term 'concept'. The development of concepts which are important for environmental literacy is also made. The concepts and subconcepts related to environmental literacy and sustainable development can be used in the development of the instrument to measure the level of environmental literacy.

CHAPTER 4

DEVELOPMENT OF CONCEPTS IMPORTANT FOR ENVIRONMENTAL EDUCATION AND ENVIRONMENTAL LITERACY

4.1 Introduction

There cannot be much doubt that the concepts held by people have a strong influence upon their attitudes, decisions, and ways of solving problems. It can be assumed that knowledge of concepts in matters affecting the environment is important to maintain quality of the environment and quality of life. According to Brody (1990-91:25) the 'comprehension and acceptance of concepts that are intelligible and rational can lead to a change in the meaning of experience for the learner'. The question is what is the exact meaning of the term 'concept' and which concepts are important for environmental education and environmental literacy.

It seems there are different views about concepts in general and concepts in environmental education in particular. In this chapter, the main focus will be to explain the term 'concept' and to develop concepts which are important for environmental education and environmental literacy. In the following paragraph an effort is made to define a 'concept'.

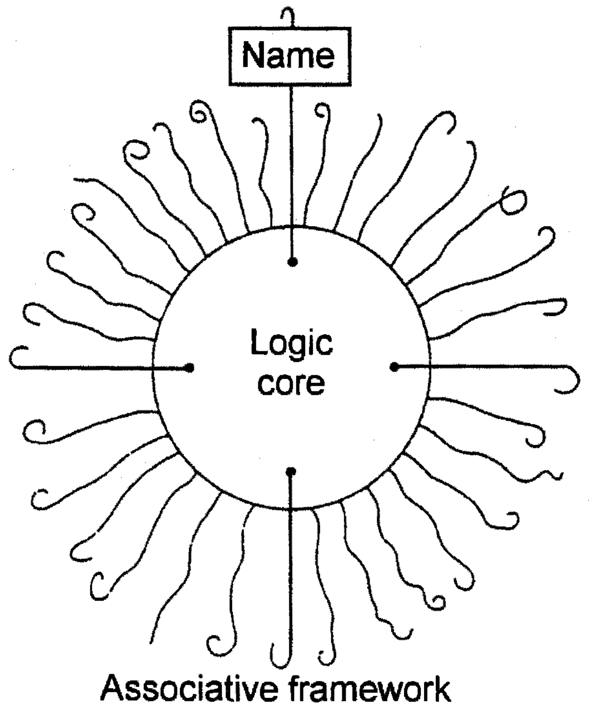
4.2 Definition of a 'Concept'

Before formulating the concepts important for environmental education and environmental literacy, it is necessary to define the term 'concept'. Do concepts have meanings? There exists some uncertainty as regards the exact meaning of the term 'concept'. Some of the views by some authors are outlined. According to Hill (1971:18) a concept may have "meaning by virtue of what is implied by its being true of something. A concept may have some meaning and also a name". A similar view is expressed by Bolton (1977) to whom a concept is an "expression through an agreed symbol of a particular meaning and which can be given a name". Chou & Roth (1995:36) noted that a concept is a way of grouping objects or events in terms of essential similarities. According to Schaefer (1979:88) a concept has something to do with an abstract structure of properties that is characteristic for a certain class of objects, events or phenomena. For example, the concept "life", "growth", "energy", "health", and the like. The concept "life", for example, has characteristics such as growth, reproduction, respiration, nutrition, excretion, locomotion, and irritability. Each one of these characteristics is further different in various groups of plants and animals. For example, there are different modes of nutrition (autotrophic, saprophytic, parasitic, insectivorous, etc.) in plants. Ausubel, Novak & Hanesian (1978:89) has defined concepts as "objects, events, situations, or properties that possess common criterial attributes and are designated in any given culture by some accepted sign or symbol or a name". For example, an owl, a sparrow and a duck bear similarities, as they are all "birds". It can be assumed that the term 'concept' refers to a mental representation that determines how entities are related. It seems that words are used to label concepts. According to Norris (1982:11) concepts are basic ideas and are abstractions of concrete events. Norris (1982) further noted that concepts are generalizations about particulars such as cause-effect, duration, dimension, attributes, and continua of phenomena or objects.

According to classical theory of concepts, each concept has a set of necessary and sufficient features that defined the concept (McShane, 1991:127). They share one or more common properties. McShane (1991:130) noted that instances of a concept share many features in common with other instances but no one set of features is common to all instances. The evidence against classical theory of concepts is that few concepts possess defining features.

Schaefer (1979:88-90) used the 'Bur' model to explain a concept. The 'Bur' model is shown in Figure 8.

Figure 8: 'Bur' Model of a Concept (Schaefer, 1979:89)



According to the 'Bur' model, a concept consists of three essential parts:

(1) The logic core of the concept, with hairs and hooklets, is the invariant representative of a certain class of things or events.

(2) Associated with the logic core there is a name. The name serves both as a vehicle for communication between individuals and as a label for effective memorization within the individual.

(3) Surrounding the logic core and additional to the associated name, there exists a tight network of further associations, the associative framework (Schaefer, 1979:88-90).

All three parts of a concept serve as attaching points for certain life situations so that the concept can be remembered and applied adequately. A concept is understood as having a logic core (an internal structure), which is surrounded by an associative framework, to which also the name (a word or symbol or the label) of the concept belongs. The name is an important determinant of a concept.

In most instances it is difficult to define a concept. A concept has personal meaning and a name (a word or symbol or the label) attached to it. In some instances, specific language or words are used to express concepts. For the purposes of this study, a concept is defined as a basic idea (central concept), with a name and have some features in common but may be different in some instances.

The importance of concepts in environmental education and environmental literacy cannot be overemphasised. Ramsey & Rickson (1976:10) stressed that knowledge of biological and ecological concepts is important in maintaining environmental quality. A similar view is expressed by Munson (1994). According to Munson (1994:30) an environmentally literate person should be able to use and apply the basic ecological concepts when considering environmental problems or issues. The knowledge of biological and ecological concepts is very important to maintain and improve the quality of the environment and quality of life.

The catch-phrase "concept rich and content light" (Munson, 1994) is relevant in this context. It indicates the importance of concepts in the teaching/learning situation. It also means that meaningful understanding of concepts in environmental education which can be applied in real life situations are essential to conserve, manage, develop and utilise natural resources. Knowledge of concepts in environmental education will equip all citizens to make sound judgements and to take appropriate action that will contribute to the sustainable development of human society and the environment. This is necessary to make sense of the world and to ensure the survival of the local, national and global environments. Knowledge of concepts can also have an influence on the behaviour patterns of people towards the quality of the environment. It is important to note that knowledge of environmental concepts can influence citizens to interact with the environment in an environmentally responsible manner. An understanding of concepts and interrelationships between concepts can provide increased support for curriculum development at various levels of the education system which can lead to an improvement in the quality of the environment and quality of life for all. Environmental education is the tool for developing environmental literacy. Hence, concepts are very important in environmental education and to foster environmental literacy of all citizens. Therefore, it can be argued that an environmentally literate person should have a meaningful knowledge of concepts.

There are many biological and ecological concepts which are important for environmental education and environmental literacy. These concepts can be identified from three major areas, the environment, environmental problems, and prevention of environmental problems. For the purposes of this study, a concept related to environmental literacy is defined as a basic idea (central concept) with a name (a key word) and have some features in common but may be different in some contexts. For example, interrelationships in the ecosystem is the basic idea, and the key words are food chain, food web, pyramid of numbers and biomass, producers, consumers (herbivores, carnivores) and decomposers which share some common features for the transfer of energy. There are many concepts which are important in environmental education and environmental literacy. The concepts related to environmental literacy are provided in Table 6.

In the following paragraphs an effort is made to formulate concepts important to environmental education and environmental literacy.

4.3 Development of Concepts Important to Environmental Education and Environmental Literacy

As noted in paragraph 4.2, there are many concepts which are important to environmental education and environmental literacy. The concern is whether words such as concepts, issues, concerns, threats, problems, terms, and topics that are used by many authors in environmental education literature have the same meaning. It seems the meaning of these words are different for such authors. For example, biodiversity is a concept to Wals & van Weelie (1997:4) but is an environmental issue to Palmer, Suggate & Matthews (1996:301). For some, conservation of resources, carrying capacity, and predator/prey interactions are concepts (Munson, 1994:31). For others, overpopulation, soil erosion, and desertification are environmental problems (Mabogunje, 1995:4). While for some others ozone layer and its depletion is an environmental issue (Boyes, Chambers & Stanisstreet, 1995:133). For Palmer, Suggate & Matthews (1996:301) deforestation is an environmental issue. Brody (1990-91:25) mentioned population growth as a topic and pollution as a concept. Roth (1992:37-38) recognized the difference between terms, concepts and events to be understood by environmentally literate citizens. Even when people mention concepts, issues, concern, threats, problems, terms, topics, they are all aspects very important to environmental education and environmental literacy. It can be assumed that there is a close link between words such as problems, issues, etc. used by many people. However, there is no general agreement as to which concepts are important for environmental education. This poses serious problems in the formulation of concepts for this study. As there is disagreement on concepts important to environmental education and environmental literacy, it is necessary to develop concepts to achieve the aims of this study.

In the United States of America (USA), substantial progress has already been made in identifying basic concepts that can be used in environmental education at different levels. Most of these studies were conducted before the 1990s (Chou & Roth, 1995:36). It was very difficult to obtain this information from the available literature. In the following paragraphs, basic concepts identified by Munson (1994), Odum (1992), Roth (1992) and Loubser (1994) are outlined.

Munson (1994:31) outlined the 20 most important ecological concepts (in Table 2) from a 50-item list by Cherrett (1989). Munson (1994) is of the opinion that these ecological concepts would be recognized and endorsed by most environmental educators as concepts essential to environmental literacy. This is because ecology forms the foundation for environmental education. Therefore, it can be argued that an environmentally literate person should have a meaningful knowledge of these important ecological concepts.

Table 2: The 20 most important ecological concepts (Munson, 1994:31)

No	Concept	No	Concept
1	The ecosystem	11	Food webs
2	Succession	12	Ecological adaptation
3	Energy flow	13	Environmental heterogeneity
4	Conservation of resources	14	Species diversity
5	Competition	15	Density dependent regulation
6	Niche	16	Limiting factors
7	Materials recycling	17	Carrying capacity
8	The community	18	Maximum sustainable yield
9	Life history strategies	19	Population cycles
10	Ecosystem fragility	20	Predator/prey interactions

Odum (1992) from the University of Georgia, Athens, developed a list of 20 great ideas in ecology that might be included in courses designed to improve environmental literacy. According to Odum (1992), concepts such as the ecosystem, human ecology and the relationships between ecology and economics mainly focus on environmental literacy. The 20 great ideas in ecology are indicated in Table 3.

Table 3: The 20 great ideas in ecology (Odum, 1992:542-544)

Concept 1: An ecosystem is a thermodynamically open, far from equilibrium, system.
Concept 2: The source-sink concept: one area or population (the source) exports to another area or population (the sink).
Concept 3: In hierarchical organization of ecosystems, species interactions that tend to be unstable, nonequilibrium, or even chaotic are constrained by the slower interactions that characterize large systems.
Concept 4: The first signs of environmental stress usually occur at the population level, affecting especially sensitive species.
Concept 5: Feedback in an ecosystem is internal and has no fixed goal.
Concept 6: Natural selection may occur at more than one level.
Concept 7: There are two kinds of natural selection, two aspects of the struggle for existence: organism versus organism, which leads to competition, and organism versus environment, which leads to mutualism.
Concept 8: Competition may lead to diversity rather than to extinction.

Table 3: Continued...

Concept 9: Evolution of mutualism increases when resources become scarce.
Concept 10: Indirect effects may be as important as direct interactions in a food web and may contribute to network mutualism.
Concept 11: Since the beginning of life on earth, organisms have not only adapted to physical conditions but have modified the environment in ways that have proven to be beneficial to life in general.
Concept 12: Heterotrophs may control energy flow in food webs.
Concept 13: An expanded approach to biodiversity should include genetic and landscape diversity, not just species diversity.
Concept 14: Ecosystem development or autogenic ecological succession is a two-phase process.
Concept 15: Carrying capacity is a two-dimensional concept involving number of users and intensity of per capita use.
Concept 16: Input management is the only way to deal with nonpoint pollution.
Concept 17: An expenditure of energy is always required to produce or maintain an energy flow or a material cycle.

Table 3: Continued ...

Concept 18: There is an urgent need to bridge the gaps between human-made and natural life-support goods and services and between non-sustainable short-term and sustainable long-term management.
Concept 19: Transition costs are always associated with major changes in nature and in human affairs.
Concept 20: A parasite-host model for man and the biosphere is a basis for turning from exploiting the earth to taking care of it.

Roth (1992:37-38) identified about 135 terms and concepts to be understood by environmentally literate citizens. They are provided in Table 4. Most of them are ecological terms or concepts. Roth (1992) did not provide a clear distinction between terms and concepts important for environmental literacy. At the same time, the list of 135 terms and concepts are too many to be used for assessment of environmental literacy for this study. Too many terms and concepts can increase the length of the questionnaire and may affect the response rate of the questionnaire. Roth (1992) also noted some major environmental events such as Earth day, Bhopal, Chernobyl, and polar ozone holes to be understood by nominally environmentally literate citizens.

Table 4: Some terms and concepts to be understood by environmentally literate citizens

Environment	Food chain	Water cycle	Biological potential
Ecology	Food web	Limiting factor	pH
Ecosystem	Species	Ground water	Photosynthesis
Resource	Scavenger	Water table	Condensation
Production	Population	Precipitation	Extinction
Scarcity	Interactions	Diversity	Competition
Nuclear energy	Mortality rate	Birth rate	Depletion
Weather	Herbivore	Carnivore	Omnivore
Oxygen	Parasite	Energy	Conduction
Acid rain	Carrying capacity	Conservation	Global warming
Siltation	Interdependence	Green house effect	Smog
Sewerage	Consumption	Ozone layer	Erosion
Desertification	Radiation	Solid waste	Toxic wastes
Decomposers	Climate	Nutrients	Leaching
Fisheries	Carbon dioxide	Irrigation	Pesticides
Land use	Weathering	Growth	Microbes
Pollution	Sanitary land fill	Biological control	Exponential growth
Wild life	Natural heritage	Strip-mining	Industrialisation
Life styles	Green revolution	Niche	Rural
Urban	Suburban	Famine	Development
Atom	Half life	Aquifer	Mutation
Sustainable yield	Biocentricity	Entropy	Succession planning
Technology	Legislation	Thermal inversion	Endangered species
Environmental resistance	Land use management	Sustainable development	Environmental quality

To determine the levels of knowledge of teachers in the RSA, Loubser (1994) used ten key concepts which should be known by all environmentally literate individuals. According to Loubser (1994) the ten key concepts correspond with concepts selected by other authors and institutions such as Ontario Ministry of Education. The ten key concepts are indicated in Table 5. The first sentence is usually the main concept.

Table 5: Ten key concepts which should be known by all environmentally literate individuals (Loubser, 1994: 37-38)

Concept 1: The earth as a closed system: the concept of ecosytem. Factors: sunshine, rain, temperature, wind, energy, soil, plants, animals, fungi. Everything is connected to everything else. Renewable/ Nonrenewable resources.
Concept 2: Human interaction within the environment: every action has an impact. Personal awareness of these impacts. Effect of consumer and market forces. Energy required to sustain current way of life: global warming.
Concept 3: Cycles: Natural cycles- water, nutrients, life-death, growth-decay, carbon- oxygen, etc. Cyclic interconnectedness. Cycles for consumer products: manufacture, use,.... competition, adaptation and succession are natural events. Energy flow is non cyclic: once it is used it is lost.
Concept 4: Interaction of economics, science (biology/chemistry/physics) and politics in environmental education: integration of learning about our world.

Table 5: Continued ...

Concept 5: Management of environment and resources for long-term sustainability. Efficient use of resources Harvesting: Plants and animals, domestic and wild population control/carrying capacity, prey-predator relationships. Farm/wildlife preservation as examples of a simplified ecosystem/shortened food chain. High productivity, modern technology and economic development must co-exist with a healthy environment.
Concept 6: Habitat: Importance of food, water, shelter, and space for personal/ human/ animal survival. Food is not magic: trace its path. Water is not magic: trace its path. Garbage and sewage disposal is not magic: follow it. A healthy, beautiful environment is a basic human need.
Concept 7: Food webs and chains: biological magnification and contamination.
Concept 8: Complexity of decision-making on environmental issues. Lack of precise information and knowledge of how the world works. Invisibility of many problems or damage: water pollution. Long-range and/or unintended effects.

Table 5: Continued ...

Concept 9: Hope: Natural rehabilitation and regeneration from environmental damage. "The environment is resilient but has its limits". Individuals can make a difference; success stories.
Concept 10: Personal commitment for the care and respect of the environment. Reduce, Reuse, Recycle, Rethink as a way of life. Environmental ethics in your job and family life. Minimize use of substances harmful to the environment: chemicals, pesticides, insecticides, CFC's and home products. Respect for all living things.

Roth (1992) identified knowledge, affect, skills and behaviour as the four strands important for environmental literacy. Mention was made of the four strands in paragraph 2.3.3. From the definitions of environmental literacy provided in paragraph 2.3 and according to Roth (1992:18) nominally environmentally literate individuals:

are familiar with:

* The nature of the basic components of living and non-living things.
* Types and examples of interactions between humans and nature.
* Basic components of social systems.

have affective sensitives about:

* Appreciation of both nature and society.
* Elementary sensitivity and empathy for both nature and society.
* Elemental perceptions of points of conflict between nature and society.

have skills:

* Identifying and defining problems.
* Recognizing issues surrounding identified problems or proposed solutions.

demonstrate:

* Organizational activities and habits aimed at maintenance of environmental quality.
* Responding and coping behaviours.

It must be noted that knowledge of biological and ecological concepts alone is not enough for environmental education and environmental literacy. There could be other concepts that can be added to the list outlined by Munson (1994), Odum (1992), Roth (1992) and Loubser (1994). Considering the specific conditions such as culture, level of education, and related elements in the RSA, these concepts could be modified. Therefore, for the purposes of this study 10 concepts related to environmental literacy were formulated from the definition of environmental literacy, the levels of environmental literacy, the characteristics of an environmentally literate person and an environmentally literate society as outlined in paragraph 2.3 and from the concepts outlined by Munson (1994), Odum (1992), Roth (1992) and Loubser (1994).

These 10 concepts were selected mainly from major areas such as ecology and interactions in the environment (concepts 1-6), participation in the identification and prevention of environmental problems (concept 7 & 8), decision making on environmental issues (concept 9), and environmental ethics (concept 10) which is important in developing environmental literacy. In most of these concepts there is a close link between knowledge, affect, skills and behaviour. Owing to the close relationship between the concepts it was very difficult to isolate the concepts as to which concept represents knowledge, affect, skills or behaviour. Researchers such as Hungerford & Volk (1990) and Sia, Hungerford & Tomera (1985/86) have indicated the interrelationship between concepts in environmental education, environmental literacy and responsible environmental behaviour. Therefore, concepts are grouped together as some features of concepts overlap with the other. The concepts related to environmental literacy selected for this study are indicated in 10 categories in Table 6. In each category, **the basic idea (central concept) is in bold** and *the subconcepts are in italics*.

Table 6: The concepts related to environmental literacy

No	Concepts
1	Basic understanding of the **biosphere** (air, water, and land) as the *life support systems* on which all living organisms *depend for habitability and survival.* Knowledge of *natural and man made environment.* Knowledge of *natural laws* and *principles of nature.*
2	Understanding of an **ecological perspective** of nature and human beings: *ecological concepts and principles, concepts of ecosystems.*
3	Awareness of *human interactions* with the environment and **interrelationships in an ecosystem**. Understanding of *natural cycles* and *energy flow* in the ecosystem. Knowledge of *food chain* and *food web.*
4	Knowledge of **environmental changes** brought about by *industrialisation, urbanisation.* Awareness of *population growth issues* and its *influence on resources,* population growth and *control,* and *problems of human settlement.* Awareness of *pollution* and *sewage disposal.*
5	Understanding of the activities to meet **basic human needs** and *wants* and *how it affects health, the environment, and quality of life.* Knowledge of *population-resource imbalances* and taking *action to correct such imbalances.* Knowledge of the *use of resources* and *minimise the use of substances harmful to the environment.*

Table 6: Continued ...

6	Awareness of *renewable and non- renewable* **resources**. Understanding the difference between actual and perceived risks from the *Destruction* of the environment and *exploitation* of natural resources and their *conservation*.
7	Knowledge of how to **maintain environmental quality** and *quality of life*. Knowledge of how *organizations*, and *groups of people contribute to environmental changes*.
8	An understanding about the **ability to make choices**. *Willingness to curtail individual privileges*. Awareness of *actions* that individuals can take to *protect the environment and public health. Personal commitment for the care and respect for the environment.*
9	Knowledge of **decision making on environmental issues** in scientific, economic, legal, social, and political contexts. Awareness of the *effect of consumer and market forces*, and reject *short term gains*. Knowledge of the relationships between high *productivity, modern technology, economic development and a healthy environment*.
10	Knowledge of **environmental ethics** as a way of life. *Respect for all living things*. Knowledge of ethical issues involved in *environmental protection and management*. Management of environment and resources for *sustainable development*.

The concepts outlined in Table 6, have a basic idea (indicated in **bold**), a name, and share some features due to the interrelationship between concepts and are different in some instances. This is according to the definition of a concept as outlined in paragraph 3.2. A concept has a basic idea, a name (a word or symbol or label), and shares some features and are different in some instances. Concept 1, for example, has the basic idea that all living organisms are dependent on the biosphere, natural and man made environment for their survival and share the habitat. In concept 2, the basic idea is ecology with the key words such as ecosystems, and related concepts and principles. The basic idea in concept 3, for example, is the interrelationships in the ecosystem. The key words with related features are natural cycles, energy flow, human interactions and interrelationships including food web and food chain. In concept 4, the basic idea is about environmental changes with the key word population growth issues which has many features in common such as pollution and sewage disposal. The important idea in concept 5, includes the impact of basic human needs on resources with key words population-resource imbalances. In concept 6, the basic idea is awareness of resources and the key words used are destruction, exploitation and conservation of resources. There is a link between concepts, as can be observed in concepts 1 to 6 as they are mainly concerned with ecology and interactions in the environment. In concept 7, the basic idea is participation and the key aspect is to maintain environmental quality which overlaps with concept 8 (the willingness and a commitment to act). In concept 8, the basic idea is the participation in the identification and prevention of environmental problems. The basic idea in concept 9, is about decision making on environmental issues. The key words are productivity, economic development, technology, and politics. Lastly, in concept 10, the emphasis is on the importance of an environmental ethic, an aspect important for sustainable development and also important to all 10 concepts outlined in Table 6.

The concepts outlined in Table 6, also possess aspects that could raise awareness, understanding, knowledge, attitudes, values, ethics, and skills to participate in the prevention of environmental problems and an urge to protect and improve the quality of the environment for the present and future generations. For example, awareness of human interactions with the environment and interrelationships in an ecosystem (concept 3), awareness of renewable and non-renewable resources (concept 6), awareness of population growth issues and its influence on resources, population growth and control, and problems of human settlement (concept 4), understanding of an ecological perspective of nature and human beings (concept 2), knowledge of natural and man made environment (concept 1), knowledge of the use of resources (concept 5), ability to make choices and willingness to curtail individual privileges (concept 8), awareness of the effect of consumer and market forces, and reject short term gains (concept 9), environmental ethics as a way of life and respect for all living things (concept 10), awareness of actions that individuals can take to protect the environment and public health (concept 8), and willingness to maintain environmental quality and quality of life (concept 7). These concepts, therefore, are in line with the definitions, aims, objectives and guiding principles of environmental education, the definition of environmental literacy, and responsible environmental behaviour as outlined in paragraphs 2.2, 2.3 and 2.4 respectively.

The 10 concepts related to environmental literacy indicated in Table 6 will be used in the development of the instrument in paragraph 5.3 to assess the level of environmental literacy of teachers from three provinces in the RSA.

4.4 Conclusion

A concept is understood as having a logic core, which is surrounded by an associative framework, to which the name of the concept also belongs. They have personal meanings and are difficult to define in most instances. A concept is defined as a basic idea, with a name and has some features in common but may be different in some instances. There are many concepts which are important in environmental education. However, there is no general agreement as to which concepts are important in environmental education and environmental literacy. Knowledge of biological and ecological concepts are important in environmental education and environmental literacy. This is because concepts that are intelligible and rational and can lead to a change in the meaning of experience. As environmental education is a tool to develop environmental literacy it is necessary to identify concepts important to environmental education and environmental literacy.

Ten concepts important to environmental education and environmental literacy were formulated. These concepts relate mainly to biological and ecological concepts. The concepts outlined in Table 6 will be used to develop an instrument to measure the level of environmental literacy of teachers.

Chapter 5 will focus on the selection of a measuring technique for measurement of environmental literacy, the development of an instrument for this purpose. The research design regarding the standardization of the instrument to measure the level of environmental literacy of teachers will also be outlined. Information on the process of data analysis will also be provided.

CHAPTER 5

DEVELOPMENT AND APPLICATION OF AN INSTRUMENT TO MEASURE ENVIRONMENTAL LITERACY OF TEACHERS

5.1 Introduction

This chapter will mainly focus on aims 3 and 4 as stated in paragraph 1.4. The emphasis will be on an investigation of possible methods to determine environmental literacy, describing the development and standardization of the instrument to assess the level of environmental literacy of teachers from selected schools in this study, selection of the sample, administration of the instrument, the major constraints in the development and use of the instrument developed to assess the level of environmental literacy of teachers in the three provinces (Northern Province, Mpumalanga Province, and North West Province) in the Republic of South Africa (RSA) and the procedure for analysing the data obtained from the instrument. Attention is also focussed on the formulation of the hypotheses to realise aim 5 as mentioned in paragraph 1.4.

5.2 Measurement of Environmental Literacy

One major constraint to the effective implementation of environmental education in schools is that there are few adequately trained teachers in environmental education. This is because environmental education is a new venture in teacher education in the RSA. Environmental education in teacher education was pioneered in the 1980s at the University of Bophuthatswana (now University of the North West) and its affiliated colleges of education (Irwin, 1990:6). Since then, several teacher education institutions (Rhodes University, University of Stellenbosch, University of South Africa, Rand Afrikaans University and others) have included environmental education as an optional module in teacher education (Irwin, 1993). It seems environmental education is not always a compulsory module in teacher education. As most of the teachers in the RSA are not trained in environmental education, it is expected that the environmental literacy of teachers is inadequate. In paragraph 2.3.3 mention was made of the three levels of environmental literacy - nominal, functional and operational. The need to assess the level of environmental literacy of teachers in the RSA was highlighted in paragraphs 1.2 and 1.3. Assessment of the level of environmental literacy of teachers is an important step that must be considered when an attempt is made to infuse environmental education into the curriculum at all levels and in all professions of the education system. Environmental literacy is assumed to exist as certain points along a continuum of competencies ranging from inability (zero), to sophisticated memory, to advanced skills (100). The question is whether it is possible to assess the level of environmental literacy of teachers. As this study is an investigation into the level of environmental literacy of teachers in the RSA, it is necessary to develop and apply methods to assess environmental literacy of teachers.

5.2.1 Preliminary Study

A preliminary study was conducted in February 1997 of 28 student-teachers from a College of Education, with biology as one of the major subjects. A questionnaire to measure the three levels (nominal, functional and operational as explained in paragraph 2.3.3) of environmental literacy of student-teachers with biology majors was developed. The instrument was divided into four parts: Part 1- Background information of student-teachers, Part 2- Nominal Environmental Literacy, Part 3- Functional Environmental Literacy, and Part 4- Operational Environmental Literacy. In this instrument, the questions and statements contain topics from ecology, various aspects of environmental education and the three levels of environmental literacy. At the nominal level the student-teachers had to indicate the awareness of important environmental terms. It must be noted that it is possible for a student-teacher to indicate that he or she is aware of all the terms. It was found that responses to multiple choice-type questions in Part 2-4 might have resulted in guessing in some cases. It was also noted that some student-teachers obtained better scores at functional level than at nominal level. At the same time, some others obtained better scores at the operational level than at the functional level. This is an indication that this instrument cannot discriminate those at the nominal, functional and operational level. There were no responses to some items, especially in Section A - background information. It seems that the student-teachers were reluctant to give certain personal information such as age group and gender as this would be used to identify them. The instrument used for the preliminary study failed to distinguish clearly between functional and operational literacy.

The results of the preliminary study were discussed at a round table during the Environmental Education Association of Southern Africa (EEASA) conference at Technikon Pretoria in July 1997 (Chacko, 1997). The comments from the participants during the EEASA '97 conference, have enabled the researcher to understand the advantages and disadvantages of the instrument and to make the necessary changes to the instrument. Some of the comments from the participants were that there is more emphasis on testing knowledge of ecology (content based) than environmental awareness and environmental literacy. Items in the questionnaire were effective but easy to guess owing to the multiple-choice items in part 2-4. Multiple-choice items might not be a true reflection of people's knowledge, and the questionnaire had some terms or items from geography. Some questions were also raised by the participants. For example, whether it is necessary to know terminology to understand the environment? What criterion is used in the selection of the items? The researcher had discussions with environmental educators who attended the EEASA '97 conference with regard to the validity and reliability of the instrument. It was noted by some of the participants that the questionnaire would be useful to discriminate student-teachers at the three levels of environmental literacy. They further noted that the questionnaires may be followed with interviews with the student- teachers to gain greater insight, especially in the sections where it can be difficult by means of this instrument alone, to verify the sincerity of verbal commitment to action in favour of the environment. As student-teachers of all subjects are effective vehicles for carrying out environmental education, the instrument had to be modified to suit all student-teachers despite their major subjects.

5.2.2 Research Reported from other Countries

Relatively little work has been done to assess the level of environmental literacy of teachers. The efforts to develop tools to assess environmental literacy were under development, but not yet implemented and validated. Wisconsin Department of Public Instruction (USA) has plans to assess environmental literacy of students and teachers (Lane, Wilke, Champeau & Sivek, 1994:9; Roth, 1992:28). Most of the existing instruments address only limited aspects of environmental literacy such as attitudes or cognitive skills and were designed for a one-time, specific use and do not lend themselves to ongoing assessment. According to Roth (1996 & 1998) "to assess environmental literacy is one that I have been wrestling with a great deal in the last few years. It is not a simple issue" (Personal communication).

In Indiana (USA), attempts have been made to assess the environmental literacy of teachers. Buethe & Smallwood (1987) developed an instrument that dealt with three major questions: (a) what important environmental vocabulary is known or unknown by teachers?, (b) how well known are environmental concepts that are directly related to the chosen vocabulary?, and (c) what are teachers' feelings about selected environmental issues? To establish a baseline of environmental literacy of teachers, Buethe & Smallwood (1987) focussed their efforts on teachers' familiarity with environmental and related terminology (only on limited aspects of nominal environmental literacy). In this study, the questionnaire was developed with inputs from five environmental experts, five university researchers from various fields and from other volunteers. Buethe & Smallwood (1987) concluded that the overall environmental literacy in Indiana teachers seems low. It was also found that science teachers had higher scores than other teachers. It was reported that there were many changes in the level of environmental literacy of teachers between 1975 and 1985 (Buethe & Smallwood, 1987). The only available information from the literature study was that mature, married, male secondary school science teachers had higher scores than other teachers (Buethe & Smallwood, 1987:41).

Abraham & Chacko (1999) developed an instrument to measure the nominal and functional levels of environmental literacy among college lecturers from affiliated colleges, University of Kerala, India. The instrument consisted of two parts. In the first part, there were 25 items. The items focussed on the following topics: water cycle, decomposers, mortality rate, ground water, carrying capacity, weathering, extinction, birth rate, sustainable development, toxic waste, biological control, environmental quality, Chernobyl, strip mining, food chain, monoculture plantations, green revolution, Rio summit, food web, sanitary land fill, net reproductive rate, exponential growth, pesticides and environmental resistance. The respondents had to indicate whether they were aware or not aware of the item. In the second part, 24 Likert-type items were included. All the items in the second part were general statements based on items in part one of the questionnaire. The questionnaire was submitted to five teachers and two lecturers for their comments. The respondents were requested to indicate on a 5-point scale whether they strongly agree, agree, neutral, disagree or strongly disagree with each one of the items. Responses in the questionnaires were individually analysed and the total scores were calculated. According to the scores obtained, the respondents were graded as "Literate" (above 80 per cent), "Aware" (50-79 per cent) and "Not aware" (below 50 per cent) in nominal and functional level of environmental literacy (Abraham & Chacko, 1999:6). This study revealed that college lecturers had only average levels of functional environmental literacy irrespective of the subjects they teach.

5.3 Development of the Instrument

Originally, the aim of this study was to assess the three levels of environmental literacy of biology teachers in Mpumalanga Province in the RSA. This aim had to be changed to assess the level of environmental literacy of all teachers in Mpumalanga Province. This is because teachers of all school subjects are vehicles for the implementation of environmental education and to foster environmental literacy in their students. Later it was decided to extend this study to the following three provinces: Northern Province, Mpumalanga Province, and North West Province in the RSA as this could help during sampling and data collection (as the researchers' place of residence and work was closer to these provinces). Therefore, one of the aims of this study was to develop and apply an instrument to measure the level of environmental literacy of teachers in the three provinces (Northern Province, Mpumalanga Province, North West Province) in the RSA. The question is whether it is possible to develop a reliable and valid instrument to measure the level of environmental literacy of teachers in the RSA.

The original intention of the present study was also to develop an instrument, which when presented to teachers, would separate the teachers into three categories - nominally, functionally, and operationally environmentally literate. Later, it was decided that it may be necessary to investigate environmental literacy of the teachers in this study without investigating the three levels (nominal, functional, and operational) of environmental literacy. This is because, in a developing country like South Africa, it seems most of the teachers are not trained in environmental education as environmental education is a new venture in teacher education in the RSA. Therefore, at this stage, a study on the three levels of environmental literacy of teachers might not be suitable as it is expected that environmental literacy of teachers is at a low level due to inadequate training in environmental education in teacher education.

As there was no suitable instrument available to achieve the aims of this study (as mentioned in paragraph 1.4) it has been necessary to develop an instrument to measure the environmental literacy of teachers in the RSA. It must be noted that the questionnaire developed for the preliminary study cannot be used to measure the level of environmental literacy of teachers as there was more emphasis on knowledge of ecology. Therefore, development of an instrument to measure the level of environmental literacy of teachers in the RSA will be discussed in the following paragraphs.

5.3.1 Selection of Measuring Instruments and Techniques

To obtain information regarding teachers' environmental literacy, the researcher could use certain measuring instruments such as questionnaires, interviews and observations. The merits and problems of using questionnaires, interviews and observations are investigated in the following paragraphs in order to select a particular measuring technique for this study.

5.3.1 (a) Questionnaires

The questionnaire is one of the most commonly used methods of obtaining information that cannot be obtained personally from a wide range of sources. According to Sax (1979: 233) by asking questions, responses can be obtained about the knowledge, values, preferences, interests, attitudes, opinions, judgement, behaviours, etc. of the respondents. Therefore, a questionnaire can possibly be regarded as a reliable instrument for collecting data for this study.

(i) Advantages of the Questionnaire

The following factors are important with regard to questionnaires:

* A questionnaire can be completed under supervision or independently.
* A properly compiled questionnaire is the best instrument available for obtaining information from a wide variety of sources (Sax, 1979:244).
* It can reach a large group of people simultaneously, who can complete it in their own time and then return it (Kerlinger, 1986:446; Mouly, 1978:189; Sax, 1979:244).
* It places less pressure on respondents because they can complete it in their own time.
* Questionnaires do not allow too much variation in responses and the data is comparable (Mouly, 1978:189; Sax, 1979:244). Because it is in writing and

is accompanied by clear instructions, greater uniformity is achieved.

* Open questions allow respondents to use their own language. The written data increases the reliability of the responses.
* It is easy to plan, compile, and administer. It can be administered by a research assistant. It can also be mailed to respondents (Cohen & Manion, 1985:304; Kerlinger, 1986:446).
* It is an economical way of collecting information, since they save time, inputs and costs (Cohen & Manion, 1985:304: Kerlinger, 1986:440; Sax, 1979:244).
* Questionnaires are impersonal. Information of a personal nature is often given, if respondents remain anonymous, or even if assurance is given that the information will be treated confidentially. If anonymous, greater honesty and frankness may be encouraged (Cohen & Manion, 1985:304; Kerlinger, 1986: 446).
* It tends to be more reliable because it is anonymous (Cohen & Manion, 1985: 304).

(ii) Disadvantages of the Questionnaire

The use of questionnaires poses some serious disadvantages.

* There is often too low a percentage of returns as respondents do not always complete and return them (Cohen & Manion, 1985:304; Kerlinger, 1986:446).
* Questionnaires that are not returned increase the likelihood of biased sampling (Sax, 1979:245).
* Those who respond are possibly more responsible people and may also be in favour of the research.
* The opinions of the non-respondents will always remain a mystery as non-respondents differ from respondents (Mouly, 1978:189).
* Some respondents regard questionnaires as unimportant and answer the questions haphazardly and without the necessary enthusiasm and seriousness.
* Questionnaires are also filled in hurriedly by some respondents (Cohen &

Manion, 1985:304).

* Questions about attitudes are more difficult to compile.
* The reliability and validity of a questionnaire is sometimes low, for it is sometimes difficult to control.
* If a question is incorrectly understood or the answer is incomplete, nothing can be done (Mouly, 1978:189).
* The same question has a different meaning for different people (Kerlinger, 1986: 446).
* They can be a poor way to determine emotions or sentiments. Emotions or sentiments are also difficult to express in writing.
* Many respondents prefer not to put controversial issues in writing (in open questions).
* Some fields of research are so sensitive, delicate, confidential or complex, that it is difficult to formulate questions about these matters.
* Many respondents fail to answer questions completely honestly. They answer in the way they think the researcher expects them to.
* If open questions are used, the respondents may be unwilling to write their answers for one reason or another (Cohen & Manion, 1985:304; Kerlinger, 1986:440; Mouly, 1978:189).
* Researchers cannot determine whether respondents are unwilling or evasive (Mouly, 1978:189).
* Questionnaires cannot be used for illiterate people, or young children (Sax, 1979:245) and present problems to people of limited literacy (Cohen & Manion, 1985:304).
* Questionnaires limit the opportunities for asking probing questions (Cohen & Manion, 1985:304).
* Questionnaires do not provide the investigator with sufficient opportunity to develop interest on the part of the respondent (Mouly, 1978:189).
* The motivation of the respondent is difficult to check (Sax, 1979:245).
* Long questionnaires may discourage respondents to ignore it.

* Placing response categories below one another requires a great deal of space, more paper, more money, more weight (more postage), and less return.
* The respondents can be influenced by the alternatives or choices the researcher gives them.

In spite of these disadvantages, the questionnaire remains an invaluable aid in many research projects. There is no doubt that the questionnaire plays a vital role in research and overcomes many difficulties in those cases where contact cannot be made between the researcher and respondents from a wider geographic area.

There are two types of questions, namely, unstructured (open), and structured (closed) questions very often used in questionnaires. In unstructured (open) questions, respondents are free to answer in their own words to reveal their thoughts and can give reasons for their responses. A major problem is that unstructured (open) questions are often difficult to score, interpret, analyse, tabulate and summarise in the final report. It is also a time-consuming and difficult process to form categories from handwritten responses from relatively large samples. At the same time, some responses may show no uniformity with other responses. In addition, questionnaires requiring written responses to open-ended questions take a lot of time and assume that respondents can express themselves adequately in writing.

On the other hand, structured (closed) questions, are worded in such a way that short, concise answers can be given from a number of alternatives or choices given. This limits the number of answers that can be given. This type of questions is easy and convenient to complete, less time consuming, confines respondents to the questions, and is relatively objective and acceptable. It is also legible, easy to tabulate, analyse and is less open to misinterpretation. The main advantage of the structured question is that all respondents answer the questions within certain limits and according to the same frame of reference that is relevant to the aims of the study (Maher & Kur, 1983:100). However, a major problem with closed questions is that the respondents may guess the answer rather than giving his or her own response. Another problem is that sometimes the researcher has not included all the possible alternative responses or too many alternative responses can frustrate the respondents.

From experience, to a large number of respondents, a closed-ended question format is generally acceptable as compared to open-ended questions. This may be because closed-ended questions can be answered by a tick or cross and the coding and statistical analysis take less time and effort. However, in a questionnaire both closed and open ended questions can be combined.

5.3.1 (b) Interviews

The interview is a direct method of gathering information through verbal interaction between individuals (Cohen & Manion, 1985:291; Sax, 1979:232). In this sense, it differs from questionnaires where the respondent is required to record in some way his responses to set questions. The interview is flexible and is ideal for acquiring information that is complex and personal and is adaptable to individual situations (Kerlinger, 1986:440; Sax, 1979:233). However, Behr (1983:145) cautions that too flexible an approach can lead to bias. To overcome this it is necessary to structure the interview to a certain extent. Vague or incomplete answers can be followed up immediately.

Two kinds of interviews commonly used are considered. A structured interview is one in which the content and procedures are organised in advance. The interview schedule determines the course of the interview and that the researcher is in control. The interview schedule contains the questions to be asked and space for recording the answers (Cohen & Manion, 1985:293; Kerlinger, 1986:446). One advantage is that a uniform approach can be followed (as the interviewer is left with little freedom to make modifications) which increases the validity and reliability of the information obtained (Kerlinger, 1986:446).

In unstructured interviews, the questions appear to arise spontaneously from the conversation. It is an open situation having greater flexibility and freedom (Cohen & Manion, 1985:293). Therefore, the respondents have the opportunity to question items presented to them.

(i) Advantages of the Interview

The interview has a number of advantages.

* Lack of response due to inability of the respondent to understand the questions can be reduced, if not eliminated (Engelhart, 1972:108).
* It allows for an "in depth" discussion as opposed to other methods of data collection (Cohen & Manion, 1985:292; Engelhart, 1972:97). Therefore, misunderstandings can be cleared up immediately (Mouly, 1978:207).
* It makes it possible to measure knowledge, values and preferences, feelings, attitudes and beliefs, perceptions and intentions of a person (Cohen & Manion, 1985:291-292; Kerlinger, 1986:446; Sax, 1979:233). It is also a useful means of obtaining personal information (Sax, 1979:233) and in probing attitudes and motives of respondents (Mouly, 1978:203).
* Questions about hopes, aspirations, and anxieties can also be asked in such a way as to elicit accurate information (Kerlinger, 1986:440).
* It reduces anxiety so that potentially threatening topics can be studied (Sax, 1979:233).
* If a respondent finds it difficult to understand a question, the interviewer can, within limits, repeat or rephrase the question (Kerlinger, 1986:440; Sax, 1979: 233). At the same time, inconsistent or vague replies can be questioned (Sax, 1979:233).
* It can be used with young children and illiterates (Sax, 1979:233).
* It allows freedom to respond in any manner the respondents see fit (Sax, 1979: 233).

* It allows interviewers to observe non verbal as well as verbal behaviour (Sax, 1979:233).
* It may be used as the principal means of gathering information having direct bearing on the research objectives (Cohen & Manion, 1985:292).
* It can be combined with other methods in a research undertaking (Cohen & Manion, 1985:293).

(ii) Disadvantages of the Interview

The interview has a number of disadvantages as well.

* It is a time-consuming process which can only reach a few respondents each day (Kerlinger, 1986:440).
* It demands careful preparation and much practice (Kerlinger, 1986:446) and a great deal of insight and adaptability on the part of the interviewer (Mouly, 1978: 203).
* The cost of collecting data is more than the use of the questionnaire (Engelhart, 1972:97; Kerlinger, 1986:440).
* The presence of the interviewer could affect the response (Mouly, 1978:207).
* Personal values, beliefs, and biases of interviewers can influence responses (Sax, 1979:234).
* It is prone to subjectivity and bias on the part of the interviewer (Cohen & Manion, 1985:292; Mouly, 1978:203).
* The recording of responses during the interview may break the continuity of the interview and may result in bias, because the interviewer may unconsciously emphasise responses that agree with his expectations and fail to note those that do not (Cohen & Manion, 1985:304; Mouly, 1978:206).
* The recording of responses at the end of the interview is likely to induce greater bias because the delay may lead to the interviewer forgetting some of the details. The forgotten details are most likely to be the ones that disagree with the

expectations of the interviewer (Cohen & Manion, 1985:304; Sax, 1979:237).

* Unstructured interviews often yield data that are difficult to summarize, categorize, and evaluate (Sax, 1979:233).
* The possibility to generalise the results is limited.

The interview is a direct method of collecting data. It makes it possible to elicit accurate information. It is also useful to measure knowledge, values, feelings, attitudes, beliefs, hopes, intentions and aspirations of the respondents. The major disadvantages are that the interview is a time-consuming process as it requires careful preparation and practice. The data obtained from interviews are difficult to summarize, categorise and evaluate. However, interviews can supplement and validate other methods.

5.3.1 (c) Observations

Observations are the principal means of collecting data in descriptive survey research (Leedy, 1985:134). One can identify meaningful actions of people, such as specific behavioural patterns, by means of systematic and detailed observations. Observation of behaviour is used to obtain descriptive information and frequently to supplement or confirm data obtained by other methods (Reid & Smith, 1981:223). According to Thierauf & Klekamp (1975:33) observation may be a casual glance or a concentrated, detailed, and lengthy one based upon the requirements of the problem under study. The purpose of observation is to probe deeply and to analyse intensively the multifarious phenomena of the life cycle of a unit (a child, a class, or a school) with a view to establishing generalisations about the wider population to which that unit belongs (Cohen & Manion, 1985:120).

There are two principal types of observation - participant and non-participant observation. In the former, the researcher engages in the very activities he/she sets out to observe. As far as the other participants are concerned, the researcher is simply a member of the group. A non-participant researcher on the other hand, stands aloof from the group activities he/she is investigating and has nothing to do with group membership. According to Cohen & Manion (1985) the type of observation is associated with the type of setting in which the research takes place.

(i) Advantages of Observation

* Observation studies are superior to experiments and surveys when data are being collected on non-verbal behaviour.
* In observation, the investigator is able to discern ongoing behaviour as it occurs and is able to make appropriate notes about its salient features.
* Because observations generally take place over an extended period of time, the researcher can develop a more intimate and informal relationship with those he/she is observing, generally in more natural environments than those in which experiments and surveys are conducted.
* Observations are less reactive than other types of data-gathering methods (Cohen & Manion, 1985:124-125).
* Observation provides the researcher with direct access to phenomena under study which would probably yield more objective and systematic data.
* By careful observations, distortions inherent in reported data can be eliminated (Reid & Smith, 1981:224)

(ii) Disadvantages of Observation

* Observations are often described as subjective, biased, impressionistic, idiosyncratic and lacking in the precise quantifiable measures. (Cohen & Manion, 1985:125).
* Recording of observations is a frequent source of concern to the inexperienced observer.
* Direct observation may require a considerable investment of time and money.
* Participants may make a special effort to conform to the researchers=

expectations because of the presence of the researcher (Reid & Smith, 1981: 333).

* In participant observations, awareness of being watched and that their actions may be reported may affect the actions of the participants (Babbie, 1973:38; Black & Champion,1976:158).

Observation provides direct access to phenomena under study (e.g. behaviour) and would yield more objective and systematic data. Observations may be used to eliminate distortions inherent in reported data. Among others, the major disadvantage is that observations demand more time and money.

From the information gathered on the advantages and disadvantages of questionnaires, interviews and observations it seems a fairly precise and accurate measurement is impossible in educational measurement. In questionnaires, interviews and observations inaccuracies may arise. These barriers cannot be overcome completely. However, the interview can supplement and validate other methods, and go deeper into motivations of respondents and their reasons for responding as they do (Kerlinger, 1986:440). A combination of questionnaires and interviews is generally better than the exclusive use of one (Maher & Kur, 1983: 102). According to researchers such as Cohen & Manion (1985:293) and Sax (1979:233) both questionnaires and interviews are a means of eliciting feelings, beliefs, experiences and attitudes, in either in a structured or relatively unstructured way. Therefore, the use of a questionnaire to assess the level of environmental literacy of teachers in this study is justifiable on the grounds that it can be used to obtain information on attitudes, values, judgement, behaviours, etc which are important in environmental education and environmental literacy. Bester (1999) is of the same view.

It seems the level of environmental literacy of teachers can be determined by direct and indirect observation of their behaviour. This includes direct self-reported performance of behaviour (Koballa, 1984:710; Shuman & Ham, 1997:25; Smith-Sebasto & Smith, 1997:27); intention of a person to engage in a given behaviour (Shuman & Ham, 1997:25); and observation of classroom activities with the students (Smith-Sebasto & Smith, 1997:27). According to Roth (1992:15) the level of environmental literacy can be determined if people should be able to demonstrate in an observable form a continuum of competencies of such as understanding, skills and actions. Environmental literacy focuses on developing an in-depth understanding of the relationship between human activity and the environment and in forming the skills needed to make decisions and take actions to maintain, restore, or improve environmental conditions. Then, it may be necessary to determine what the teachers in this study know regarding the environment; how they feel about it; what commitments they are willing to make; and what commitments they do make. According to Roth (1992:15) a person's level of environmental literacy should be assessed with the cognitive (knowledge), affective (feeling) and the psychomotor (action) domain in mind. Shuman & Ham (1997:25) noted that both direct observation of the behaviour and self-reported performance of behaviour have been shown to produce accurate measures of behaviour. They further noted that intention is a measure of the likelihood that a person will engage in a given behaviour. According to Koballa (1984:710) direct self report measures by respondents are a better method of studying attitude change than indirect procedures. Therefore, it can be expected that verbal commitment by teachers in this study should be seen as a strong intention for action. According to Smith-Sebasto & Smith (1997:27) the level of environmental literacy of teachers might be inferred from the content of the activities with the students and from reports of own behaviour. It was noted that behaviour is seen to be predicted by behavioural intention, which can be assessed by the use of a questionnaire (Shepherd & Farleigh, 1986:344; Towler & Shepherd, 1992:16). Therefore, in this study, direct self reported performance of behaviour and intention to engage in a given behaviour by the teachers will be used to assess the level of environmental literacy of teachers.

For this study, the researcher identified the questionnaire as the most suitable measuring instrument. The assumption is that information required for this study is not obtainable in more reliable and valid ways than the use of the questionnaire.

5.3.1 (d) The Questionnaire for the Study

As noted in the previous paragraphs, a questionnaire can be used to obtain information on awareness, knowledge, attitudes, values, judgement, behaviours, etc which are important in environmental education and environmental literacy. In many studies in environmental education, for example, Bogner & Wiseman (1997), Chan (1996), Ryan (1991), and Thompson & Gasteiger (1985), questionnaires were used to investigate awareness, knowledge, attitude, concern, behaviour, etc of the respondents. It must be noted that the success of the questionnaire used to gather data will depend on the open, honest views and frank opinions provided by the respondents. However, the openness of the respondent can be inhibited by ego, fear, misunderstanding, social expectations, etc. To encourage openness, accuracy, and a better return of the questionnaire, anonymity was guaranteed to all respondents. Even if the respondents do respond honestly to a questionnaire, Rotondi (1989:92) noted that the respondents may deliberately falsify demographic data (personal income, job category, age, seniority, gender, educational level) in an attempt to preserve anonymity. This is likely to occur if respondents have expressed negative viewpoints. This type of information is very difficult to be corrected. Some respondents may even feel that their handwriting or particular expressions would be used to reveal their identity. Therefore, closed response categories were used to provide much more anonymity than using open questions. Thus, reducing the risk of obtaining unreliable information from the respondents.

The questionnaire developed for this study (See Appendix A) consists of two sections - Section A and Section B (B1 and B2). The questionnaire consists of 147 items. This included 12 items (Section A) on background information of the respondents and 135 items (Section B1 - 108 items and Section B2 - 27 items) to determine the level of environmental literacy (awareness, knowledge, attitudes and participation) of the respondents. The questionnaire was used to test the hypothesis stated in paragraph 5.8.

(i) Items in Section A of the Questionnaire

Items in Section A of the questionnaire were used to obtain background information of the respondents with regard to gender, age, location of work place and residence, qualifications, learning area, teaching experience, training in environmental education, and membership of environmental education organizations. The background information of the respondents can be used to understand the nature and direction of the relationship, if any, between environmental literacy and these variables.

There are 12 items in Section A (1-12). Some items (1, 11 and 12) had only two alternatives from which to choose. Items (3 and 4) had three alternatives, item nine had four alternatives, item five had five alternatives, item seven had six alternatives and items (2, 6, 8 and 10) had eight alternatives from which to choose. All the items in this section had to be answered by means of a single stroke (with an HB pencil) in the Survey Response Page 01 and 02 (Appendix B). For example,
Number on the questionnaire is A1. Gender. If your answer is "Female", mark on the Survey Response Page as follows:

1 [1] ~~[2]~~ [3] [4] [5] [6] [7] [8]

The following items were closed or structured items.

Item 1. Gender:

Male = 1

Female = 2

Item 2. In which age category are you?

24 Years or less = 1

25-29 Years = 2

30-34 Years = 3

35-39 Years = 4

40-44 Years = 5

45-49 Years = 6

50-54 Years = 7

55 Years or older = 8

Item 3. Location of your school.

Urban = 1

Rural = 2

Semi-urban = 3

Item 4. Location of your home.

Urban = 1

Rural = 2

Semi-urban = 3

Item 5. Please indicate your highest academic qualifications

Standard 10 = 1

B.A = 2

B.Sc = 3

B.Comm = 4

Other = 5

Item 6. In which learning area is your highest qualification?

Language, Literacy and Communication = 1

Human & Social Sciences = 2

Mathematics, Mathematical literacy & Mathematical sciences = 3

Natural Sciences = 4

Arts & Culture = 5

Economics & Management Sciences = 6

Life Orientation = 7

Technology = 8

Item 7. Please indicate your professional qualifications

J.S.T.C	= 1
P.T.C	= 2
P.T.D	= 3
S.T.D	= 4
U.D.E	= 5
Other	= 6

Item 8. Teaching experience in years

3 Years or less	= 1
4-7 Years	= 2
8-11Years	= 3
12-15 Years	= 4
16-19Years	= 5
20-23Years	= 6
24-27 Years	= 7
28 Years or more	= 8

Item 9. In which Phase are you teaching?

Foundation Phase (Grade 1-3)	= 1
Intermediate Phase (Grade 4-6)	= 2
Senior Phase (Grade 7-9)	= 3
Further Education & Training Phase (Grade 10-12)	= 4

Item 10. Please indicate the learning area in which you offer tuition.

Language, Literacy and Communication	= 1
Human & Social Sciences	= 2
Mathematics, Mathematical literacy & Mathematical sciences	= 3
Natural Sciences	= 4
Arts & Culture	= 5

Economics & Management Sciences	= 6
Life Orientation	= 7
Technology	= 8

Item 11. Have you received any training in environmental education?

Yes	= 1
No	= 2

Item 12. Do you belong to any environmental education organisation?

Yes	= 1
No	= 2

It was not possible to make provision for all possible responses to items five (5) and seven (7) in the questionnaire. The possible academic and professional qualifications of teachers in the sample area are too many and inclusion of all responses will increase the length of the questionnaire.

(ii) Items in Section B of the Questionnaire

Items in Section B (B1and B2) of the questionnaire were used to measure the level of environmental literacy of teachers. As point of departure, ten central concepts, each representative of particular subconcepts related to environmental literacy, were selected from the definitions of environmental literacy, the levels of environmental literacy, the characteristics of an environmentally literate person and an environmentally literate society as outlined in paragraph 2.3. The ten central concepts and subconcepts related to environmental literacy are provided in Table 6. These concepts were selected mainly from three major areas, namely the environment, environmental problems and prevention of environmental problems, which are important in developing environmental literacy.

Invaluable assistance in the design of the instrument for this study was obtained from the work done in related fields of environmental education and environmental literacy. Many ideas in design and construction were incorporated from studies reported by Abraham & Chacko (1999); Bester (1999); Buethe & Smallwood (1987); Leeming, Dwyer, Portr, & Cobern (1993); Leeming, Porter, Dwyer, Cobern, & Oliver (1997); Loubser (1994); Pohorille (1985); Roth (1998); Smith-Sebasto & Smith (1997), as well as from experts in the fields of ecology, environmental education, statistics, psychology and some statements from various sources were modified to suit the particular needs of this study. A total of 370 items were developed, some adapted from other instruments and some developed by the researcher, according to the definition of environmental literacy, levels of environmental literacy, characteristics of environmentally literate persons and society. Sorting of the 370 items was done to eliminate duplicate or overlapping items and of formulating clusters of items that fit into the 10 concepts (in Table 6) selected for this study. Many items (235) had to be eliminated because of their unsuitability to measure environmental literacy of teachers.

Finally, 135 items (Section B1 -120 items and Section B2 - 27 items) were selected to represent the 10 concepts and subconcepts related to environmental literacy (Table 6) and the disposition level of the respondents. In this context, disposition level refers to awareness, knowledge, attitudes and participation which includes personal involvement, skills, commitment, etc. of respondents to take part in positive action towards the resolution of environmental problems and the prevention of new ones. Within the framework of this study, it was however, difficult to include specific items to assess the skills of a person. As behaviour involves action, direct reports of behaviour are an indication of the skills of the respondents (Kuhlemeier, Van den Bergh & Lagerweij, 1999:5) in this study. For example, item 90 (Table:8), "I make compost with biodegradable wastes". Such an activity involves certain skills in making compost. Therefore, items to assess skills of the respondents are included under participation. It is expected that these items can be used to investigate the environmental literacy of teachers selected for this study. In the questionnaire presented to the teachers selected for this study, all the items for a concept were arranged in an order. The arrangement of the items is shown in Table 7.

Table 7: Items in Section B of the questionnaire

Concept	Items				Number of items
	Awareness	Knowledge	Attitude	Participation	
Concept 1	13-15	16-18	19-21	22-24	12
Concept 2	25-27	28-31	32-33	34-37	13
Concept 3	38-40	41-43	44-46	47-49	12
Concept 4	50-52	53-55	56-58	59-62	13
Concept 5	63-65	66-69	70-72	73-75	13
Concept 6	76-77	78-82	83-85	86-91	16
Concept 7	92-93	94-97	98-101	102-104	13
Concept 8	105-107	108-110	111-115	116-119	15
Concept 9	120- (1-2)*	(3-5)*	(6-8)*	(9-11)*	12
Concept 10	(12-13)*	(14-15)*	(16-22)*	(23-27)*	16
Total	27	34	36	38	135

* Items indicated in brackets are in Section B2 of the questionnaire.

For each concept there are items to test awareness, knowledge, attitude and participation in the prevention and solving of environmental problems. Items on participation include direct self-reported performance of behaviour, intention of a person to engage in a given behaviour, and activities with the students. There were 27 items for awareness, 34 items for knowledge, 36 items for attitude and 38 items for participation. For example,

Item 25. The earth is like a spaceship, with only limited resources on board (awareness)

Item 43. Earthworms play an important role in a food chain (knowledge)

Item 58. Factory waste may be disposed of into rivers because it has no effect on biological life in the rivers (attitude)

Item 87. I often buy products made with recycled materials (participation)

The respondents had to indicate on a 4-point scale, to what extent they agree or disagree with each item by means of a single stroke indicating 1, 2, 3 or 4 in the appropriate space provided for each item. The following instruction was also given in the questionnaire: "use the following scale for your responses".

Strongly agree = 1

Agree = 2

Disagree = 3

Strongly disagree = 4

Items from Section B1 (13-120) were answered on Survey Response Page 01 and items from Section B2 (1-27) were answered on Survey Response Page 02.

The desired response to items (13-120) in Section B1 and items (1-27) in Section B2 are given in Table 8.

Table 8: Desired responses to items in Section B of the questionnaire

Item No	Item	Desired Response
13	The particular place in which living organisms live provides the resources it needs to survive.	Positive
14	Food, water, shelter and space are all necessary for the survival of life.	Positive
15	Plants and animals depend on each other in many ways.	Positive
16	The earth has a limited capacity to recycle materials naturally.	Positive
17	Burning of coal releases gases into the atmosphere which affects the survival of living organisms.	Positive
18	Intensive farming has changed air, water and land as life support systems.	Positive
19	Humans must live in harmony with nature in order to survive.	Positive
20	I am not concerned about overgrazing because it is not always harmful to the environment.	Negative
21	I do not worry about too many wild animals being killed because in the long run things will balance.	Negative
22	I am happy to offer help to take air samples to test the level of air pollution in a nearby industrial area on a free afternoon.	Positive
23	I am willing to be involved in a project to develop a school garden.	Positive
24	I will stop using aerosols containing harmful gases.	Positive

Table 8: Continued ...

Item No	Item	Desired Response
25	The earth is like a spaceship, with only limited resources on board.	Negative
26	Indigenous trees have no advantages for human beings.	Negative
27	Wildlife is important in the cultural heritage of all regions and groups of people.	Positive
28	If a drought exists in a certain area and plants die off, predators such as lions in the area will also be in danger of extinction.	Positive
29	In an ecosystem there are producers, carnivores, herbivores, omnivores, and decomposers.	Positive
30	Ecosystems consist of people and other animals, plants and other life forms, and non-living factors interacting and interdependent in a wide variety of ways.	Positive
31	Loss of the particular place where it lives has contributed to many species of wildlife becoming endangered.	Positive
32	Tree planting days will increase public awareness of the necessity of trees.	Positive
33	I think there is too much fuss about pesticides entering the food chain.	Negative
34	I would be interested to know what kind of little creatures live in ponds.	Positive

Table 8: Continued ..

Item No	Item	Desired Response
35	I enjoy talking about the TV programmes I watched about nature.	Positive
36	I am willing to participate in recycling paper at my school.	Positive
37	When shopping, I avoid buying products made from animal furs or skin.	Positive
38	At present, most of the energy used in South Africa comes from burning of coal and wood.	Positive
39	Energy from the sun is passed on to animals through food chains and food webs.	Positive
40	Trees in plantations cause lower water flows into rivers.	Positive
41	Only very little of the sun's energy is reaching tertiary consumers such as human beings in an ecosystem.	Positive
42	Carbon dioxide produced by burning coal causes a warmer climate.	Positive
43	Earthworms play an important role in a food chain.	Positive
44	We should save plants and animals from extinction.	Positive
45	When natural fires occur within national park boundaries it is better to have a "let it burn" policy.	Negative
46	Individual actions such as collecting cans for recycling have no effect on the environment.	Negative

Table 8: Continued ...

Item No	Item	Desired response
47	I shall support a campaign to kill all snakes because snake bites can be fatal.	Negative
48	I am willing to be involved in a tree planting campaign.	Positive
49	I will strive to study problems in nature.	Positive
50	The energy from sunlight absorbed by plants may be utilised by animals which eat plants.	Positive
51	High concentrations of sewage in an area result in a serious depletion of dissolved oxygen in water.	Positive
52	There is continuous environmental pollution from industry.	Positive
53	Limiting the size of the family is important to avoid overpopulation.	Positive
54	All of the following factors will contribute to the pollution of the atmosphere: Veld fires, braai fires, smoke from factories, and smoke from cars.	Positive
55	Abundant resources and low death rates stimulate rapid growth in a population of organisms.	Positive
56	It is important to repair leaking taps.	Positive
57	When humans interfere with nature, it produces disastrous consequences.	Positive

Table 8: Continued …

Item No	Item	Desired response
58	Factory waste may be disposed of in rivers because it has little effect on biological life in the rivers.	Negative
59	I encourage others to limit the size of families to avoid overpopulation.	Positive
60	I would be willing to write letters asking people to help reduce pollution.	Positive
61	I encourage people to start using electricity for cooking so that smoke pollution from homes will be reduced.	Positive
62	I feel responsible to teach about environmental changes brought about by urbanisation in the normal classroom situation.	Positive
63	All animals, including human beings have basic needs.	Positive
64	Some resources once used are unavailable to future generations.	Positive
65	Coal is an inexhaustible natural resource.	Negative
66	Harmful gases in the atmosphere can be reduced if people do not use aerosols.	Positive
67	If the hole in the ozone layer gets worse more ultra-violet sun rays will reach the earth.	Positive
68	If the number of people in the world rises further at a faster rate we will no longer be able to maintain a healthy environment.	Positive
69	Waste materials cannot be used in a positive manner by organisms in meeting their basic needs.	Positive
70	Scarcity of factors essential for survival of organisms limits population growth.	Positive

Table 8: Continued ...

Item No	Item	Desired response
71	Community education can counteract the effect of misuse of natural resources.	Positive
72	In order to provide food for human beings, forests must be cleared so that grains can be grown.	Negative
73	I would be willing to use public transport in order to reduce air pollution.	Positive
74	Every time I go shopping, I am willing to take a bag so that there is no need to get a plastic one from the shop.	Positive
75	When shopping, I avoid buying products known to be harmful to the environment.	Positive
76	The more people there are, the fewer resources are available per person.	Positive
77	The overuse of resources often results in environmental problems such as the destruction of the particular place where living organisms are found.	Positive
78	Conservation is the wise use of the environment to achieve sustainable environmental quality.	Positive
79	Depletion of the ozone layer causes heating of the earth.	Positive
80	Certain animal and plant species can be saved from extinction by the proclamation of nature reserves.	Positive

Table 8: Continued ...

Item No	Item	Desired response
81	Energy, its production, uses, and conservation is essential in the maintenance of a sustainable society.	Positive
82	Illegal hunting is harmful to the environment.	Positive
83	It is important to make compost with biodegradable home wastes.	Positive
84	I am not interested in learning about the reasons behind the disappearance of forests.	Negative
85	It is important for all of us to reduce the consumption of material goods.	Positive
86	I always switch lights off when I don't need them anymore.	Positive
87	I often buy products made with recycled materials.	Positive
88	I normally leave the water running when I brush my teeth.	Negative
89	Whenever possible, I take a shower instead of a bath in order to conserve water.	Positive
90	I make compost with biodegradable wastes.	Positive
91	Environmentally responsible behaviour includes personal action that benefits the environment.	Positive
92	Misuse of natural resources will not affect human beings.	Negative

Table 8: Continued ...

Item No	Item	Desired Response
93	The quantity of water on earth is constant and may be used over and over.	Negative
94	Environmental quality is the net sum of the consequences of individual and group actions.	Positive
95	Individual lifestyles such as mode of transport affect the environment directly or indirectly.	Positive
96	Many factories contribute to the formation of acid rain.	Positive
97	Green revolution is a programme focussing on the propagation of fast growing plant species to grow more food.	Positive
98	Only science teachers should know how the environment works.	Negative
99	I get upset when I see other people littering.	Positive
100	I try to behave in an environmentally responsible manner.	Positive
101	It is necessary for us to know about the environmental problems of people in other countries.	Positive
102	I will vote for or against a political candidate because of the views of the political candidate on environmental issues.	Positive
103	I encourage my students to use both sides of a paper.	Positive
104	I encourage my students to pick up litter at school.	Positive
105	Consumers need to be able to evaluate benefits as well as drawbacks for the environment when purchasing goods.	Positive

Table 8: Continued ...

Item No	Item	Desired response
106	Recycling paper will result in fewer trees being cut for commercial purposes.	Positive
107	Increased consumption of natural resources results in increased environmental pollution.	Positive
108	Advertising tends to ignore the drawbacks of a product to the overall health of the environment.	Positive
109	Use of unleaded petrol will reduce air pollution.	Positive
110	A reduction in the consumption of material goods will reduce the amount of wastes.	Positive
111	I do not think it is my responsibility to teach environmental issues in the normal classroom situation.	Negative
112	If I make an attempt to regulate my actions with respect to air pollution, I am sure this will have a positive effect on air quality.	Positive
113	When I see smoke from chimneys, I think of air pollution.	Positive
114	Even if I stop buying environmentally harmful products, it would make little difference because others are still buying these products.	Negative
115	I support the modification of the environment to provide comfort and leisure.	Negative

Table 8: Continued ...

Item No	Item	Desired response
116	I am making personal sacrifices for the sake of slowing down pollution even though the immediate results may not be significant.	Positive
117	I am an active member in an environmentalist group.	Positive
118	I have changed some of my negative behaviours during the past few years to protect the environment.	Positive
119	I am infusing the study of environmental aspects into my teaching.	Positive
120	When pesticides are used to kill insects, no other animals are affected.	Negative
B2		
1	Economic development often produces more environmental problems than benefits.	Positive
2	Social values and customs influence personal conservation behaviour.	Positive
3	The uses of technology for disease prevention have resulted in rapid increases in the human population.	Positive
4	Ozone gas protects life on Earth from damaging effects of ultraviolet radiation.	Positive
5	The green house effect is an increase in carbon dioxide.	Positive

Table 8: Continued …

Item No	Item	Desired response
6	People have the right to change nature whenever they want to.	Negative
7	The benefits of modern consumer products are more important than the pollution that results from their production and use.	Negative
8	It is solely the government's responsibility to solve environmental problems.	Negative
9	A goal of my teaching is to increase the level of environmental responsibility in students.	Positive
10	I would like to discuss the influence of political decision making on the environment with my students.	Positive
11	I discuss relationships between economic development and a healthy environment with other people.	Positive
12	Human society has not developed sustainable feedback mechanism for the use and reuse of basic materials.	Positive
13	The management of natural resources to meet the needs of future generations demands long-term planning.	Positive
14	Humans tend to select short-term economic gains, which often result in long-term environmental loses.	Positive
15	In a food chain energy is supplied by green plants.	Positive
16	Individual citizens should be stimulated to become well informed about the environment.	Positive

Table 8: Continued ....

Item No	Item	Desired response
17	It is important to protect all useful animals.	Positive
18	The better we understand earth, the better we can manage our resources.	Positive
19	Humans have a responsibility to develop respect for the rights of others.	Positive
20	Educators must help students develop concern for the environment.	Positive
21	Because humans are more intelligent than other living beings, they have the greatest right to live.	Negative
22	We must set aside more land to support endangered plants.	Positive
23	I will try to persuade others to take part in environmentally responsible behaviour.	Positive
24	Because of my teaching my learners have a concern for the environment.	Positive
25	It is my conviction that I should point out to others not to smoke.	Positive
26	I discuss with my family ways to protect the environment for future generations.	Positive
27	I believe my teaching contributes to the development of environmentally literate citizens.	Positive

The desired response to 19 items from Section B1 (20, 21, 26, 33, 45, 46, 47, 58, 65, 72, 84, 88, 92, 93, 98, 111, 114, 115, 120) and four (4) items from Section B2 (6, 7, 8 and 21) were negative and the other (112) items were positive. This information will be used during scoring and analysis of the questionnaire. The scores for the negative items will be reversed so that high scores represent positive response.

(iii) Content Validity of the Questionnaire

Content validation was done before the instrument was presented to the teachers in this study. In July 1999, the following information was submitted to eight (8) specialists in environmental education and ecology. The information submitted to the specialists included concepts related to environmental literacy (Table 6), arrangement of the items in the questionnaire (Table 7 indicating items on awareness, knowledge, attitude and participation for each concept), items 13-120 in Section B1 and items 1-27 in Section B2 of the questionnaire and the desired responses (Table 8) as well as general information on the items in Section B of the questionnaire. All specialists had several years of experience in their area of specialisation. Seven (7) specialists are based at universities and one is a specialist in ecology and sustainable development. They were requested to make their comments as to the content validity of the instrument to assess the level of environmental literacy of teachers in the RSA. The major concern was the length of the questionnaire to be given to the teachers which may result in a low response rate mainly because of too many questions. Secondly, it was difficult to isolate questions owing to the interrelationship between the ten concepts related to environmental literacy. Thirdly, because of the interrelationship between awareness, knowledge, attitude and participation it was difficult to sort out questions into levels or categories. For example, is it possible to draw a clear distinction between awareness and knowledge? Bak (1999) is of the opinion that awareness is a kind of knowledge. An important question is, which concepts are important enough to be included in the questionnaire to assess environmental literacy of teachers. To make the research more relevant, one expert argued that the questionnaire should include some questions related to issues of sustainable socio-economic development and issues of environmental management in the developing world. This was mainly because a majority of South Africans are still very much in the developing phase of their community lives. It was suggested that questions that encourage the respondent to see environmental issues as part and parcel of development issues would make the questionnaire much more holistic and more relevant.

After receiving the comments from the experts, necessary adjustments were made to the instrument. That is, items mainly with unnecessary detail, items with contested desired answers and items with grammar and spelling mistakes were rewritten. Some questions that encourage the respondents to see environmental issues as part and parcel of development issues were also included. Several items, for example, items from Section B1 - 14, 18, 27, 64, 65, 77, 91, 95, 97, 114 and items 1, 3, 4, 5, 14, 16, and 18 from Section B2 with unnecessary detail had to be rewritten. For example, the original statement for item 18 was "activities such as reducing forests, increasing the amount of chemicals released into the atmosphere, and intensive farming has changed air, water and land as life support systems". This item was changed to "Intensive farming has changed air, water and land as life support systems". Wherever possible the items in the questionnaire were made shorter mainly by removing unnecessary detail.

Items with contested desired answers were also rewritten. For example, item 96 and 17 (Section B2). The original statement for item 96 was "factories producing items for profit may use processes that contribute to acid rain". This was changed to " many factories contribute to the formation of acid rain". This is because all factories produce items for profit, otherwise, it is unlikely that they all exist. In the case of item 17 (Section B2), the original statement was "It is important to protect all animals in the ecosystem". This may mean that even locusts, ticks, etc should be protected. Therefore, item 17 (Section B2) was changed to "It is important to protect all useful animal". Errors in items in Section B1 such as 30, 38, 47, 50, 67, 69 and errors in items in Section B2 such as 12, 21 and 24 were also corrected. Because of the procedures for devising an instrument has been established it can be hypothesised that the instrument developed shows the necessary content validity to assess environmental literacy of teachers in the RSA.

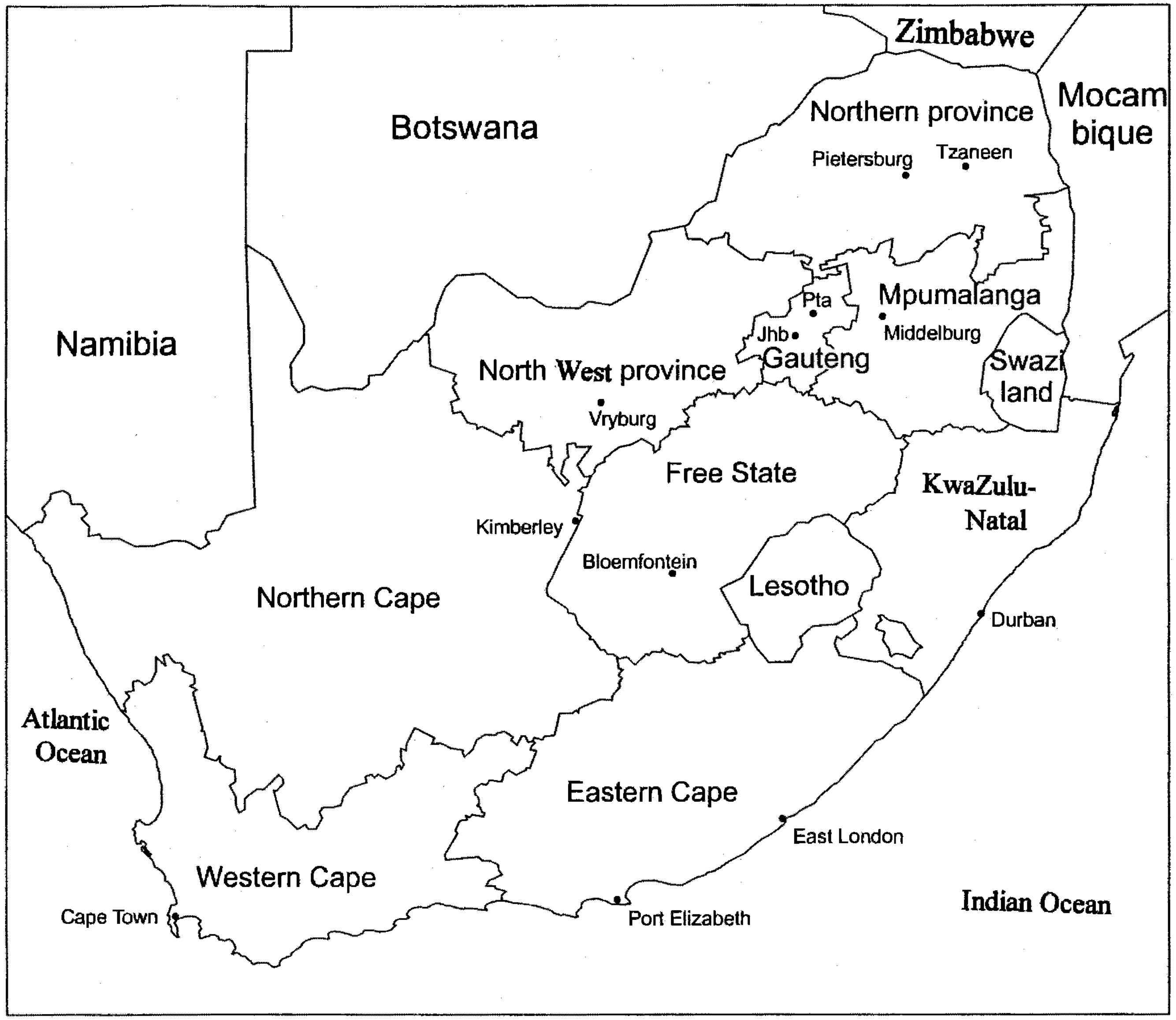
5.4 The Sample Area

The sample area selected for this study is situated in the Northern province, North West province and Mpumalanga province in the RSA. The capitals of these provinces are Pietersburg, Mafikeng and Nelspruit respectively. The sample area and the precise boundaries of the sample area are outlined in Map 1. On its borders lie the Northern Cape province, Free State province, Gauteng Province, and Kwazulu/Natal province. The sample area is also bordered by the following neighbouring countries, Botswana, Zimbabwe, Mozambique and Swaziland.

The sample area covers 319 720 Km2, 26,2 per cent of the total area of the RSA (28 per cent urban and 72 per cent rural) with a population of 9817,000, that is, 25,9 per cent of the total population of the RSA (Luüs & Oberholzer, 1994; RSA,1997). It must be noted that in Northern province, 88,1 per cent of the area is rural.

The literacy rate in the RSA is about 58 per cent (RSA,1997). The literacy rate is low in the northern parts of the RSA. It is estimated that in adults (persons who are 15 and older), the literacy rate is approximately 75,48 per cent in Mpumalanga province, 73,64 per cent in Northern province, and 69,46 per cent in North West province (RSA,1997). There are several major languages spoken in the sample area. The major languages spoken in Mpumalanga province are Swazi (30,2%), Zulu (24,2%), Ndebele (11,3%), Sepedi (10,2%), Afrikaans (9,3%) and others. The major languages spoken in Northern province are Sepedi (56,7%), Tsonga (22,7%), Venda (11,8%) and others. The major languages spoken in North West province are Setswana (59%), Afrikaans(8,8%), Xhosa (6,3%), Sepedi (5,2%), Sesotho (5,0%), Tsonga (5,4%) and others. It must be noted that Zulu (22,4%), Xhosa (17,5%), and Afrikaans (15,1%) are the three major languages spoken by the majority of South Africans (RSA,1997). The three major languages spoken in the

Map 1: Republic of South Africa



sample area are Setswana, Sepedi, and Swazi.

In the sample area, the major environmental problems include the use of traditional fuel (wood), rapid deforestation, soil erosion, poor agricultural methods and cattle ownership which leads to overgrazing. The major source of pollution is from mines, from homes (domestic fires), from industry, from motor vehicles, veld fires, inefficient rubbish removal systems especially in the rural areas, rubbish in the street and other sources. In Mpumalanga, the power house of South Africa, for example, has atmospheric conditions which are very adverse for dispersing pollutants especially from power stations, paper factories, petrochemical industries, and others. All are important sources of atmospheric pollution (Tyson, Kruger, & Louw, 1988). The situation is not much different in the Northern province and North West province. This is likely to have some effects on the natural resources and vegetation of the sample area and also to cause damage of some kind to human health.

5.5 Selection of Schools and Teachers

It was difficult to visit all schools in the three provinces within the time frame for this study. Another problem was the availability of finance and transport to visit schools that are very far from my place of work and residence. Therefore, school selection was made at the convenience of the researcher (as the researchers' place of residence and work is closer to the three provinces mentioned in paragraph 5.4) though care was taken to ensure that the three provinces were represented.

For the purposes of this study, from all the schools in the three provinces (Mpumalanga Province, Northern Province, and North West Province) in the RSA, only 53 schools (both primary and secondary) were selected. That is, 16 schools from Mpumalanga Province, 15 schools from Northern Province, and 22 schools from North West Province. From each primary school, teachers were selected from Foundation Phase and from Intermediate Phase. From each secondary (high) school, teachers were selected from

Senior Phase and from Further Education & Training Phase. In Mpumalanga province and North West province few Middle Schools (Grade 7-9) participated in this study. The willingness of the teachers to participate in this study has played a major role in the selection of teachers from each school. The selection of teachers according to province, schools, and phase is provided in Table 9.

Table 9: Selection of Teachers

Province	Number of schools	Number of teachers			
		FP*	IP*	SP*	FETP*
Mpumalanga	16	35	35	35	35
Northern	22	35	35	35	35
North West	15	35	35	35	35
Total	53	105	105	105	105

FP* = Foundation Phase (Grade 1-3)

IP* = Intermediate Phase (Grade 4-6)

SP* = Senior Phase (Grade 7-9)

FETP* = Further Education & Training Phase (Grade 10-12)

Once the schools had been chosen, arrangements were made to visit the schools. In brief interviews with the principals of these schools, the researcher outlined the aim of the research, provided an introductory letter about the research (Appendix C), and sought permission to meet at least ten (10) teachers. The researcher then arranged a meeting with the selected teachers in each school. A meeting with the teachers was necessary to find out whether they were willing to participate in the study. If many teachers from the selected schools were not willing to take part in the study, it will affect the number of teachers participating in this study.

From the 420 teachers selected for this study, 368 returned the questionnaire. Owing to factors such as time, on the part of the researcher, and the workload of the teachers towards the end of the academic year, it was decided that follow-up visits to schools was not necessary. According to some researchers it seems late respondents are often similar to non-respondents (Roth, 1998).

Sixteen (16) questionnaires were discarded owing to incomplete data on the Survey Response Page. Therefore, the total number of responses was 352 (83,8 per cent). There were 134 (38,1 per cent) male teachers and 218 (61,9 per cent) female teachers. The majority (65,3 per cent) were from the age category of 30-44 years and a teaching experience of 4-19 years (75,9 per cent). There were 83 teachers from Foundation phase, 93 teachers from Intermediate phase, 88 teachers from Senior phase and 88 teachers from Further Education & Training phase. Among the respondents, 103 had standard 10 as their highest academic qualification, 64 had B.A, 24 had B.Sc., 12 had B.Comm. while 149 respondents had other academic qualifications. The majority of the teachers in this study had qualifications in Language, Literacy and Communication (LLC) and offer tuition in this learning area. With regard to the location of work place, the majority were from rural areas. Regardless of their academic qualifications, learning area, phase in which tuition is offered, only 14,2 per cent of the respondents had membership in environmental education organisations.

5.6 Administration of the Questionnaire

The selection of schools and teachers were done as explained in paragraph 5.5. All Survey Response Pages (01 and 02) were given a four digit number (0001-0420).The questionnaire was presented to the 420 selected teachers at their own schools by the researcher. The questionnaire contained a letter of introduction (Appendix C) explaining the purpose of the research and requesting co-operation. To ensure a high return of the questionnaires, the researcher visited the teachers and collected the questionnaires and the completed Survey Response Pages.

5.6.1 Information to Teachers

The teachers were given the freedom to clarify items in the questionnaire with the researcher. The following information was also included in the questionnaire to teachers in this study. For example,

* Please read the following carefully before you answer the questionnaire.
* Your honest opinion is of great importance.
* There is no way in which you can be identified.
* Please attempt all the items in this questionnaire.
* Please do not write anything on the questionnaire.
* Do not write above the red line on the Survey Response Page. Start below the red line next to number 1.
* For each item indicate your response by means of a single stroke with an HB pencil on the appropriate number on the Survey Response Page, for example

  1 [1] ~~[2]~~ [3] [4] [5] [6] [7] [8]
* Please make sure that the answer numbers on the Survey Response Page correspond to the question number on the questionnaire. Indicate your response to items 1-120 of Section B1 on Survey Response Page 01 and to items 1-27 of Section B2 on Survey Response Page 02.
* Kindly return the completed Survey Response Pages and the questionnaire to me.

According to Koballa (1984:711), there is little reason to misrepresent if anonymity is guaranteed. Considering the advantages and disadvantages of questionnaires, several precautions were taken. For example, to obtain maximum participation from the respondents, all questionnaires were conducted anonymously to encourage teachers to participate and to express views frankly. The researcher assured the teachers that their names will not be mentioned in the final report of this study. This would result in the maximum return of the questionnaires and possibly honest answers in the questionnaire.

5.7 Major Constraints in the Development and Use of the Instrument to Assess the Environmental Literacy of Teachers

There were several major constraints in the development and use of the questionnaire to assess the environmental literacy of teachers. Chacko (1998) identified several problems in the development of an instrument to assess the environmental literacy of teachers. The major problem was that there is no clear definition of environmental literacy. The term environmental literacy does not mean the same to everyone and continues to lack precision as there is much disagreement about the depth of understanding of each concept, issue, etc. Therefore, for the purposes of this study, the researcher developed a definition for environmental literacy.

The second major problem was the development of the instrument itself. The problem of validity of items in questionnaires is an old one. A questionnaire designed for this study is an index of what the respondents are willing to admit about their awareness, attitudes, knowledge, skills, actions, participation, prevention and the like. The interrelatedness of cognitive, affective and psychomotor domains cannot be overemphasised. It was very difficult to separate items on awareness, knowledge, attitude, and participation. It was also difficult to compile items for concepts 1 to 10 owing to the interrelatedness of the concepts.

The questionnaire developed for this study was nine pages long with 147 items for the respondents to attempt. Designing a questionnaire which is relatively short but covers all the aspects and concepts, was very demanding. Various factors may affect responses of respondents to a questionnaire such as school characteristics and the subjects taught at school. Although, a 4-point scale was used to avoid neutral comments from the respondents it is possible that teachers could exaggerate their behaviours and skills. It is also possible that some teachers did not participate in this study as they saw it as a form of evaluation.

Another problem was the nature of the data gathering technique to assess environmental literacy. Validation of the questionnaire and analysis of the data from the survey response pages took more time than anticipated.

It was a major constraint to reach a large sample for the study due to factors such as time, finance, location of the schools and availability of transport.

A number of factors over which the researcher had little or no control might have come into play during the administration of the questionnaire. For example, the researcher was aware of the shortcomings of the use of only a questionnaire to assess the level of environmental literacy. However, Leeming, Dwyer, Porter & Cobern (1993) reported that many researchers used Likert-type questionnaires to assess environmental knowledge, attitude, behaviour, etc. This study only assessed direct self-reported performance of behaviour and intention to engage in a given behaviour rather than actual behaviour by teachers. It may be possible to assess the levels of environmental literacy if teachers are able to demonstrate in an observable form a continuum of competencies of awareness, knowledge, attitude, actions, and the like.

It is often difficult to assess the sincerity of a verbal commitment by using a questionnaire. It has been shown by Hines, Hungerford & Tomera (1986-87:2) that what people indicate on a questionnaire is often inconsistent with their actual behaviour. Actual commitment infers behaviour in which the individual is currently engaged. It must be noted that what people say their attitudes are and what their attitudes really are may not be the same. Responses to the questionnaire used may reflect an individual's perception of how he or she should respond rather than his actual personal commitment. The question arises whether it is possible to assess, for example, the attitude of respondents that they may not otherwise divulge. There may be variations in the extent to which people, even if they wish to be truthful, can give accurate responses to statements about themselves. According to Bogner & Wiseman (1997:114) the validity of responses to individual items is not so important when considered in the broader methodological context. With regard to environmental behaviour, many human beings hold two positions; the one they talk about and the one they act on. Therefore, higher scores in 'verbal' than in 'actual' commitment would reflect the general expectation. Verbal commitment may normally be somewhat preferable for individuals to the actual commitment levels of engagement. In terms of social desirability, probable behaviour in the future is more likely to be expressed in terms of what one 'ought' to say than are descriptions of one's true behaviour. One would normally expect that we are verbally much more in favour of environmentally oriented behaviour than in our actual reported behaviour (Bogner & Wiseman, 1997:118). According to Leeming, Dwyer, Porter & Cobern (1993:18), it is not always easy to collect follow up data to determine whether the reported behaviour persisted over a period or not. Bogner & Wiseman (1997:114) noted that observing subjects to determine whether, what they claim to do is what they in fact do, is a procedure both morally dubious and with a large sample very expensive. Therefore, in this study, verbal commitment of the respondents should be seen as an intention to act.

5.8 Hypotheses

Hypotheses with reference to the level of environmental literacy of teachers as outlined in the literature review and its relationship with some of the factors mentioned in paragraph 1.3, will be formulated. As relatively little work has been done to assess the level of environmental literacy of teachers it was difficult to make an assumption of the relationship between environmental literacy and some of the variables. At the same time, most of the researches reported in the literature (Paragraph 1.2.2), address only limited aspects of environmental literacy. In this study, the hypotheses are stated using the variables namely, gender, age category, location of school, educational qualifications, years of teaching experience and subjects taught (learning area), exposure to environmental education programmes, and membership of environmental education organizations which were used in the prediction of environmental concerns (not necessarily environmental literacy of teachers). It must be noted that empirical evidence on the direction of the relationship between various factors in the prediction of environmental concern are conflicting and ambiguous (paragraph 1.3). However, it can be hypothesised that there are several factors that contribute to the present level of environmental literacy of teachers and there is a significant difference between environmental literacy and those factors. The only available information from the literature study was that mature, married, male secondary school science teachers had higher scores than other teachers (Buethe & Smallwood, 1987:41)

In line with aim 5 of this study (paragraph 1.4), to investigate possible relationships between certain identified factors and the level of environmental literacy of teachers, the following hypotheses were formulated.

(i) There is a significant difference between male and female teachers with regard to the level of environmental literacy.

(ii) There is a significant difference between environmental literacy of teachers in different age groups.

(iii) There is a significant difference between environmental literacy of teachers from schools in different areas.

(iv) There is a significant difference between environmental literacy of teachers with regard to the place of residence.

(v) There is a significant difference between environmental literacy of teachers involved in the different learning areas.

(vi) There is a significant difference between environmental literacy of teachers with different qualifications.

(vii) There is a significant difference between environmental literacy of teachers with varying years of teaching experience.

(viii) There is a significant difference between environmental literacy of teachers teaching in different phases.

(ix) There is a significant difference between environmental literacy of teachers in the different learning areas in which they offer tuition.

(x) There is a significant difference between the level of environmental literacy of teachers who received training in environmental education and teachers who did not receive any training.

(xi) There is a significant difference between the level of environmental literacy of teachers who are members of environmental education organisations and teachers who are not members of environmental education organisations.

5.9 Analysis of Data

The data obtained from the questionnaire will be analysed using the Statistical Analysis System (SAS) Version 6.1.2. Analysis of Section A of the questionnaire will be done according to the variables such as gender, age, location of the work place and residence, qualifications (academic and professional), years of teaching experience, learning area, phase in which tuition is offered, membership of environmental education organizations, and training in environmental education. The background information of the respondents will be used to understand the nature and direction of the relationship, if any, between environmental literacy and these variables. This information is also important as it can be targeted to improve the level of environmental literacy of teachers. The scores for the 23 negative items will be reversed so that high scores represent positive responses. An analysis of the questionnaire will also be done to yield the number and percentage responses of respondents with regard to awareness, knowledge, attitude, and participation.

An item analysis will be done for all the items in each of the four aspects of environmental literacy as well as for the questionnaire as a whole. The reliability of the questionnaire will be determined by calculating the alpha coefficient for each aspect of environmental literacy as well as for the questionnaire as a whole. The validity of the questionnaire will be established by both content validity and construct validity.

The norms of the questionnaire will be established so that other researchers can use it and interpret their results in the context of this study.

Testing of hypotheses will be done using analysis of variance (F test) and t-test. This will be necessary to determine whether there is a significant difference between the variables that may influence environmental literacy.

Using stanines it will be possible to establish the level of environmental literacy of the respondents. The first three stanines (1,2,3) below average, the next three stanines (4,5,6) as average, and the top three stanines (7,8,9) as above average. The results of the data analysis will be provided in chapter 6.

5.10 Conclusion

The main focus in this chapter was on the measurement of environmental literacy, the development of the questionnaire, presentation of the questionnaire to teachers and selection of the sample. The sample consisted of 420 teachers randomly selected from selected schools from the three provinces in the RSA. The researcher did the presentation of the questionnaire himself to the teachers who participated in the study. In the final analysis 352 responses were used. Techniques for analysing the data were also provided. Major constraints exist in the development and use of the instrument to assess the level of environmental literacy of teachers in the RSA.

In chapter 6 an investigation into the level of environmental literacy of teachers in three provinces (Northern Province, Mpumalanga Province, and North West Province) in the RSA will be made from an analysis of data obtained from questionnaire responses from teachers selected for this study.

CHAPTER 6

RESULTS OF THE EMPIRICAL INVESTIGATION

6.1 Introduction

It was highlighted in the review of the literature (paragraphs 2.2 - 2.3) that the development of an environmentally literate citizenry is a major goal of environmental education. This is necessary because active participation of the general public is a key factor in preventing and solving environmental problems. According to the literature study (paragraph 2.3) environmental literacy involves awareness of the total environment, knowledge of environmental problems, attitudes which lead to responsible environmental behaviour, and participation in solving or preventing environmental problems.

It seems the development of environmentally literate citizens who will take care of the environment will be determined by well-trained teachers and their level of environmental literacy. It was noted in paragraph 1.2 that effective integration of environmental education into the present school curriculum is hampered because most teachers are not adequately trained in the different teaching strategies and approaches in environmental education and their inadequate level of environmental literacy. It is important to note that the way teachers deal with environmental education is greatly influenced by their own level of environmental literacy. Therefore, before designing effective environmental education programmes to foster environmental literacy, it was necessary to assess the level of environmental literacy of teachers.

However, in the literature scrutinised there were no studies that assessed the environmental literacy of teachers in the area in which this study was undertaken. As there was no suitable instrument to achieve the aims of this study (as mentioned in paragraph 1.4) it was necessary to develop an instrument to assess the level of environmental literacy of teachers. Therefore, an aim of this study was to develop and standardize an instrument to assess the level of environmental literacy of teachers in the RSA. The development of the questionnaire was discussed in paragraph 5.3.

To ascertain whether the instrument is suitable for measuring the level of environmental literacy of teachers (aim 4, paragraph 1.4) it was administered to 420 teachers from 53 schools from three provinces in the RSA. Information on the selection of teachers was provided in paragraph 5.5.

In this chapter, the main focus will be on the analysis of responses of 352 teachers. The data from the Survey Response Pages were analysed using the Statistical Analysis System (SAS) Version 6.1.2. The results of the analysis will be discussed in the following paragraphs. Among others, this will include item analysis of the four aspects of environmental literacy (awareness, knowledge, attitude, and participation) and the questionnaire as a whole, determining the reliability of the questionnaire, establishing the validity of the questionnaire, determining the norms of the questionnaire and testing of hypotheses.

6.2 Item Analysis

An item analysis was done for all the items (135) in Section B (Section B1, 108 items and Section B2, 27 items) of the questionnaire. The items in Section B were based on four aspects of environmental literacy namely, awareness, knowledge, attitude and participation. An item analysis was done for each one of the four aspects. The aim of the item analysis was to determine whether an item contributes to the total of the section it belongs. If an item makes no contribution to the total or contributes negatively, the item could be omitted. The decision whether to retain or omit an item was also based on a Cronbach's Alpha Reliability Coefficient. An item could be omitted if it strengthens the Cronbach's Alpha Coefficient of the particular section.

6.2.1 Item Analysis: Awareness

The 27 items for awareness showed a reliability of 0,743. Item V93 was deleted because of a low correlation with the total. When omitted the reliability changed from 0,743 to 0,793. The item analysis for awareness is provided in Table 10.

Table 10: Item analysis - Awareness

No. of respondents : 304
No. of items : 27
Alpha reliability coefficient: 0,743

Item	Item correlation with total	Alpha if item is left out
V13	0,156	0,742
V14	0,225	0,739
V15	0,311	0.734
V25	0,480	0,721
V26	0,255	0,737
V27	0,387	0,728
V38	0,208	0,740
V39	0,227	0,738
V40	0,174	0,743
V50	0,386	0,728
V51	0,400	0,727
V52	0,328	0,732
V63	0,337	0,734
V64	0,321	0,733
V65	0,229	0,739
V76	0,375	0,730
V77	0,473	0,726
V92	0,309	0,734
V93*	0,067	0,752
V105	0,496	0,723
V106	0,478	0,724
V107	0,349	0,731
V120	0,353	0,777
Q1	0,126	0,745
Q2	0,303	0,734
Q12	0,228	0,738
Q13	0,290	0,735

* Items with a low correlation.

6.2.2 Item Analysis: Knowledge

The knowledge section consisted of 34 items. It was found that items V69 and Q5 showed very low correlations with the total and therefore it was decided to omit these items. Therefore, the reliability changed from 0,827 to 0,839. All other items were retained. The item analysis for knowledge is provided in Table 11.

Table 11: Item analysis - Knowledge

No. of respondents : 336 No. of items : 34 Alpha reliability coefficient: 0,827		
Item	Item correlation with total	Alpha if item is left out
V16	0,245	0,825
V17	0,333	0,823
V18	0,259	0,825
V28	0,301	0,824
V29	0,372	0,822
V30	0,479	0,819
V31	0,299	0,824
V41	0,191	0,828
V42	0,358	0,822
V43	0,395	0,820
V53	0,294	0,824
V54	0,342	0,823
V55	0,371	0,821
V66	0,396	0,821
V67	0,469	0,819
V68	0,276	0,824
V69*	0,043	0,833
V78	0,322	0,823
V79	0,422	0,820
V80	0,392	0,821

Table 11: Continued ...

Item	Item correlation with the total	Alpha if item is left out
V81	0,434	0,820
V82	0,244	0,826
V94	0,356	0,822
V95	0,502	0,818
V96	0,521	0,816
V97	0,272	0,825
V108	0,355	0,822
V109	0,305	0,824
V110	0,265	0,825
Q3	0,406	0,820
Q4	0,296	0,824
Q5*	0,099	0,831
Q14	0,271	0,825
Q15	0,257	0,825

* Items with a low correlation.

6.2.3 Item Analysis: Attitude

This section consisted of 36 items. It was found that item V115 showed a low correlation with the total and therefore it was decided to omit item V115. When omitted, the reliability coefficient of attitude changed from 0,861 to 0,867. The item analysis for attitude is provided in Table 12.

Table 12: Item analysis - Attitude

No. of respondents : 320
No. of items : 36
Alpha reliability coefficient: 0,861

Item	Item correlation with total	Alpha if item is left out
V19	0,471	0,856
V20	0,359	0,858
V21	0,517	0,854
V32	0,474	0,856
V33	0,362	0,858
V44	0,481	0,855
V45	0,252	0,861
V46	0,289	0,860
V56	0,430	0,857
V57	0,292	0,860
V58	0,493	0,855
V70	0,236	0,861
V71	0,311	0,859
V72	0,463	0,855
V83	0,375	0,858
V84	0,497	0,855
V85	0,292	0,859
V98	0,537	0,853
V99	0,272	0,860
V100	0,387	0,858
V101	0,421	0,857
V111	0,565	0,852
V112	0,328	0,859
V113	0,298	0,859
V114	0,172	0,863
V115*	0,058	0,867
Q6	0,351	0,858
Q7	0,343	0,858

Table 12: Continued ...

Item	Item correlation with total	Alpha if item is left out
Q8	0,364	0,858
Q16	0,425	0,857
Q17	0,318	0,859
Q18	0,456	0,857
Q19	0,366	0,858
Q20	0,369	0,858
Q21	0,297	0,860
Q22	0,189	0,862

* Items with a low correlation.

6.2.4 Item Analysis: Participation

This section on participation consisted of 38 items. It was found that three items V88, V89 and V117 showed a low correlation with the total. Therefore, it was decided to omit these items. When omitted, the reliability coefficient of participation changed from 0,850 to 0,861. The item analysis for participation is provided in Table 13.

Table 13: Item analysis - Participation

No. of respondents : 307
No. of items : 38
Alpha reliability coefficient: 0,850

Item	Item correlation with total	Alpha if item is left out
V22	0,326	0,846
V23	0,259	0,848
V24	0,319	0,847
V34	0,405	0,845
V35	0,478	0,843
V36	0,388	0,845
V37	0,127	0,853
V47	0,245	0,849
V48	0,388	0,845
V49	0,349	0,846
V59	0,313	0,847
V60	0,425	0,844
V61	0,485	0,843
V62	0,463	0,844
V73	0,162	0,851
V74	0,240	0,849
V75	0,351	0,846
V86	0,390	0,845
V87	0,410	0,844
V88*	0,080	0,854
V89*	0,063	0,855
V90	0,377	0,845
V91	0,375	0,845
V102	0,327	0,846
V103	0,324	0,846
V104	0,330	0,846
V116	0,353	0,846
V117*	0,063	0,853

Table 13: Continued ...

Item	Item correlation with total	Alpha if item is left out
V118	0,355	0,846
V119	0,464	0,843
Q9	0,321	0,846
Q10	0,549	0,841
Q11	0,463	0,844
Q23	0,388	0,845
Q24	0,465	0,844
Q25	0,464	0,843
Q26	0,368	0,846
Q27	0,467	0,843

* Items with a low correlation.

The decision whether to retain or omit an item was based on the item correlation with the total and the reliability coefficient. It was indicated in tables (Table 10 - 13) that seven (7) items, namely V93 (awareness), V69 and Q5 (knowledge), V115 (attitude), and V88, V89, and V117 (participation) should be omitted owing to their low correlation with the total and negative influence on the reliability coefficient of the instrument. This means that the reliability coefficient of the four aspects (awareness, knowledge, attitude and participation) of environmental literacy will be higher than the coefficients indicated in tables 10 to 13.

6.3 Reliability of the Questionnaire

A questionnaire is considered to be reliable if the reliability coefficient is 0,8 or higher. The nearer to 1, the higher the reliability. This means that the difference between the variance of the actual score and the observed score are small.

In this study, the reliability was established by calculating the alpha coefficient for each aspect of environmental literacy as well as for the questionnaire as a whole. The final reliability coefficients for each section are given in Table 14.

Table 14: Reliability of the questionnaire

Aspect of environmental literacy	Alpha coefficient	No. of items
Awareness	0,793	26
Knowledge	0,839	32
Attitude	0,867	35
Participation	0,861	35
Total Questionnaire	0,945	128

As shown in Table: 14, the reliability coefficient for the questionnaire as a whole is 0,945. As this value is close to one (higher than 0,8), this questionnaire can be considered as a reliable instrument to measure environmental literacy of teachers.

6.4 Validity of the Questionnaire

In general terms, validity refers to the extent to which a test measures what it is intended to measure as defined by the researcher (Mulder, 1996:215)). Various types of validity are discussed in the literature.

Content validity depends on the opinions, comments and suggestions of experienced and suitably qualified people (experts). On the strength of their opinions, the researcher can then omit, amend or even add certain items. This means that content validity cannot be established statistically.

Construct validity is concerned with the degree to which the instrument actually measures the theoretical construct that it is supposed to measure.

In this study, both the content and construct validity of the questionnaire was established as explained in the following paragraphs.

6.4.1 Content Validity

The development of the items in the questionnaire for this study was outlined in paragraph 5.3 and the development of concepts related to environmental education and environmental literacy were explained in paragraph 4.3. Content validation was verified before the questionnaire was presented to the teachers in this study (Refer paragraph 5.3.1) by submitting it to eight specialists in environmental education, ecology and sustainable development. The information submitted to the specialists included the identified concepts related to environmental literacy (Table 6), arrangement of the items in the questionnaire (Table 7 indicating items on awareness, knowledge, attitude and participation for each concept) and the desired responses (Table 8) as well as general information on the items in Section B of the questionnaire. They were requested to make their comments as to the content validity of the instrument to assess the level of environmental literacy of teachers in the RSA.

After receiving the comments from the experts, necessary adjustments were made to the questionnaire. That is, items mainly with unnecessary detail, items with contested desired answers and items with grammar and spelling mistakes were rewritten. Some questions that encourage the respondents to see environmental issues as part and parcel of development issues were also included. Several items, for example, items 14, 18, 27, 64, 65, 77, 91, 95, 97, 114 from Section B1 and items 1, 3, 4, 5, 14, 16, and 18 from Section B2 with unnecessary detail had to be rewritten. For example, the original statement for item 18 "Activities such as reducing forests, increasing the amount of chemicals released into the atmosphere, and intensive farming have changed air, water and land as life support systems" was changed to "Intensive farming has changed air, water and land as life support systems". Wherever possible the items in the questionnaire were made shorter mainly by removing unnecessary detail.

Items with contested desired answers were also rewritten. For example, item 96 and 17 (Section B2). The original statement for item 96 "factories producing items for profit may use processes that contribute to acid rain" was changed to " many factories contribute to the formation of acid rain". This is because all factories produce items for profit, otherwise, it is unlikely that they all exist. In the case of item 17 (Section B2), the original statement was "It is important to protect all animals in the ecosystem". This may mean that even locusts, ticks, etc. should be protected. Therefore, item 17 (Section B2) was changed to "It is important to protect all useful animals". Errors in items in Section B1 such as 30, 38, 47, 50, 67, 69 and errors in items in Section B2 such as 12, 21 and 24 were also corrected.

The major concern was the length of the questionnaire to be given to the teachers which may result in a low response rate due to fatigue. It was also difficult to isolate questions due to the interrelationship among the ten concepts related to environmental literacy. In addition, the interrelationship between awareness, knowledge, attitude and participation made it difficult to classify questions into these categories. To make the research more relevant, one expert argued that the questionnaire should include some questions related to sustainable socio-economic development and issues of environmental management in the developing world. This was mainly because the majority of South Africans are still very much in the developing phase of their community lives. It was suggested that questions that encourage the respondent to see environmental issues as part and parcel of development issues would make the questionnaire much more holistic and more relevant. The comments of the experts indicate that, with the proposed amendments, the questionnaire shows the necessary content validity to assess environmental literacy of teachers in the RSA.

6.4.2 Construct Validity

It often happens that a questionnaire consists of different subsections, measuring different constructs. The present questionnaire is an example of such a situation since it measures awareness, knowledge, attitude and participation with regard to the environment. In total the questionnaire measures environmental literacy. Although the test consists of different constructs, they are related to one another and to the total construct of the test because they all deal with behaviour in an environmental context. One would therefore expect to find significant positive correlations among the constructs (subsections) and between each construct. (subsection) and the construct measured by the questionnaire in total (environmental literacy). If such correlations exist, one can regard the questionnaire to be construct valid. Therefore, in order to determine construct validity, correlation coefficients were calculated between the four different constructs and between each construct and the total of the test. These correlation coefficients appear in Table 15.

Table 15: Intercorrelations between environmental literacy and the variables

Variables	Awareness	Knowledge	Attitude	Participation
Total (EL)	0,895*	0,882*	0,885*	0,877*
Awareness		0,799*	0,727*	0,705*
Knowledge			0,673*	0,694*
Attitude				0,701*

*Statistically significant at .01 level.

EL = Environmental Literacy

All the correlations seem to be high positive correlations, significantly on the 1% level. The different constructs therefore strongly relate to one another as expected and consequently the questionnaire may be considered construct valid.

6.5 Determining the Norms of the Questionnaire

A norm is an objective standard whereby the scores which a testee obtains on a measuring instrument, are interpreted. With norms a researcher who presents a particular instrument at a later occasion to a group of testees, will be in a position to interpret the score obtained by each testee in terms of the results obtained by the standardisation group (Mulder, 1996:201). There are several methods to determine norms for a questionnaire. In this study, stanines (standard scores divided into nine categories) were used. The nine categories are derived by grouping the scores into intervals of 0,5z. For example, the first stanine encloses the whole area below -1,75z, while the ninth stanine encloses the whole area above 1,75z. A summary of the limits, percentage of area and cumulative percentage of each stanine are shown in Table 16.

Table 16: Limits, areas and cumulative percentages of stanines

Stanine	Limits	% of Area	Cumulative Percentage
9	+ 4 to + 1,75z	4	Above 96
8	+ 1,75z to + 1,25z	7	90 - 96
7	+ 1,25z to + 0,75z	12	78 - 89
6	+ 0,75z to + 0,25z	17	61 - 77
5	+ 0,25z to - 0,25z	20	41 - 60
4	- 0,25z to - 0,75z	17	24 - 40
3	- 0,75z to -1,25z	12	12 - 23
2	- 1,25z to -1,75z	7	5 - 11
1	- 1,75z to - 4	4	0 - 4

The stanines for each aspect of environmental literacy as well as the questionnaire as a whole were calculated according to Table 16. In the interpretation of the stanines, the first three stanines (1,2,and 3) are regarded as below average, the next three stanines (4,5 and 6) as average and the top three stanines (7,8 and 9) as above average (Mulder, 1996:205).

Tables 17 to 21 demonstrate how the raw scores are grouped into stanines for each of the aspects, awareness, knowledge, attitude, and participation.

6.5.1 Transformation of the Raw Scores into Stanines: Awareness

The transformation of raw scores into stanines for the aspect awareness is provided in Table 17.

Table: 17 Transformation of the raw scores into stanines: Awareness

Raw Scores	Stanine
27 - 66	1
67 - 70	2
71 - 74	3
75 - 78	4
79 - 82	5
83 - 87	6
88 - 93	7
94 - 97	8
98 - 108	9

The lowest possible score for awareness was 27 and the highest possible score was 108. Scores ranging from 27 to 74 are regarded as below average, scores between 75 and 87 as average and scores from 88 to 108 as above average.

6.5.2 Transformation of the Raw Scores into Stanines: Knowledge

The transformation of raw scores into stanines for the aspect knowledge is provided in Table 18.

Table: 18 Transformation of the raw scores into stanines: Knowledge

Raw Score	Stanine
34 - 82	1
83 - 87	2
88 - 92	3
93 - 96	4
97 - 101	5
102 - 107	6
108 - 115	7
116 - 120	8
121 - 136	9

The lowest possible score for knowledge was 34 and the highest possible score was 136. Scores ranging from 34 to 92 are regarded as below average, scores between 93 and 107 as average and scores from 108 to 136 as above average.

6.5.3 Transformation of the Raw Scores into Stanines: Attitude

The transformation of raw scores into stanines for the aspect attitude is provided in Table 19.

Table: 19 Transformation of the raw scores into stanines: Attitude

Raw Score	Stanine
36 - 87	1
88 - 93	2
94 - 102	3
103 - 109	4
110 - 115	5
116 - 121	6
122 - 126	7
127 - 133	8
134 - 144	9

The lowest possible score for attitude was 36 and the highest possible score was 144. Scores ranging from 36 to 102 are regarded as below average, scores between 103 and 121 as average and scores from 122 to 144 as above average.

6.5.4 Transformation of the Raw Scores into Stanines: Participation

The transformation of raw scores into stanines for the aspect participation is provided in Table 20.

Table: 20 Transformation of the raw scores into stanines: Participation

Raw Score	Stanine
38 - 88	1
89 - 96	2
97 - 100	3
101 - 105	4
106 - 111	5
112 - 118	6
119 - 125	7
126 - 131	8
132 - 152	9

The lowest possible score for participation was 38 and the highest possible score was 152. Scores ranging from 38 to 100 are regarded as below average, scores between 101 and 118 as average and scores from 119 to 152 as above average.

6.5.5 Transformation of the Raw Scores into Stanines: Questionnaire as a Whole

The transformation of raw scores into stanines for the questionnaire as a whole is provided in Table 21.

Table: 21 Transformation of the raw scores into stanines: Questionnaire as a whole

Raw Score	Stanine
135 - 349	1
350 - 373	2
374 - 393	3
394 - 410	4
411 - 427	5
428 - 451	6
452 - 472	7
473 - 492	8
493 - 540	9

The lowest possible score for all items in the questionnaire as a whole was 135 and the highest possible score was 540. Scores ranging from 135 to 393 are regarded as below average, scores between 394 and 451 as average and scores from 452 to 540 as above average.

A summary of the norms for the questionnaire as a whole and the four aspects of environmental literacy are given in Table 22.

Table 22: Classification of the environmental literacy scores in categories

Aspect	Below Average	Average	Above Average
Awareness	27 - 74	75 - 87	88 - 108
Knowledge	34 - 92	93 - 107	108 - 136
Attitude	36 - 102	103 - 121	122 - 144
Participation	38 - 100	101 - 118	119 - 152
Total Questionnaire	135 -393	394 - 451	452 - 540

6.6 Testing of Hypotheses

In this paragraph, the testing of the hypotheses stated in paragraph 5.8 is outlined.

6.6.1 Testing of Hypothesis 1

With regard to hypothesis 1 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between male and female teachers with regard to environmental literacy.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents (N=352) were divided into two groups based on gender. Group 1 represents 134 males and Group 2 represents 218 females. To determine whether Group 1 differed significantly from Group 2 regarding environmental literacy the mean of each group was calculated for each aspect of environmental literacy, as well as for the questionnaire as a whole. The t-test for independent samples was used to determine whether these means differ significantly. The results are indicated in Table 23.

Table 23: Difference between the level of environmental literacy of male and female teachers

Variable	Group	Number	Mean	SD	T	DF	P
Awareness	Male	134	82,46	8,75			
	Female	218	80,39	9,04	2,12	350	$p < 0,05$
Knowledge	Male	134	100,71	10,22			
	Female	218	99,77	10,69	0,82	350	$p > 0,05$
Attitude	Male	134	113,37	12,69			
	Female	218	110,75	12,74	1,87	350	$p > 0,05$
Participation	Male	134	109,04	11,43			
	Female	218	109,42	12,19	0,29	350	$p > 0,05$
Total	Male	134	423,92	38,64			
	Female	218	418,44	40,23	1,26	350	$p > 0,05$

According to the information given in Table 23, a t-value of 1,26 was obtained for the questionnaire as a whole, with $p > 0,05$. This means thahat the null hothesis cannot be rejected. The implication is that there is no significant difference between the average environmental literacy of male and female teachers.

However, Table 23 reveals that there is a significant difference between male and female teachers with regard to awareness as an aspect of environmental literacy. In this instance, the null hypothesis can be rejected at 5% level of significance. The averages for males (82,5) are higher than that of females (80,4) indicating a higher level of environmental awareness. For the other aspects no significant differences could be indicated.

From the research reported by Buethe & Smallwood (1987:41) it appears that male teachers are more environmentally literate than female teachers. The results from the present study showed, however, that male and female teachers do not differ significantly with regard to environmental literacy except for awareness as an aspect of environmental literacy.

6.6.2 Testing of Hypothesis 2

With regard to hypothesis 2 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the environmental literacy of teachers in different age groups.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into eight age groups, namely,

Group 1 : 24 years or less
Group 2 : 25-29 years
Group 3 : 30-34 years
Group 4 : 35-39 years
Group 5 : 40-44 years
Group 6 : 45-49 years
Group 7 : 50-54 years
Group 8 : 55 years or older

(a) Comparison between the eight age groups with regard to environmental literacy in general

The average environmental literacy scores of teachers in the different age groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 24.

Table 24: Difference between the level of environmental literacy of teachers in the different age groups

Group	N	Mean	SD
1. 24 years or less	12	413,17	50,46
2. 25-29 years	55	420,75	36,79
3. 30-34 years	80	417,56	36,89
4. 35-39 years	79	418,68	38,23
5. 40-44 years	71	424,62	42,38
6. 45-49 years	36	422,94	42,62
7. 50-54 years	13	434,92	38,08
8. 55 years or older	6	402,83	55,57

$F\ (7,344) = 0,69; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the level of environmental literacy of teachers in the different age groups.

It appears that the results obtained in this study, contradicts the research results obtained by Buethe & Smallwood (1987). According to Buethe & Smallwood (1987:41) mature teachers show higher levels of environmental literacy.

(b) Comparison between the eight age groups with regard to environmental awareness

The average environmental awareness scores for each of the eight groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 25.

Table 25: Difference between the level of environmental awareness of teachers in the different age groups

Group	N	Mean	SD
1. 24 years or less	12	80,58	10,70
2. 25-29 years	55	80,53	8,33
3. 30-34 years	80	80,87	8,51
4. 35-39 years	79	80,99	8,82
5. 40-44 years	71	81,83	9,21
6. 45-49 years	36	80,89	9,68
7. 50-54 years	13	84,54	9,33
8. 55 years or older	6	81,50	14,01

$F(7,344) = 0{,}38$; $p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average awareness (as an aspect of environmental literacy) of teachers in the different age groups.

(c) Comparison between the eight age groups with regard to environmental knowledge

The average environmental knowledge scores for each of the eight groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 26.

Table 26: Difference between the level of environmental knowledge of teachers in the different age groups

Group	N	Mean	SD
1. 24 years or less	12	98,50	10,563
2. 25-29 years	55	99,84	10,13
3. 30-34 years	80	99,53	9,36
4. 35-39 years	79	100,08	9,96
5. 40-44 years	71	101,15	11,72
6. 45-49 years	36	100,31	11,38
7. 50-54 years	13	104,15	10,46
8. 55 years or older	6	92,67	15,16

$F(7{,}344) = 0{,}89$; $p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average knowledge (as an aspect of environmental literacy) of teachers in the different age groups.

(d) Comparison between the eight age groups with regard to environmental attitude

The average environmental attitude scores for each of the eight groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 27.

Table 27: Difference between the level of environmental attitude of teachers in the different age groups

Group	N	Mean	SD
1. 24 years or less	12	107,92	15,87
2. 25-29 years	55	112,69	12,59
3. 30-34 years	80	110,84	12,13
4. 35-39 years	79	110,77	12,32
5. 40-44 years	71	112,92	13,35
6. 45-49 years	36	112,28	12,32
7. 50-54 years	13	117,62	14,40
8. 55 years or older	6	105,83	14,33

$F(7,344) = 0,99; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average attitude (as an aspect of environmental literacy) of teachers in the different age groups.

(e) Comparison between the eight age groups with regard to environmental participation

The average environmental participation scores for each of the eight groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 28.

Table 28: Difference between the level of environmental participation of teachers in the different age groups

Group	N	Mean	SD
1. 24 years or less	12	107,08	14,68
2. 25-29 years	55	109,42	11,36
3. 30-34 years	80	108,28	10,84
4. 35-39 years	79	108,71	12,05
5. 40-44 years	71	110,70	12,25
6. 45-49 years	36	110,83	13,25
7. 50-54 years	13	110,46	9,70
8. 55 years or older	6	104,33	15,95

$F (7,344) = 0,56; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between average participation (as an aspect of environmental literacy) of teachers in the different age groups.

There is insufficient literature dealing with the four identified aspects of environmental literacy and the age of teachers. It was noted by Buethe & Smallwood (1987:41) that mature teachers had better scores in environmental literacy. But, according to the present study, there is no significant difference between the teachers in the different age categories regarding the four aspects (awareness, knowledge, attitude and participation) of environmental literacy.

6.6.3 Testing of Hypothesis 3

With regard to hypothesis 3 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the level of environmental literacy of teachers from schools in different areas.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into three groups based on the location of the school, namely

Group 1 : Urban

Group 2 : Rural

Group 3 : Semi-urban

(a) Comparison between the three groups (Location of the school) with regard to environmental literacy in general

The average environmental literacy scores of the three groups with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 29.

Table 29: Difference between the level of environmental literacy of teachers from different school locations

Group	N	Mean	SD
Urban	24	435,17	41,41
Rural	210	419,43	40,51
Semi-urban	118	419,49	37,48

$F(2,349) = 1,76; \; p > 0,05$

The null hypothesis cannot be rejected as p > 0,05. Therefore, there is no significant difference in the level of environmental literacy between teachers from the three groups (urban, rural and semi-urban).

(b) Comparison between the three groups (Location of the school) with regard to environmental awareness

The average environmental awareness scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 30.

Table 30: Difference between the level of environmental awareness of teachers from different school locations

Group	N	Mean	SD
Urban	24	83,88	9,44
Rural	210	80,80	9,32
Semi-urban	118	81,29	8,20

$F(2,349) = 1,28$; $p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. Therefore, there is no significant difference regarding awareness as an aspect of environmental literacy between teachers from different locations of the school.

(c) Comparison between the three groups (Location of the school) with regard to environmental knowledge

The average environmental knowledge scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 31.

Table 31: Difference between the level of environmental knowledge of teachers from different school locations

Group	N	Mean	SD
Urban	24	102,71	12,76
Rural	210	99,72	10,80
Semi-urban	118	100,32	9,44

$F(2,349) = 0{,}90; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. Therefore, there is no significant difference regarding knowledge as an aspect of environmental literacy between teachers from different locations of the school.

(d) Comparison between the three groups (Location of the school) with regard to environmental attitude

The average environmental attitude scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 32.

Table 32: Difference between the level of environmental attitude of teachers from different school locations

Group	N	Mean	SD
Urban	24	114,67	12,76
Rural	210	111,59	10,80
Semi-urban	118	111,42	9,44

$F\ (2{,}349) = 0{,}68;\quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. Therefore, there is no significant difference regarding attitude as an aspect of environmental literacy between teachers from different locations of the school.

(e) Comparison between the three groups (Location of the school) with regard to environmental participation

The average environmental participation scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 33.

Table 33: Difference between the level of environmental participation of teachers from different school locations

Group	N	Mean	SD
Urban	24	116,17	12,52
Rural	210	109,05	11,79
Semi-urban	118	108,27	11,57

$F\,(2{,}349) = 4{,}58; \quad p < 0{,}05$

The null hypothesis can be rejected at the 5% level of significance. Therefore, there is a significant difference regarding participation as an aspect of environmental literacy between teachers from different locations of the school. In order to establish between which groups this difference exists, t-values were calculated by means of a t-test for independent samples. These results are shown in Table 34.

Table 34: Differences between the level of environmental participation of teachers from different school locations (t-test analysis)

Groups	Difference between the means	T value	Significance
1- 2	7,11	$t > 2{,}41$	$p < 0{,}05$ *
1 - 3	7,90	$t > 2{,}41$	$p < 0{,}05$*
2 - 3	0,78	$t < 2{,}41$	$p > 0{,}05$

* Comparisons significant at the 5% level.

There is a significant difference between groups 1 and 2, as well as groups 1 and 3. That is, between urban and rural as well as between urban and semi-urban. The mean of group 1 (116,2) is significantly higher than that of group 2 (109,1) and group 3 (108,3) indicating that teachers from urban schools obtained higher scores for the participation aspect of environmental literacy. There were no studies reported in the available literature comparing the environmental literacy of teachers from urban, rural, and semi-urban areas.

The result from this study indicates that there is no significant difference in the level of environmental literacy (except for participation) between teachers from the three locations of school (urban, rural and semi-urban).

6.6.4 Testing of Hypothesis 4

With regard to hypothesis 4 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference in the level of environmental literacy of teachers with regard to the place of residence.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into three groups based on the location of their home, namely Group 1 : Urban

Group 2 : Rural

Group 3 : Semi-urban

(a) Comparison between the three groups (Location of home) with regard to environmental literacy in general

The average environmental literacy scores of the three groups with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 35.

Table 35: Difference between the level of environmental literacy of teachers from different home locations

Group	N	Mean	SD
Urban	112	423,19	42,03
Rural	145	419,88	40,57
Semi-urban	95	418,37	35,41

$F(2,349) = 0{,}41; \ p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the level of environmental literacy between the three groups.

There is insufficient literature dealing with environmental literacy of teachers with regard to place of residence. According to the present study, there is no significant difference in the level of environmental literacy between the three groups (urban, rural and semi-urban) with regard to the location of home.

(b) Comparison between the three groups (Location of home) with regard to environmental awareness

The average environmental awareness scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 36.

Table 36: Difference between the level of environmental awareness of teachers from different home locations

Group	N	Mean	SD
Urban	112	81,48	9,02
Rural	145	81,19	9,39
Semi-urban	95	80,79	8,33

$F\ (2{,}349) = 0{,}15; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference in the average awareness (as an aspect of environmental literacy) of teachers from different locations of home.

(c) Comparison between the three groups (Location of home) with regard to environmental knowledge

The average environmental knowledge scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 37.

Table 37: Difference between the level of environmental knowledge of teachers from different home locations

Group	N	Mean	SD
Urban	112	101,11	10, 47
Rural	145	99,29	11,24
Semi-urban	95	100,24	9,33

$F\ (2,349) = 0,95;\quad p > 0,05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average knowledge (as an aspect of environmental literacy) of teachers from different locations of home.

(d) Comparison between the three groups (Location of home) with regard to environmental attitude

The average environmental attitude scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 38.

Table 38: Difference between the level of environmental attitude of teachers from different home locations

Group	N	Mean	SD
Urban	112	112,26	13,47
Rural	145	111,84	12,49
Semi-urban	95	110,99	12,43

$F (2,349) = 0,26; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference in the average attitude (as an aspect of environmental literacy) of teachers from different locations of home.

(e) Comparison between the three groups (Location of home) with regard to environmental participation

The average environmental participation scores for each of the three groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 39.

Table 39: Difference between the level of environmental participation of teachers from different home locations

Group	N	Mean	SD
Urban	112	110,43	13,03
Rural	145	109,13	11,49
Semi-urban	95	108,14	11,04

$F\ (2{,}349) = 0{,}97; \quad p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average knowledge (as an aspect of environmental literacy) of teachers from different locations of home.

There is insufficient literature dealing with the four aspects of environmental literacy with regard to place of residence. According to the present study, there is no significant difference in the four aspects of environmental literacy of teachers with different places of residence.

6.6.5 Testing of Hypothesis 5

With regard to hypothesis 5 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the environmental literacy of teachers involved in the different learning areas.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into the following eight groups (learning areas).

Group 1 : Language, Literacy and Communication (LLC)

Group 2 : Human & Social Sciences (HSS)

Group 3 : Mathematics, Mathematical Literacy & Mathematical Sciences (MMLMS)

Group 4 : Natural Sciences (NS)

Group 5 : Arts & Culture (AC)

Group 6 : Economic & Management Sciences (EMS)

Group 7 : Life Orientation (LO)

Group 8 : Technology (TE)

(a) Comparison between the eight groups (Learning area) with regard to environmental literacy in general

The average environmental literacy scores of the eight groups with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 40.

Table 40: Difference between the level of environmental literacy of teachers involved in the different learning areas

Group	N	Mean	SD
1. LLC	124	413,71	38,10
2. HSS	63	422,14	38,70
3. MMLMS	46	417,22	37,16
4. NS	64	432,89	39,44
5. AC	16	408,88	41,32
6. EMS	23	436,26	44,36
7. LO	12	424,42	43,17
8. TE	4	391,00	34,62

$F(7,344) = 2,60; \quad p < 0,01$

The null hypothesis can be rejected at the 1% level of significance as $p < 0,01$. There is a significant difference between the average environmental literacy scores of teachers in the eight groups. In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. These results are shown in Table 41.

Table 41: Difference between the level of environmental literacy of teachers involved in the different learning areas (t-test analysis)

Groups	Difference between the means	T value	Significance
1- 2	8,43	$t < 3,14$	$p > 0,05$
1 - 3	3,51	$t < 3,14$	$p > 0,05$
1 - 4	19,18	$t > 3,14$	$p < 0,05$ *
1 - 5	4,84	$t < 3,14$	$p > 0,05$
1 - 6	22,55	$t < 3,14$	$p > 0,05$
1 - 7	10,71	$t < 3,14$	$p > 0,05$
1 - 8	22,71	$t < 3,14$	$p > 0,05$
2 - 3	4,93	$t < 3,14$	$p > 0,05$
2 - 4	10,75	$t < 3,14$	$p > 0,05$
2 - 5	13,27	$t < 3,14$	$p > 0,05$
2 - 6	14,12	$t < 3,14$	$p > 0,05$
2 - 7	2,27	$t < 3,14$	$p > 0,05$
2 - 8	31,14	$t < 3,14$	$p > 0,05$
3 - 4	15,67	$t < 3,14$	$p > 0,05$
3 - 5	8,34	$t < 3,14$	$p > 0,05$
3 - 6	19,04	$t < 3,14$	$p > 0,05$
3 - 7	7,20	$t < 3,14$	$p > 0,05$

Table 41: Continued ...

Groups	Difference between the means	t-value	Significance
3 - 8	26,22	t < 3,14	p > 0,05
4 - 5	24,02	t < 3,14	p > 0,05
4 - 6	3,37	t < 3,14	p > 0,05
4 - 7	8,47	t < 3,14	p > 0,05
4 - 8	41,89	t < 3,14	p > 0,05
5 - 6	27,39	t < 3,14	p > 0,05
5 - 7	15,54	t < 3,14	p > 0,05
6 - 7	11,84	t < 3,14	p > 0,05
6 - 8	45,26	t < 3,14	p > 0,05
7 - 8	33,42	t < 3,14	p > 0,05

* Comparisons significant at 5% level.

There is a significant difference between groups 1 and 4. This indicates that the major difference in the level of environmental literacy is between teachers involved in Language, Literacy and Communication (group 1) and those involved in Natural Sciences (group 4). The mean of group 1 (413) is significantly lower than that of group 4 (432) indicating that group 4 had significantly higher levels of environmental literacy. This is in line with the studies reported by Buethe & Smallwood (1987). According to Buethe & Smallwood (1987) science teachers had higher levels of environmental literacy than other teachers.

(b) Comparison between the eight groups (Learning areas) with regard to environmental awareness

The average environmental awareness scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 42.

Table 42: Difference between the level of environmental awareness of teachers involved in the different learning areas

Group	N	Mean	SD
1. LLC	124	79,95	8,71
2. HSS	63	82,30	8,65
3. MMLMS	46	80,72	8,81
4. NS	64	82,39	8,34
5. AC	16	79,19	9,71
6. EMS	23	84,30	9,52
7. LO	12	81,83	9,25
8. TE	4	75,25	7,14

$F\ (7{,}344) = 1{,}44; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference in the average awareness (as an aspect of environmental literacy) of teachers from different learning areas.

(c) Comparison between the eight groups (Learning areas) with regard to environmental knowledge

The average environmental knowledge scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 43.

Table 43: Difference between the level of environmental knowledge of teachers involved in the different learning areas

Group	N	Mean	SD
1. LLC	124	97,55	10,58
2. HSS	63	101,32	10,02
3. MMLMS	46	99,24	7,93
4. NS	64	103,39	10,80
5. AC	16	97,38	9,73
6. EMS	23	105,26	11,42
7. LO	12	101,33	12,87
8. TE	4	97,00	3,92

$F(7,344) = 3{,}27; \quad p < 0{,}01$

The null hypothesis can be rejected at 1 % level of significance as $p < 0{,}01$. There is a significant difference in the average knowledge (as an aspect of environmental literacy) of teachers from different learning areas. In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. This is shown in Table 44.

Table 44: Difference between the level of environmental knowledge of teachers involved in the different learning areas (t-test analysis)

Groups	Difference between the means	T value	Significance
1 - 2	3,77	$t < 3,14$	$p > 0,05$
1 - 3	1,69	$t < 3,14$	$p > 0,05$
1 - 4	5,84	$t > 3,14$	$p < 0,05$*
1 - 5	0,17	$t < 3,14$	$p > 0,05$
1 - 6	22,55	$t > 3,14$	$p < 0,05$*
1 - 7	7,71	$t < 3,14$	$p > 0,05$
1 - 8	0,55	$t < 3,14$	$p > 0,05$
2 - 3	2,08	$t < 3,14$	$p > 0,05$
2 - 4	2,07	$t < 3,14$	$p > 0,05$
2 - 5	3,94	$t < 3,14$	$p > 0,05$
2 - 6	3,94	$t < 3,14$	$p > 0,05$
2 - 7	0,02	$t < 3,14$	$p > 0,05$
2 - 8	4,32	$t < 3,14$	$p > 0,05$
3 - 4	4,15	$t < 3,14$	$p > 0,05$

Table 44: Continued ...

Groups	Difference between the means	T value	Significance
3 - 5	1,86	t < 3,14	p > 0,05
3 - 6	6,02	t < 3,14	p > 0,05
3 - 7	2,09	t < 3,14	p > 0,05
3 - 8	2,24	t < 3,14	p > 0,05
4 - 5	6,02	t < 3,14	p > 0,05
4 - 6	1,87	t < 3,14	p > 0,05
4 - 7	2,06	t < 3,14	p > 0,05
4 - 8	6,39	t < 3,14	p > 0,05
5 - 6	7,89	t < 3,14	p > 0,05
5 - 7	3,96	t < 3,14	p > 0,05
5 - 8	0,38	t < 3,14	p > 0,05
6 - 7	3,93	t < 3,14	p > 0,05
6 - 8	8,26	t < 3,14	p > 0,05
7 - 8	4,33	t < 3,14	p > 0,05

* Comparisons significant at 5% level.

There is a significant difference between groups 1 and 4, as well as groups 1 and 6. That is, between teachers involved in Language, Literacy & Communication (LLC) and those in

Natural Sciences (NS) as well as between teachers involved in Language, Literacy & Communication (LLC) and those in Economic & Management Sciences (EMS). The mean of group 1 (97) is significantly lower than that of group 4 (103) indicating that natural science teachers had higher scores in knowledge aspect of environmental literacy. This finding supports the research reported by Buethe & Smallwood (1987) showing that natural science teachers had higher levels of knowledge than other teachers.

It was also found that the mean of group 1 (97) is significantly lower than that of group 6 (105) indicating that teachers in Economic & Management Sciences also had higher scores in knowledge aspect of environmental literacy. According to a study by Abraham & Chacko (1999), college lecturers had average environmental literacy irrespective of the subjects they teach. In this study, however, it seems that teachers in natural sciences had higher scores in the knowledge aspect of environmental literacy.

(d) Comparison between the eight groups (Learning areas) with regard to environmental attitude

The average environmental attitude scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 45.

Table 45: Difference between the level of environmental attitude of teachers involved in the different learning areas

Group	N	Mean	SD
1. LLC	124	110,69	12,26
2. HSS	63	111,63	13,16
3. MMLMS	46	111,09	12,55
4. NS	64	115,56	11,74
5. AC	16	105,31	14,10
6. EMS	23	116,00	14,22
7. LO	12	110,00	10,46
8. TE	4	99,25	15,65

$F\ (7{,}344) = 2{,}56;\quad p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average attitude (as an aspect of environmental literacy) of teachers from different learning areas.

(e) Comparison between the eight groups (Learning area) with regard to environmental participation

The average environmental participation scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 46.

Table 46: Difference between the level of environmental participation of teachers involved in the different learning areas

Group	N	Mean	SD
1. LLC	124	107,61	11,15
2. HSS	63	109,05	11,24
3. MMLMS	46	107,67	11,79
4. NS	64	112,98	12,40
5. AC	16	108,88	11,41
6. EMS	23	112,09	15,31
7. LO	12	112,17	10,48
8. TE	4	100,25	9,11

$F(7,344) = 2,02; \quad p > 0,05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average participation (as an aspect of environmental literacy) of teachers from different learning areas.

It appears that there is a significant difference between the average environmental literacy of teachers in different learning areas. The major difference exists between teachers involved in Language, Literacy and Communication (LLC) and those in Natural Science (NS). The Natural Science teachers had higher scores. There is a significant difference between groups 1 (LLC) and 4 (NS), as well as groups 1 (LLC) and 6 (Economic & Management Sciences - EMS) with regard to the knowledge aspect of environmental literacy. The result from this study indicates that there is no significant difference between the average awareness (as an aspect of environmental literacy) of teachers in different learning areas. The same applies to attitude and participation.

6.6.6 Testing of Hypothesis 6

With regard to hypothesis 6 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the level of environmental literacy of teachers with different qualifications.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into the following five groups based on qualifications.

Group 1 : Standard 10

Group 2 : B.A

Group 3 : B.Sc

Group 4 : B.Comm

Group 5 : Other

(a) Comparison between the five groups (Qualifications) with regard to environmental literacy in general

The average environmental literacy scores of the five groups with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 47.

Table 47: Difference between the level of environmental literacy of teachers with different qualifications

Group	N	Mean	SD
1. Standard 10	103	416,31	35,71
2. B.A	64	418,88	37,62
3. B.Sc	24	417,50	51,44
4. B.Comm	12	446,00	41,59
5. Other	149	422,58	40,48

$F\ (4,347) = 1,70;\ \ p > 0,05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average environmental literacy of teachers with different qualifications.

It appears that the results obtained in this study, contradict research results reported by Buethe & Smallwood (1987). According to Buethe & Smallwood (1987) science teachers had higher levels of environmental literacy than other teachers. It is assumed that secondary school science teachers in the United States of America hold a B.Sc degree).

(b) Comparison between the five groups (Qualifications) with regard to environmental awareness

The average environmental awareness scores for each of the five groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 48.

Table 48: Difference between the level of environmental awareness of teachers with different qualifications

Group	N	Mean	SD
1. Standard 10	103	80,39	8,52
2. B.A	64	81,50	8,31
3. B.Sc	24	82,08	10,85
4. B.Comm	12	88,42	7,81
5. Other	149	80,85	9,15

$F\ (4,347) = 2,32;\ p < 0,05$

The null hypothesis can be rejected at the 5% level of significance as $p < 0,05$. There is a significant difference between the average awareness (as an aspect of environmental literacy) scores of teachers with different qualifications. In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. These results are shown in Table 49.

Table 49: Difference between the level of environmental awareness of teachers with different qualifications (t-test analysis)

Groups	Difference between the means	t-value	Significance
1 - 2	1,11	$t < 2,83$	$p > 0,05$
1 - 3	1,70	$t < 2,83$	$p > 0,05$
1 - 4	8,03	$t > 2,83$	$p < 0,05$ *
1 - 5	0,46	$t < 2,83$	$p > 0,05$
2 - 3	0,58	$t < 2,83$	$p > 0,05$
2 - 4	6,92	$t < 2,83$	$p > 0,05$
2 - 5	0,65	$t < 2,83$	$p > 0,05$
3 - 4	6,33	$t < 2,83$	$p > 0,05$
3 - 5	1,23	$t < 2,83$	$p > 0,05$
4 - 5	7,56	$t > 2,83$	$p < 0,05$ *

* Comparisons significant at 5% level.

There is significant difference between the average scores of groups 1 and 4, as well as between groups 4 and 5. That is, between teachers with only a Standard 10 and those with a B.Comm as well as between teachers with a B.Comm and others. The mean of group 1 (80) is significantly lower than that of group 4 (88) indicating that B.Comm graduates had higher scores in the awareness aspect of environmental literacy. It was also found that the mean of group 5 (81) is significantly lower than that of group 4 (88) indicating that B.Comm graduates had higher scores in the awareness aspect of environmental literacy than others.

(c) Comparison between the five groups (Qualifications) with regard to environmental knowledge

The average environmental knowledge scores for each of the five groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 50.

Table 50: Difference between the level of environmental knowledge of teachers with different qualifications

Group	N	Mean	SD
1. Standard 10	103	98,79	9,71
2. B.A	64	100,00	8,38
3. B.Sc	24	101,54	11,93
4. B.Comm	12	107,00	12,28
5. Other	149	100,32	11,32

$F\ (4{,}347) = 1{,}84; \quad p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference between the average knowledge (as an aspect of environmental literacy) score of teachers with different qualifications.

(d) Comparison between the five groups (Qualifications) with regard to environmental attitude

The average environmental attitude scores for each of the five groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 51.

Table 51: Difference between the level of environmental attitude of teachers with different qualifications

Group	N	Mean	SD
1. Standard 10	103	110,00	11,11
2. B.A	64	110,55	13,72
3. B.Sc	24	108,13	16,80
4. B.Comm	12	118,58	16,93
5. Other	149	113,50	12,02

$F(4,347) = 2,72; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average attitude (as an aspect of environmental literacy) scores of teachers with different qualifications.

(e) Comparison between the five groups (Qualifications) with regard to environmental participation

The average environmental participation scores for each of the five groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 52.

Table 52: Difference between the level of environmental participation of teachers with different qualifications

Group	N	Mean	SD
1. Standard 10	103	108,59	11,46
2. B.A	64	108,75	10,76
3. B.Sc	24	107,71	14,65
4. B.Comm	12	111,67	13,16
5. Other	149	110,03	12,13

$F\ (4,347) = 0{,}49;\quad p > 0{,}05$

The null hypothesis cannot rejected as p > 0,05. There is no significant difference between the average participation (as an aspect of environmental literacy) score of teachers with different qualifications.

In conclusion, it was found that there is no significant difference between the average environmental literacy of teachers with different qualifications. The same applies to environmental knowledge, environmental attitude and environmental participation. B.Comm. graduates had higher scores in environmental awareness than those teachers with Standard 10 as their highest academic qualification. However, there is a significant difference between the average environmental awareness scores of teachers with different qualifications.

6.6.7 Testing of Hypothesis 7

With regard to hypothesis 7 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the level of environmental literacy of teachers with varying years of teaching experience.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole .

The respondents were divided into the following eight groups based on years of teaching experience.

Group 1 : 3 years or less
Group 2 : 4 - 7 years
Group 3 : 8 - 11 years
Group 4 : 12 - 15 years
Group 5 : 16 - 19 years
Group 6 : 20 - 23 years
Group 7 : 24 - 27 years
Group 8 : 28 years +

(a) Comparison between the eight groups (Teaching experience) with regard to environmental literacy in general

The average environmental literacy scores of the eight groups of teachers with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 53.

Table 53: Difference between the level of environmental literacy of teachers with different years of teaching experience

Group	N	Mean	SD
1. 3 years or less	29	418,10	34,84
2. 4 - 7 years	75	419,04	35,67
3. 8 - 11 years	72	411,46	39,27
4. 12 - 15 years	62	423,66	38,29
5. 16 - 19 years	58	425,60	41,41
6. 20 - 23 years	31	421,87	45,42
7. 24 - 27 years	13	429,46	39,12
8. 28 years +	12	436,17	56,34

$F\ (7{,}344) = 1{,}13;\ p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average environmental literacy score of teachers in the eight groups based on years of teaching experience.

(b) Comparison between the eight groups (Teaching experience) with regard to environmental awareness

The average environmental awareness scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 54.

Table 54: Difference between the level of environmental awareness of teachers with different years of teaching experience

Group	N	Mean	SD
1. 3 years or less	29	79,69	8,22
2. 4 - 7 years	75	81,11	8,05
3. 8 - 11 years	72	79,97	8,49
4. 12 - 15 years	62	81,40	9,39
5. 16 - 19 years	58	81,66	9,38
6. 20 - 23 years	31	81,39	10,35
7. 24 - 27 years	13	85,69	7,73
8. 28 years +	12	83,50	12,12

$F(7,344) = 0,92; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average awareness (as an aspect of environmental literacy) score of teachers with regard to years of teaching experience.

(c) Comparison between the eight groups (Teaching experience) with regard to environmental knowledge

The average environmental knowledge scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 55.

Table 55: Difference between the level of environmental knowledge of teachers with different years of teaching experience

Group	N	Mean	SD
1. 3 years or less	29	99,45	9,82
2. 4 - 7 years	75	100,52	8,97
3. 8 - 11 years	72	98,44	9,77
4. 12 - 15 years	62	100,55	10,60
5. 16 - 19 years	58	100,62	11,15
6. 20 - 23 years	31	101,32	12,09
7. 24 - 27 years	13	97,77	13,75
8. 28 years +	12	104,25	13,92

$F\ (7{,}344) = 0{,}74; \quad p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference between the average knowledge (as an aspect of environmental literacy) score of teachers with regard to years of teaching experience.

(d) Comparison between the eight groups (Teaching experience) with regard to environmental attitude

The average environmental attitude scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 56.

Table 56: Difference between the level of environmental attitude of teachers with different years of teaching experience

Group	N	Mean	SD
1. 3 years or less	29	111,38	9,54
2. 4 - 7 years	75	110,95	12,62
3. 8 - 11 years	72	109,07	13,14
4. 12 - 15 years	62	112,89	11,69
5. 16 - 19 years	58	113,50	13,03
6. 20 - 23 years	31	111,65	13,89
7. 24 - 27 years	13	113,77	14,30
8. 28 years +	12	117,33	16,78

$F(7,344) = 1,10; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average attitude (as an aspect of environmental literacy) score of teachers with regard to years of teaching experience.

(e) Comparison between the eight groups (Teaching experience) with regard to environmental participation

The average environmental participation scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 57.

Table 57: Difference between the level of environmental participation of teachers with different years of teaching experience

Group	N	Mean	SD
1. 3 years or less	29	109,03	12,35
2. 4 - 7 years	75	108,17	10,71
3. 8 - 11 years	72	106,39	11,92
4. 12 - 15 years	62	110,32	12,15
5. 16 - 19 years	58	111,43	11,23
6. 20 - 23 years	31	109,55	13,31
7. 24 - 27 years	13	114,38	10,93
8. 28 years +	12	112,00	14,54

$F\ (7{,}344) = 1{,}49; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average participation (as an aspect of environmental literacy) score of teachers with regard to years of teaching experience.

There is insufficient literature dealing with the four aspects of environmental literacy in relation to years of teaching experience. According to the present study, there is no significant difference between environmental literacy of teachers with different years of teaching experience.

6.6.8 Testing of Hypothesis 8

With regard to hypothesis 8 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the level of environmental literacy of teachers teaching in different phases.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into the following four groups (Phase in which tuition is offered).

Group 1 : Foundation Phase
Group 2 : Intermediate Phase
Group 3 : Senior Phase
Group 4 : Further Education & Training Phase

(a) Comparison between the four groups (Phase) with regard to environmental literacy in general

The average environmental literacy scores of the four groups of teachers with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 58.

Table 58: Difference between the level of environmental literacy of teachers teaching in different phases

Group	N	Mean	SD
1. Foundation Phase	83	420,89	36,94
2. Intermediate Phase	93	410,48	41,03
3. Senior Phase	88	425,86	41,53
4. Further Education & Training Phase	88	425,45	37,36

$F\ (3{,}348) = 3{,}02;\ p > 0{,}05$

The null hypothesis cannot be rejected as p > 0,05. There is no significant difference in the average environmental literacy scores of teachers from the four groups (phase in which tuition is offered).

(b) Comparison between the four groups (Phase) with regard to environmental awareness

The average environmental awareness scores for each of the four groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 59.

Table 59: Difference between the level of environmental awareness of teachers teaching in different phases

Group	N	Mean	SD
1. Foundation Phase	83	80,84	8,57
2. Intermediate Phase	93	78,59	8,83
3. Senior Phase	88	82,77	9,60
4. Further Education & Training Phase	88	82,63	8,32

$F\,(3,348) = 4{,}43; \quad p < 0{,}01$

The null hypothesis can be rejected as $p < 0{,}01$. There is a significant difference between the average awareness (as an aspect of environmental literacy) score of teachers teaching in different phases. In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. These results are shown in Table 60.

Table 60: Difference between the level of environmental awareness of teachers teaching in different phases (t-test analysis)

Groups	Difference between the means	T value	Significance
1 - 2	2,25	$t < 2{,}65$	$p > 0{,}05$
1 - 3	1,93	$t < 2{,}65$	$p > 0{,}05$
1 - 4	1,78	$t < 2{,}65$	$p > 0{,}05$
2 - 3	4,18	$t > 2{,}65$	$p < 0{,}05$*
2 - 4	4,03	$t > 2{,}65$	$p < 0{,}05$*
3 - 4	0,15	$t < 2{,}65$	$p > 0{,}05$

* Comparisons significant at 5% level.

There is a significant difference between the scores of groups 2 and 3, as well as those of groups 2 and 4. That is, between teachers teaching in Intermediate Phase (IP) and teachers teaching in Senior Phase (SP) as well as teachers teaching in Intermediate Phase (IP) and those teaching in Further Education & Training (FET). The mean of group 2 (78) is significantly lower than that of group 3 (82) and that of group 4 (82) indicating that teachers teaching in Senior Phase and Further Education & Training had higher scores than teachers teaching in Intermediate Phase (IP) in awareness as an aspect of environmental literacy. There were no studies reported in the literature investigating the environmental literacy of teachers in the four phases. According to the present study, teachers from Senior Phase and Further Education & Training Phase had higher scores in environmental literacy.

(c) Comparison between the four groups (Phase) with regard to environmental knowledge

The average environmental knowledge scores for each of the four groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 61.

Table 61: Difference between the level of environmental knowledge of teachers teaching in different phases

Group	N	Mean	SD
1. Foundation Phase	83	99,63	10,30
2. Intermediate Phase	93	97,78	9,78
3. Senior Phase	88	101,50	11,07
4. Further Education & Training Phase	88	101,69	10,55

$F\ (3{,}348) = 2{,}80; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average knowledge (as an aspect of environmental literacy) scores of teachers teaching in the different phases.

(d) Comparison between the four groups (Phase) with regard to environmental attitude

The average environmental attitude scores for each of the four groups were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 62.

Table 62: Difference between the level of environmental attitude of teachers teaching in different phases

Group	N	Mean	SD
1. Foundation Phase	83	112,49	11,78
2. Intermediate Phase	93	108,05	13,76
3. Senior Phase	88	113,14	13,22
4. Further Education & Training Phase	88	113,55	11,47

$F(3,348) = 3{,}70; \quad p < 0{,}05$

The null hypothesis can be rejected at 5% level of significance as $p < 0{,}05$. There is a significant difference between the average attitude (as an aspect of environmental literacy) score of teachers teaching in different phases. In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. This is shown in Table 63.

Table 63: Difference between the level of environmental attitude of teachers teaching in different phases (t-test analysis)

Groups	Difference between the means	T value	Significance
1- 2	4,44	$t < 2{,}65$	$p > 0{,}05$
1 - 3	0,64	$t < 2{,}65$	$p > 0{,}05$
1 - 4	1,05	$t < 2{,}65$	$p > 0{,}05$
2 - 3	5,08	$t > 2{,}65$	$p < 0{,}05$*
2 - 4	5,49	$t > 2{,}65$	$p < 0{,}05$*
3 - 4	0,41	$t < 2{,}65$	$p > 0{,}05$

* Comparisons significant at 5% level.

There is a significant difference between the average scores of groups 2 and 3, as well as those of groups 2 and 4. That is, between teachers teaching in Intermediate Phase and those teachers teaching in Senior Phase as well as teachers teaching in Intermediate Phase and those teachers teaching in Further Education & Training. The mean of group 2 (108) is significantly lower than that of group 3 (113) and that of group 4 (113) indicating that teachers teaching in Senior Phase and Further Education & Training had higher scores in attitude as an aspect of environmental literacy. There were no studies reported in the literature investigating the environmental literacy of teachers in the four phases.

(e) Comparison between the four groups (Phase) with regard to environmental participation

The average environmental participation scores for each of the four groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 64.

Table 64: Difference between the level of environmental participation of teachers teaching in different phases

Group	N	Mean	SD
1. Foundation Phase	83	110,00	10,77
2. Intermediate Phase	93	108,14	13,29
3. Senior Phase	88	110,44	11,25
4. Further Education & Training Phase	88	108,63	11,98

$F\ (3,348) = 0,76;\quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average participation (as an aspect of environmental literacy) score of teachers teaching in the different phases.

There is insufficient literature dealing with the four aspects of environmental literacy in relation to the phase in which tuition is offered. It was found that tteachers teaching in Senior Phase and Further Education & Training had higher scores in environmental awareness as an aspect of environmental literacy than teachers teaching in Intermediate

Phase. The same applies for environmental attitude.

6.6.9 Testing of Hypothesis 9

With regard to hypothesis 9 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between the environmental literacy of teachers in the different learning areas in which they offer tuition.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents were divided into the following eight groups (learning area in which they offer tuition).

Group 1 : Language, Literacy and Communication (LLC)
Group 2 : Human & Social Sciences (HSS)
Group 3 : Mathematics, Mathematical Literacy & Mathematical Sciences (MMLMS)
Group 4 : Natural Sciences (NS)
Group 5 : Arts & Culture (AC)
Group 6 : Economic & Management Sciences (EMS)
Group 7 : Life Orientation (LO)
Group 8 : Technology (TE)

(a) Comparison between the eight groups (Tuition) with regard to environmental literacy in general

The average environmental literacy scores of the eight groups of teachers with regard to the questionnaire as a whole were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. These results appear in Table 65.

Table 65: Difference between the level of environmental literacy of teachers in different learning areas in which they offer tuition

Group	N	Mean	SD
1. LLC	133	416,62	40,57
2. HSS	47	420,30	40,42
3. MMLMS	66	416,27	35,77
4. NS	76	433,14	39,82
5. AC	12	426,33	26,39
6. EMS	9	413,89	60,42
7. LO	7	398,14	13,20
8. TE	2	420,00	14,14

$F\ (7{,}344) = 1{,}81;\ \ p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average environmental literacy of teachers in the different learning areas in which they offer tuition.

(b) Comparison between the eight groups (Tuition) with regard to environmental awareness

The average environmental awareness scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 66.

Table 66: Difference between the level of environmental awareness of teachers in different learning areas in which they offer tuition

Group	N	Mean	SD
1. LLC	133	80,00	8,96
2. HSS	47	81,64	8,55
3. MMLMS	66	80,56	8,74
4. NS	76	83,25	9,29
5. AC	12	83,08	6,65
6. EMS	9	81,11	13,24
7. LO	7	80,86	7,17
8. TE	2	80,00	7,07

$F(7,344) = 1,05; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average awareness (as an aspect of environmental literacy) score of teachers in the different learning areas in which they offer tuition.

(c) Comparison between the eight groups (Tuition) with regard to environmental knowledge

The average environmental knowledge scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 67.

Table 67: Difference between the level of environmental knowledge of teachers in different learning areas in which they offer tuition

Group	N	Mean	SD
1. LLC	133	98,62	11,09
2. HSS	47	100,49	9,60
3. MMLMS	66	99,36	8,69
4. NS	76	103,66	10,89
5. AC	12	100,42	4,40
6. EMS	9	103,33	16,12
7. LO	7	90,43	5,06
8. TE	2	100,00	2,83

$F\ (7,344) = 2,74;\ p < 0,01$

The null hypothesis can be rejected at 1% level of significance as $p < 0,01$. There is a significant difference between the average knowledge (as an aspect of environmental literacy) score of teachers in the different learning areas in which they offer tuition.

In order to determine between which groups differences exist, t-values were calculated by means of a t-test for independent samples. These values are shown in Table 68.

Table 68: Difference between the level of environmental knowledge of teachers in different learning areas in which they offer tuition (t-test analysis)

Groups	Difference between the means	T value	Significance
1- 2	1,87	t < 3,14	p > 0,05
1 - 3	0,74	t < 3,14	p > 0,05
1 - 4	5,03	t > 3,14	p < 0,05*
1 - 5	1,79	t < 3,14	p > 0,05
1 - 6	4,71	t < 3,14	p >0,05
1 - 7	8,20	t < 3,14	p > 0,05
1 - 8	1,38	t < 3,14	p > 0,05
2 - 3	1,13	t < 3,14	p > 0,05
2 - 4	3,17	t < 3,14	p > 0,05
2 - 5	0,07	t < 3,14	p > 0,05
2 - 6	2,84	t < 3,14	p > 0,05
2 - 7	10,06	t < 3,14	p > 0,05
2 - 8	0,49	t < 3,14	p > 0,05
3 - 4	4,29	t < 3,14	p > 0,05
3 - 5	1,05	t < 3,14	p > 0,05
3 - 6	3,97	t < 3,14	p > 0,05
3 - 7	8,94	t < 3,14	p > 0,05

Table 68: Continued ...

Groups	Difference between the means	T value	Significance
3 - 8	0,64	$t < 3,14$	$p > 0,05$
4 - 5	3,24	$t < 3,14$	$p > 0,05$
4 - 6	0,33	$t < 3,14$	$p > 0,05$
4 - 7	13,23	$t > 3,14$	$p < 0,05$*
4 - 8	3,66	$t < 3,14$	$p > 0,05$
5 - 6	2,92	$t < 3,14$	$p > 0,05$
5 - 7	9,99	$t < 3,14$	$p > 0,05$
5 - 8	0,42	$t < 3,14$	$p > 0,05$
6 - 7	12,91	$t < 3,14$	$p > 0,05$
6 - 8	3,33	$t < 3,14$	$p > 0,05$
7 - 8	9,57	$t < 3,14$	$p > 0,05$

* Comparisons significant at 0,05 level.

There is a significant difference between the average scores of groups 1 and 4, as well as those of groups 4 and 7. That is, between teachers teaching Language, Literacy & Communication (LLC) and those teaching Natural Sciences (NS) as well as between teachers teaching Natural Sciences (NS) and those teaching Life Orientation (LO). The mean of group 1 (98) is significantly lower than that of group 4 (103) indicating that natural science teachers had higher scores in the knowledge aspect of environmental literacy than those teachers teaching Language, Literacy & Communication. This finding supports the research reported by Buethe & Smallwood (1987) showing that natural science teachers had higher levels of knowledge than other teachers. It was also found that the mean of group 7 (90) is significantly lower than that of group 4 (103) indicating that teachers in Natural Sciences had higher scores in knowledge aspect of environmental literacy than those teaching Life Orientation.. According to a study by Abraham & Chacko (1999), college lecturers had average environmental literacy irrespective of the subjects they teach. In this study, however, it seems that teachers in natural sciences had higher scores in knowledge as an aspect of environmental literacy.

(d) Comparison between the eight groups (Tuition) with regard to environmental attitude

The average environmental attitude scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 69.

Table 69: Difference between the level of environmental attitude of teachers in different learning areas in which they offer tuition

Group	N	Mean	SD
1. LLC	133	111,47	12,65
2. HSS	47	111,32	13,89
3. MMLMS	66	110,42	12,35
4. NS	76	114,63	11,69
5. AC	12	113,33	8,84
6. EMS	9	107,44	23,97
7. LO	7	103,57	4,69
8. TE	2	112,50	4,95

$F(7,344) = 1,26; \quad p > 0,05$

The null hypothesis cannot be rejected as $p > 0,05$. There is no significant difference between the average environmental attitude (as an aspect of environmental literacy) score of teachers offering tuition in the different learning areas.

(e) Comparison between the eight groups (Tuition) with regard to environmental participation

The average environmental participation scores for each of the eight groups of teachers were calculated. In order to compare these averages, an analysis of variance (F-test) was carried out. The results are indicated in Table 70.

Table 70: Difference between the level of environmental participation of teachers in different learning areas in which they offer tuition

Group	N	Mean	SD
1. LLC	133	108,48	11,95
2. HSS	47	109,09	12,75
3. MMLMS	66	107,32	10,80
4. NS	76	113,39	11,83
5. AC	12	111,08	11,09
6. EMS	9	103,67	13,93
7. LO	7	103,86	4,02
8. TE	2	108,00	2,83

$F(7,344) = 2{,}24; \quad p > 0{,}05$

The null hypothesis cannot be rejected as $p > 0{,}05$. There is no significant difference between the average environmental participation (as an aspect of environmental literacy) score of teachers in the different learning areas in which they offer tuition.

It was found that there is no significant difference between average environmental literacy scores of teachers in the different areas in which they offer tuition. The same applies to environmental awareness, environmental attitude and environmental participation. However, there is a significant difference between the average environmental knowledge scores of teachers in the different learning areas in which they offer tuition. Teachers teaching natural sciences had a higher score in environmental knowledge than those teachers teaching Language, Literacy & Communication and Life Orientation.

6.6.10 Testing of Hypothesis 10

With regard to hypothesis 10 stated in paragraph 5.8, the following null hypothesis was tested:

> The environmental literacy of teachers who received training in environmental education does not differ from teachers who did not receive any training.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents (N=352) were divided into two groups. Group 1 (N=114) represents those who received training in environmental education and Group 2 (N=238) represents those who received no training in environmental education. To determine whether the level of environmental literacy of Group 1 differed from Group 2, the mean of each group was calculated for each aspect of environmental literacy, as well as for the questionnaire as a whole. The t-test for independent samples was used to determine whether the means differed significantly. This was done for each aspect of environmental literacy and the questionnaire as a whole. The results are indicated in Table 71.

Table 71: Difference between the level of environmental literacy of teachers who received training in environmental education and those who did not receive any training in environmental education

Variable	Group	Number	Mean	SD	T	DF	P
Awareness	1*	114	82,71	9,81			
	2*	238	80,44	8,47	2,23	350	$p < 0,05$
Knowledge	1	114	101,65	11,80			
	2	238	99,39	9,77	1,89	350	$p > 0,05$
Attitude	1	114	114,44	12,66			
	2	238	110,45	12,64	2,77	350	$p < 0,01$
Participation	1	114	112,25	12,24			
	2	238	107,85	11,47	3,30	350	$p < 0,01$
Total	1	114	429,14	42,11			
Questionnaire	2	238	416,40	37,84	2,85	350	$p < 0,01$

1* = Teachers who received training in environmental education

2* = Teachers who did not receive any training in environmental education

According to the information given in Table 71, a t-value of 2,85 was obtained for the total questionnaire, with $p < 0,01$. This means that the null hypothesis can be rejected at 1% level of significance. There is a significant difference between the average environmental literacy of teachers who received training in environmental education (mean = 429) and those who received no training in environmental education (mean = 416).

However, Table 71 reveals that with regard to knowledge, the null hypothesis cannot be rejected. Therefore, there is no significant difference between those who received training in environmental education and those who did not receive any training in environmental education with regard to knowledge as an aspect of environmental literacy.

It was found that t the null esis can be rejected at 5% level of significance for awareness and at 1% level of significance for attitude and participation. In all these instances the averages for group 1 are higher than that of group 2 indicating a higher level of environmental literacy by those who received training in environmental education. This means that in general, the two groups of teachers differ significantly with regard to environmental literacy (except for knowledge).

There is insufficient literate dealing with the four aspects of environmental literacy and the training received in environmental education.

6.6.11 Testing of Hypothesis 11

With regard to hypothesis 11 stated in paragraph 5.8, the following null hypothesis was tested:

> There is no significant difference between teachers who are members of environmental education organisations and teachers who are not members of environmental education organisations with regard to the level of environmental literacy.

The null hypothesis was stated for each aspect of environmental literacy as well as for the questionnaire as a whole.

The respondents (N=352) were divided into two groups. Group 1 (N=50) represents teachers who are members of environmental education organisations and Group 2 (N=302) represents teachers who are not members of environmental education organisations. To determine whether the level of environmental literacy of Group 1 differed from Group 2, the mean of each group was calculated for each aspect of environmental literacy, as well as for the questionnaire as a whole. The t-test for independent samples was used to determine whether there is a significant difference between the level of environmental literacy of teachers who are members of environmental education organisations and teachers who are not members of environmental education organisations. This was done for each aspect of environmental literacy and the questionnaire as a whole. The results are indicated in Table 72.

Table 72: Difference between the level of environmental literacy of teachers who are members and those who are not members of environmental education organisations

Variable	Group	Number	Mean	SD	T	DF	P
Awareness	1*	50	80,20	9,57			
	2*	302	81,34	8,88	0,83	350	p >0,05
Knowledge	1	50	98,30	10,54			
	2	302	100,43	10,49	1,33	350	p > 0,05
Attitude	1	50	110,18	13,19			
	2	302	112,00	12,70	0,94	350	p > 0,05
Participation	1	50	110,32	11,03			
	2	302	109,10	12,02	0,67	350	p > 0,05
Total	1	50	417,54	40,22			
Questionnaire	2	302	421,02	39,62	0,57	350	p > 0,05

1* = Teachers who are members of environmental education organisations

2* = Teachers who are not members of environmental education organisations

According to the information given in Table 72, a t-value of 0,57 was obtained for the total questionnaire, with $p > 0,05$. This means that the null hypothesis cannot be rejected. There is no significant difference between the average environmental literacy of teachers who are members of environmental education organisations and those who are not members of environmental education organisations. At the same time, the null hypothesis cannot be rejected for the four aspects of environmental literacy. It implies that no significant difference could be indicated for the four aspects of environmental literacy with regard to membership of environmental education organisations.

There is insufficient literature dealing with the aspects of environmental literacy and membership of environmental education organisations.

6.7 Conclusion

An item analysis was carried out for each aspect (awareness, knowledge, attitude and participation) of environmental literacy as well as for the questionnaire as a whole. Seven items were excluded from the final questionnaire. The reliability of the questionnaire was measured by calculating the alpha coefficient. This was found to be 0,945 for the questionnaire as a whole. Therefore, the questionnaire can be considered as a reliable measuring instrument. The validity of the questionnaire was established by both content validity and construct validity. It was determined that the questionnaire could be considered as both content and construct valid. It could therefore be considered as a suitable instrument to measure the level of environmental literacy of teachers.

The norms of the questionnaire were determined by converting the raw scores into stanines for each aspect (awareness, knowledge, attitude and participation) of environmental literacy as well as for the questionnaire as a whole. For the questionnaire as a whole, scores ranging from 135 to 393 are regarded as below average, scores between 394 and 451 as average, and scores from 452 to 540 as above average.

The following conclusions were arrived at after the testing of the hypotheses:

(i) In general, the male and female teachers do not differ significantly except for awareness as an aspect of environmental literacy. There is no significant difference between aspects such as knowledge, attitude, and participation in relation to the gender of the teachers.

(ii) There is no significant difference between the level of environmental literacy of teachers in the different age groups for the four aspects of environmental literacy and for the questionnaire as a whole.

(iii) There is no significant difference in the level of environmental literacy of teachers with regard to the location of the school. It was found that teachers from urban schools had higher scores in participation as an aspect of environmental literacy.

(iv) There is no significant difference between the level of environmental literacy of teachers with regard to place of residence for the four aspects of environmental literacy and for the questionnaire as a whole.

(v) There is a significant difference between environmental literacy of teachers with regard to different learning areas in which it was found that group 4 (Natural Science) teachers had higher levels of environmental literacy than group 1 (Language, Literacy & Communication) teachers. It was also found that group 4 (Natural Science) and group 6 (Economic & Management Sciences) teachers had higher scores in the knowledge aspect of environmental literacy than group 1 (Language, Literacy & Communication) teachers.

(vi) There is no significant difference between the level of environmental literacy of teachers with different qualifications for the four aspects of environmental literacy and for the questionnaire as a whole. However, there was a significant difference between the average environmental awareness scores of teachers with different qualifications. Teachers with a B.Comm. degree had higher scores than those with Standard 10.

(vii) There is no significant difference between the level of environmental literacy of teachers with different years of teaching experience for the four aspects of environmental literacy and for the questionnaire as a whole.

(viii) There is no significant difference between the level of environmental literacy of teachers with regard to the phase in which they offer tuition. It was found that teachers from group 3 (Senior Phase) and group 4 (Further Education & Training Phase) had higher scores in awareness as an aspect of environmental literacy than group 1 (Intermediate Phase) teachers. The same applies to environmental attitude.

(ix) There is no significant difference between the level of environmental literacy of teachers with regard to the learning area in which they offer tuition. It was found that group 4 (Natural Science) teachers had higher scores in knowledge aspect of environmental literacy than group 1 (Language, Literacy & Communication) and group 7 (Life Orientation) teachers.

(x) There is a significant difference between environmental literacy of teachers who received training in environmental education and teachers who did not receive any training in environmental education. There is no significant difference between the two groups with regard to knowledge as an aspect of environmental literacy.

(xi) There is no significant difference between environmental literacy of teachers who are members of environmental education organisations and those who are not members of environmental education organisations.

Chapter 7 will, apart from concluding statements, contain a summary of the research findings to form a useful baseline to establish continued teacher assistance and also in the curriculum development for environmental education pre-service and in-service teacher education, the need to generalise the findings in similar environmental settings in the RSA and the need for further research.

CHAPTER 7

SUMMARY OF RESULTS, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter contains a summary of the research findings, conclusions and recommendations for continued teacher assistance, content of environmental education in teacher education and empowerment of local communities through environmental education. Possibilities for further research are also highlighted.

There is evidence to show that human activity is leading to various environmental problems such as pollution, the greenhouse effect, depletion of the ozone layer, and the extinction of plants and animals on a broad scale (Paragraph 2.2). As stated in chapter 2, it is becoming increasingly imperative that all citizens have a well developed environmental literacy. That is, all citizens must have a strong working knowledge of how the natural systems work and how human activity affects the environment and how human activity may be harmonized with the environment. They need the knowledge and skills to investigate and evaluate problems, and to take effective action. They need to develop values, positive attitudes, commitment and responsibility to become wise and empowered citizens who will act to keep the environment healthy in order to meet the basic needs of all the citizens. They also share the responsibility for the welfare of future generations. This is because all our needs and those of future generations are met by the environment and the quality of the environment affects the quality of our lives. Therefore, it is assumed that development of environmental literacy may ensure long-term success to maintain the quality of the environment, the quality of life, and to share the responsibility for the welfare of the present and future generations.

Developing environmental literacy is a major challenge for schools and teachers. It is the abilities of teachers that determine whether we educate learners to become adults who can identify environmental problems and solve the problems by means of democratic participation. Seemingly, the most effective means of improving learning experiences for learners is to improve the preparation of their teachers. For the purposes of this study, it was therefore necessary to develop and standardize an instrument to measure the level of environmental literacy of teachers.

7.2 Summary of Results

The present study was based on claims of researchers that teachers are not adequately trained in environmental education. This may mean that teachers often lack the necessary preparation and confidence to teach environmental education (Paragraph 1.2). A literature study was done to realise aims 1 and 2. The literature study included discussions on the goals aims, objectives and guiding principles of environmental education; definition of environmental literacy, environmentally literate citizen and environmentally literate society, levels of environmental literacy; as well as discussions on responsible environmental behaviour were provided (aim 1). A literature study was also done to outline principles, goals and aims of sustainable development as well as education for sustainability (aim 2). The concepts developed from the literature study were used in the development of the instrument for this study. An empirical investigation was carried out to develop and standardize an instrument to measure the level of environmental literacy of teachers to realise aims 3-5.

7.2.1 Findings from Literature Study

Environmental education can be regarded as an educational approach intended to foster awareness, knowledge, sensitivity, values, attitudes, motivation, skills, and commitment needed to take actions for sustainable development. Environmental education is a holistic approach and involves cognitive, affective, and the psychomotor domains of human development.

Environmental literacy involves awareness of the total human environment, knowledge of environmental problems, attitudes which lead to responsible environmental behaviour, and participation in solving or preventing environmental problems. Acquisition of environmental literacy is a developmental process which takes place over a lifetime. There are degrees/levels of environmental literacy that build and grow from simpler to more complex levels. There is also a rough pattern of how people progress in their development of environmental literacy. This pattern of progress can be divided into three levels - nominal, functional and operational. Nominal implies basic awareness and understanding; functional implies narrowly focussed issue application; operational implies broad application in daily life.

An environmentally literate person has awareness and knowledge of:

* the physical process that shapes the patterns of the Earth's surface;
* the characteristics and distribution of ecosystems;
* the characteristics, distribution, and migration of human population;
* the patterns and networks of economic interdependence;
* the processes, patterns, and functions of human settlement;
* the changes that occur in the perception, use, distribution, and importance of resources;
* how human actions modify the environment; and
* how physical systems affect human systems.

An environmentally literate person also shares a variety of skills. These include:

* assessing objective, reliable information relevant to specific issues;
* communicating information to others effectively;
* making thoughtful choices from among a range of alternatives;
* working effectively with others to bring about needed changes; and
* a range of basic process skills such as observing, classifying, inferring, predicting, measuring, compare & contrast, critical thinking, creative thinking, communicating, interpreting data, estimating, categorizing, analyzing, synthesizing, drawing conclusions, and cooperative skills; and

* decision making skills such as formulating operational definitions, generating relevant questions, gathering verifiable information, suggesting potential alternative solutions, projecting consequences of each alternative, choosing among alternatives, acting on choice, and cooperative problem solving.

An environmentally literate person also shares certain habits of mind. They:

* look for the various systems that are involved in issues that concern them;
* seek the historical development and background of issues as well as their current status;
* are open to new ideas;
* remain skeptical of quick fix solutions;
* anticipate the potential consequences of a variety of action alternatives before selecting one;
* look for connections and interconnections among issues;
* investigate the historical development of an environmental issue; and
* seek and treat root causes rather than superficial symptoms of dysfunctional systems.

One of the aims of environmental education is to produce environmentally literate citizens. The five categories of objectives of environmental education (awareness, knowledge, attitudes, skills and participation) provide a good foundation to support environmental education and to focus on responsible environmental behaviour. This behaviour is synonymous with environmental literacy. This is because aspects of environmental literacy such as awareness, knowledge, attitudes, participation and prevention coincide with the five categories of objectives of environmental education. It is expected that the variables such as knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and sense of responsibility that would predict responsible environmental behaviour would foster environmental literacy. It seems environmental problems can be reduced by developing positive attitudes and behaviour patterns.

It was highlighted that sound environmental education leads to the development of an environmentally literate citizenry who are willing to make choices and take day to day actions that will conserve and enhance the ability of the environment to sustain functioning ecosystems and meet human needs now and generations yet to come. There exists a strong relationship between environmental education, environmental literacy, and education for sustainability. Environmental education is a cornerstone for education for sustainability.

It seems factors such as gender, age category, place of work, place of residence, qualifications, learning area, teaching experience, training in environmental education, and membership of environmental education organisations may contribute to the level of environmental literacy of teachers. The extent of this link has not been well established as yet.

7.2.2 Findings from Analysis and Evaluation of Data from the Questionnaires

One of the aims of this study was to develop and standardize an instrument to measure the level of environmental literacy of teachers in the three provinces (Mpumalanga Province, North West Province and Northern Province) in the RSA.
An empirical investigation was carried out with the following aims:

* To develop and standardize an instrument to measure the level of environmental literacy of teachers.
* To investigate how certain identified factors relate to the level of environmental literacy of teachers and the nature and direction of these relationships.

From the available literature, 10 concepts related to environmental literacy were identified. A questionnaire to measure environmental literacy was developed using the identified concepts. The questionnaire was submitted to eight experts for comments to establish content validity and necessary adjustments were made. The development of the questionnaire was discussed in paragraph 5.3. Items (1-12) in section A of the questionnaire were used to obtain background information such as gender, age category, qualifications, and training in environmental education of the respondents. In section B of the questionnaire, 135 items were categorised according to awareness, knowledge, attitude and participation. The questionnaire was presented to 420 teachers from the selected primary and secondary schools in three provinces in the RSA. There was 83,8% response. Data obtained from the questionnaires were analysed using Statistical Analysis System (SAS) Version 6.1.2. An item analysis was done for all the items in section B of the questionnaire. An analysis was done for each one of the four aspects of environmental literacy namely, awareness, knowledge, attitude and participation and the questionnaire as a whole.

In this study, the reliability was established by calculating the alpha coefficient for each aspect of environmental literacy as well as for the questionnaire as a whole. The reliability coefficient for the questionnaire as a whole is 0,949. As this value is close to one (higher than 0,8), this questionnaire can be considered as a reliable instrument to measure environmental literacy of teachers.

In order to determine construct validity, correlation coefficients were calculated between the four different constructs and between each construct and the total of the test. All correlations seem to be high positive correlations, significantly on the 1% level. Therefore, the instrument can be considered as both valid and reliable. Because of reliability and validity, the questionnaire can be considered suitable to measure the level of environmental literacy of teachers.

In this study, norms were determined for the questionnaire in terms of stanines. The lowest possible score for all items in the questionnaire as a whole was 135 and the highest possible score was 540. Scores ranging from 135 to 393 are regarded as below average, scores between 394 and 451 as average and scores from 452 to 540 as above average.

An item analysis was done for all the items (135) in section B of the questionnaire. The level of environmental literacy of teachers on the four aspects (awareness, knowledge, attitude, and participation) of environmental literacy remained at different levels. The level of awareness was high among the teachers compared to the other aspects of environmental literacy.

Based on the findings (paragraph 6.6.10), there is a significant difference between the average environmental literacy of teachers who received training in environmental education (N=114, mean = 429) and those who received no training in environmental education (N=238, mean = 416). As the majority of teachers who participated in this study received no training in environmental education, it can be assumed that the level of environmental literacy of teachers in general, is inadequate. This finding is supported by the views noted in the literature study (Paragraphs 1.2.2, 1.3 and 5.3 respectively).

The following conclusions were arrived at after the testing of the hypotheses:

(i) In general, the male and female teachers do not differ significantly regarding environmental literacy except for awareness as an aspect of environmental literacy. There is no significant difference between the other aspects namely, knowledge, attitude, and participation in relation to the gender of the teachers.

(ii) There is no significant difference between the level of environmental literacy of teachers in different age groups for the four aspects of environmental literacy separately or collectively.

(iii) There is no significant difference in the level of environmental literacy of teachers with regard to the location of the school. It was found however, that teachers from urban schools had higher scores in participation as an aspect of environmental literacy.

(iv) There is no significant difference between the level of environmental literacy of teachers with regard to place of residence for the four aspects of environmental literacy separately or collectively.

(v) There is a significant difference between the environmental literacy of teachers involved in the teaching of the different learning areas. It was found that group 4 (Natural Science) teachers had higher levels of environmental literacy than group 1 (Language, Literacy & Communication) teachers. It was also found that group 4 (Natural Science) and group 6 (Economic & Management Sciences) teachers had higher scores in the knowledge aspect of environmental literacy than group 1 (Language, Literacy & Communication) teachers.

(vi) There is no overall significant difference between the level of environmental literacy of teachers with different qualifications. However, there is a significant difference between the environmental awareness of teachers with different qualifications. Teachers with a B.Comm. degree had a higher environmental awareness score than those with Standard 10.

(vii) There is no significant difference between the level of environmental literacy of teachers with different years of teaching experience with regard to the four aspects of environmental literacy separately or collectively.

(viii) There is no significant difference between the overall level of environmental literacy of teachers with regard to the phase in which they offer tuition. It was found however, that teachers from group 3 (Senior Phase) and group 4 (Further Education & Training Phase) had significantly higher scores in both awareness and attitude as an aspect of environmental literacy than group 1 (Intermediate Phase) teachers.

(ix) There is no significant difference between the level of environmental literacy of teachers in general with regard to the learning area in which they offer tuition. It was found that group 4 (Natural Science) teachers had significantly higher scores in the knowledge aspect of environmental literacy than group 1 (Language, Literacy & Communication) and group 7 (Life Orientation) teachers.

(x) There is a significant difference between the environmental literacy of teachers who received training in environmental education and teachers who did not receive any training except for knowledge as an aspect of environmental literacy.

(xi) There is no significant difference between the environmental literacy of teachers who are members of environmental education organisations and those who are not members of environmental education organisations.

The results reveal that, in general, the various identified factors such as gender, age category, place of work, place of residence seem to have little bearing on the level of environmental literacy of teachers in the sample. One important finding from this study is that there is a significant difference between environmental literacy of teachers who received training in environmental education and teachers who did not receive any training in environmental education (Paragraph 6.6.10). It was also found that there is a significant difference between environmental literacy of teachers with regard to the different learning areas. In this instance, teachers teaching Language, Literacy and Communication obtained lower scores than others.

Certain standard limitations are inherent in all investigations. In this study, it was very difficult to assess the level of honesty, with which the teachers responded to the items in the questionnaire.

7.3 Recommendations

The need for pre-service and in-service teacher education in environmental education, the development of environmental education curricula to improve the level of environmental literacy of teachers, the empowerment of local communities through environmental education, and the need for further research is highlighted.

7.3.1 Teacher Education

The study

Many researchers reported inadequate in-service and pre-service training of teachers ~~as a~~ & this is key

teachers for effective implementation of EE

major constraint to the development of environmental education (Paragraphs 1.2 and 1.3). A widespread view among environmental educators, supports the claim that for the implementation of environmental education in schools and its quality, the key factor is the teacher (Papadimitriou, 1995:85-86; Shongwe, 1992:18; Simmons, 1993:8). Therefore, the professional development of teachers in environmental education, is an important issue to be addressed. An important question is, "what kind of professional development in environmental education do teachers need and which process should be followed?". In many cases it has been difficult to determine how decisions were made about what kind of preparation teachers need to become effective environmental educators. In the following paragraphs, the need for improving the professional preparation of teachers (pre-service and in-service) in environmental education is addressed.

skills, content, methods to infuse EE theory

(a) Pre-service teacher education

It is believed that environmental problems will be solved only if people alter their values, attitudes, and behaviours (Paragraph 2.4). Decisions on vital environmental issues such as toxic wastes, water pollution, the greenhouse effect, and threats to biodiversity require an environmentally literate citizenry. To create an informed citizenry, it is important to target pre-service teacher education for imparting this knowledge to the learners. One way to make certain that teachers are being educated in important environmental areas is to offer them courses that will make them active participants in environmental education. As teachers give highest priority in their curricula to those topics in which they are most knowledgeable, teachers must be trained in environmental education.

learner constructs

By training teachers in environmental education, we can help them overcome their lack of confidence in teaching environmental issues. Pomerantz (1990-91:22) noted that more extensive background information on a topic, can provide additional subject matter expertise that could help overcome teachers' initial reluctance to present environmental material to students. Therefore, environmental educators must first understand how teachers view nature and what educational opportunities they associate with natural settings. Teachers also need training to learn what can be accomplished in different institutional settings. Without direction, teachers will rely on their previous experiences.

Teachers need preparation in special programmes that provide information about the obtainability of different environmental education resources, allows application of different methods and strategies with opportunities for practising and building confidence and provision of skills to overcome educational and administrative constraints for the practice of new methodologies (Shongwe, 1992:18). Teachers need to be trained to adapt to new conditions in which environmental education as a new approach may be implemented. There is also a need for teacher training in content, methods and learning process for effectively preparing teachers to achieve environmental goals and objectives in the classroom. Teacher training in interdisciplinary approaches and in field studies of environment is also needed. Three dimensions relating to teacher training and preparation can be identified: Level of preparation (having sufficient knowledge to teach environmental topics); Level of confidence (feeling competent and comfortable with teaching environmental topics); and Desire for training (the need for additional education and training on environmental issues). Development of environmental literacy must become a basic objective of education at all levels. Teachers need to be trained through a curriculum that has environmental education as a component which can facilitate their teaching to promote environmental literacy for sustainability.

Resources

aims guidelines

conceptualisation

field of study

As mentioned in paragraph 3.3, there is some evidence (in the COTEP document) to ensure that pre-service teacher education provides a significant element of environmental education so that all teachers are competent to deliver environmental education in the different learning areas.

(b) In-service teacher education

The ~~need for environmental~~ education in in-service teacher education is vital for the effective introduction of environmental education into schools. This is because it is believed that the effective means of improving learning experiences of students is to improve the preparation of their teachers. It was noted in paragraph 1.2 that environmental education is a new venture in teacher education which means that few

implementation

teachers were trained in environmental education in colleges of education and other teacher education institutions. Many teachers in the present study had received no previous formal training in environmental education (Paragraph 6.6.10) in our colleges and universities to accomplish the aims and objectives of environmental education. This is because environmental education was not offered in the teacher education curriculum of the recent past. For this reason, a comprehensive in-service teacher education programme should be developed so that teachers are more effective in helping students to acquire knowledge, skills, and positive attitudes which are essential in contributing to the solution of environmental problems.

content

In-service teacher education should prepare teachers for a dual role as both environmental educator and environmental activist. This preparation should enable them to "play a decisive role in the prevention and solution of environmental problems .... through their participation, as citizens and professionals, in the elaboration and carrying out of environmental policies" (UNESCO, 1977:16). Little has changed since. Volk, Hungerford & Tomera (1984:17) stated that the need for in-service teacher education is perceived to be a major need at the elementary, middle, and secondary levels and increases at each successive level. Therefore, programmes in teacher education should focus on courses to prepare students to become environmentally aware, scientifically cognizant, and active citizens.

learning programmes

Teachers need to be up to date with the content of their syllabuses and with the new developments in teaching methods. Teachers who feel they have a poor knowledge base about environmental topics may feel somewhat ill-prepared to offer environmental education. An option would be to provide training courses to help such teachers gain more confidence and knowledge about environmental topics. It is important for environmental educators to begin to understand the perceived needs of teachers. That is, before deciding on the content of the in-service programme, it is important to find out about teachers' ideas concerning environmental education and its practice. It is crucial to take appropriate measures to understand teachers' knowledge of environmental matters in the context of their initial and in-service teacher education.

Teachers often had limited exposure to environmental understandings and critical and creative thinking skills and environmental decision-making skills in their own educational development. These teachers need involvement in in-service teacher education to give them basic knowledge and skills to guide learners to achieve environmental literacy for sustainability. Teacher education has to "convey the importance of holistic, transdisciplinary approaches and practice the integration of the cognitive, affective and action domains that good environmental education entails" (Shallcross & Wilkinson, 1998:244).

In-service education should give due attention to a proper location of environmental RNCS education in relation to the whole curriculum framework and the context of children's learning. There exists an immediate and critical need for in-service teacher education in the field of environmental education. Teachers' professional development in environmental education, is closely related to a change in their conception and practice of environmental education, the way they conceive their own role in school context as well as their ability to make good use of the opportunities offered to them to alter particular institutional settings that form obstacles to better practice (Papadimitriou, 1995:89). Real and permanent change is only possible with the teacher in the classroom.

School-based in-service workshops seem to be a better option. It should give special attention to cross-curricular issues, including familiarisation with the location of environmental education as a cross-curricular theme and with specific documentation concerning the teaching and learning of its particular knowledge, understanding and skills.

effective

The successful implementation of an environmental education in schools will need the inclusion of environmental component in pre-service teacher education and must be accompanied by in-service teacher education. This is because of the historical neglect of environmental education in pre-service teacher education programmes and the failure of many in-service teacher education programmes to adopt a critical practice-based orientation.

(c) Content of environmental education in teacher education

infusion

The incorporation of environmental education into the formal curriculum often poses problems for teachers (Paragraph 1.2), inter alia, when teachers are not part of the actual process of developing the curriculum. Shongwe (1992:5) noted that consultation between teachers and curriculum designers for environmental education appears to be non-existent. Designing a curriculum for environmental education is problematic. This is because environmental education is interdisciplinary in nature and requires knowledge and skills from a multitude of specialities (Lemmons, 1994:475). At the same time, building a coherent curriculum in the context of sustainable development and environmental protection is problematic, because the topic is ambiguous and because almost any subject can relate to it (Lemmons, 1994:476). The amount of knowledge and skills required for environmental education is more than any one person can master. At the same time, there is no easy formula regarding what to teach or how to balance problems of depth and breadth of knowledge and skills. This may be the reason why universities and colleges have diverse emphasis on subject matter and skills. The question is, which particular field of knowledge or discipline is a necessary condition of environmental competency? For example, knowledge about the environment is required from such areas as natural science, psychology, philosophy, law, administration, management, economics, political science, and sociology. Skills required include research and investigation, critical thinking, quantitative analysis, communication, and action-oriented problem-solving.

According to Lemmons (1994: 477) development of standardised certification programs for environmental professionals and the development of accreditation standards for college and university academic programs are based on the premise that we know: what constitutes environmental problems and the nature of their solutions; what knowledge and skills are required to solve them; and how to assess competency in understanding of environmental problems and their solutions. Whether this premise should be accepted is not clear. Who decides who is an environmental professional, and what is the basis for that decision? Decisions need to be made regarding the level of education and experience that an individual must have in order to be called an environmental educator. Do we know what is important and what is not important?

According to Braus (1995:47), teachers must be trained in: what environmental education is all about; how to facilitate open-ended discussions; how to teach thinking across the curriculum; how to teach environmental education action skills and problem solving; how to deal with information and technology; how to teach in an interdisciplinary way and integrate environmental education across the curriculum and how to teach holistically.

Since it appears desirable for teachers and their students to develop a holistic view of the environment and the associated problems and issues, the scope and sequence of environmental education experiences for prospective teachers should form a well-planned comprehensive program. Some basic ecological and environmental concepts should be developed early in the training experiences for teachers to serve as a foundation for subsequent environmental learning and teaching experiences (Pettus, 1982:184). In connection with curriculum development, Papadimitriou (1995:90) recommended action research as the proper process for inquiry based professional development of teachers in environmental education. The subsequent experiences should be designed to develop further understanding of environmental problems and issues, to develop knowledge and skills to help solve environmental problems and for providing environmental education for students.

However, according to Pettus (1982: 184-185), to prepare teachers to provide effective environmental education, teacher education programs should include the following elements as minimum requirements for those completing the programs.

(A) A comprehensive set of experiences designed to develop understanding, and skills related to environmental ~~conditions~~ and concerns and to promote attitudes and behaviours for maintaining environmental quality.

- * Knowledge of the bio-physical environment.
  - Organism and ecosystem requirements and dynamics.
  - Earth resources, their abundance and use.
  - The physical geology and geography of environments and their effects.
  - Natural laws, environmental analysis, and prediction of environmental phenomena.
- * Knowledge of the socio-cultural environment
  - The biological, social, and cultural foundations of behaviour in humans.
  - Economic principles and the effects of economic conditions on people and their environment.
  - The characteristics of human socio-cultural units and the governing dynamics within and among those units.
  - Identifying and facilitating understanding, skill, attitude, and behavioural changes in people.
- * Skills for effective participation in environmental activities.
  - Problem solving and decision making skills.
  - Skill in making predictions based on evidence, patterns and probability - long range planning ability.
  - The ability to collect and analyse environmental information or data.
  - The ability to communicate effectively - proficiency in conveying and receiving ideas and concepts.
  - Interpersonal skills - the ability to function effectively as a member of a group for solving a common problem or realising common goals.
- * Desirable attitudes and behaviours for maintaining environmental quality.
  - Concern about environmental issues, the availability of resources and the use of resources.
  - Views humans as part of the environment and as an agent in environmental

change.

- Considers the options and values of others in efforts to adopt individual and group environmental policies and actions.
- Displays personal action and commitment for maintaining a suitable environment.

(B) A comprehensive set of practical experiences designed to develop competence in planning appropriate learning experiences in environmental education for students and in effectively guiding students through those experiences.

* Identifying and utilising available resources in the community.
* Working with others as part of a group to solve problems and make decisions.
* Planning and guiding learners through environmental education learning experiences.
  - Identifying and trying effective ways of teaching environmental awareness, concepts and skills.
  - Providing learners with appropriate opportunities to develop skills and attitudes for helping to solve environmental problems through active involvement in seeking solutions to real and simulated problems.
  - Leading values clarification discussions and delineating the pros and cons of controversial environmental positions.
* Evaluating the outcomes of environmental education instruction and instructional programs.

Glasgow & Robinson (1986:7-8) list the following as important in teacher education:

* the history and philosophy of environmental education;
* the environment (biophysical, socio-cultural and components) and their interactions;
* problems in the environment (natural and man-made) and dealing with these problems.

According to Orr (1994:14) a student should have a basic knowledge of the following topics: the laws of thermodynamics, the basic principles of ecology, carrying capacity, energetics, limits of technology, sustainable agriculture and forestry, steady-state economics and environmental ethics.

Subbarini (1998: 244) outlined a curriculum model composed of three interacting systems. That is, the environment (natural and built), environmental problems and environmental protection. Each of the three systems is composed of three interacting subsystems. The environment is composed of biosphere, technosphere and sociosphere. The environmental problems consist of population, pollution and depletion of natural resources. The environmental protection consists of environmental legislation, scientific and technological counter measures, and education. The content of this curriculum is presented in line with the three laws of nature. The manipulation of the content of the curriculum in relation to the laws of nature helps in dealing with the holistic and complex nature of the environment, and permits the smooth and clear presentation of environmental issues and problems which are complex and ever-changing.

To improve the quality of life and maintain the quality of the environment through daily actions, teachers need to be environmentally literate as teachers are responsible for moulding students. Arguably, those seeking teaching posts must demonstrate certain competencies in environmental education. To this end, the Wisconsin Administrative Code (Wisconsin Department of Public Instruction, 1991:79) identified seven competencies in environmental education that must be demonstrated by those seeking certification to teach. The first four of these competencies are content-oriented and the last three deal with methodology. The competencies include the following:

* Natural resources and their conservation;
* Ecological concepts and principles;
* Energy in physical and biological systems;
* People-environment interactions including
  - a holistic review;

- human population growth issues and problems, and

- environmental impact of technology;

* The application of affective education methods to environmental education curriculum and instruction;
* The ability to infuse environmental topics into a subject area utilising a variety of instructional techniques; and
* The ability to teach about citizen involvement in environmental issues and problem resolution.

The teaching strategies and teaching methods suggested by Glasgow & Robinson (1986:103-123) and Lahiry, Sinha, Gill, Malik & Mishra (1988:84-108) are problem-solving; experimentation; case studies; out of classroom activities and field trips; projects; surveys; role playing and simulation; debates and discussions; buzz activity; and brain-storming. According to Volk & Hungerford (1981:36) problem identification is important in a world replete with many environmental issues needing investigation.

Based on the above, the following can be recommended regarding an environmental education curriculum. In line with the objectives and guidelines of environmental education, the following teaching methods should also be included:

* involve the learners' active participation in learning;
* provide many diverse experiences;
* enable learners to evaluate situations;
* help learners make decisions based on the study; and
* enable them to apply knowledge to new situations.

The major components that should be included in the pre-service environmental education curricula for teacher education are the following:

* Basic competencies in biological, physical, social, and behavioural science;
* Understanding the interrelationships of the human ecosystem;
* Community problem-solving projects;

* Environmental problems and environmental protection;
* Identifying and facilitating desirable attitude and behavioural changes;
* Educational theory, teaching strategies, teaching methods, and teaching skills; and
* Environmental education teaching experience prior to final teacher certification.

The following are the components that can be included in a program for in-service training of teachers in environmental education:

* Coverage of basic science content;
* Provide training in environmental content and in methods of teaching environmental education with a variety of experience;
* Directly involve teachers with the particular environments under consideration;
* Engage teachers in exploring their own values and feelings about the environment and their relationship to it; and
* Fieldwork experience, use of the school site, and the wider environment.

It may be assumed that most of the same components would be desirable for both in-service and pre-service teacher education. However, consideration must be given to conditions within the in-service context which are different from those present in pre-service programs. It is important to give consideration to the basic aims of environmental education when drawing up curricula for environmental education in teacher education.

7.3.2 Empowerment of Local Communities through Environmental Education

As noted in paragraph 1.2, much of the environmental degradation that continues to occur today, is the result of the failure of our society and its educational systems to provide citizens with the basic understandings and skills needed to make informed choices about interactions and interrelationships in the environment. Much of the environmental degradation may be reduced by achieving higher levels of environmental literacy of all citizens in our society. Environmental literacy can best be achieved by optimal exposure of individuals to their environments. It must be noted that environmental literacy can provide a valuable resource for sustainable development, if it can be passed on to the students in schools. Environmental education can help citizens in becoming environmentally knowledgeable, skilled and dedicated citizens who are willing to work, individually and collectively to improve or maintain the quality of the environment.

Teachers, more than any other professional group, are confronted with both the impacts of social circumstances and the dominant concepts of the world and of colleagues, parents and pupils, yet they are obliged to educate the children entrusted to them and help them become mature responsible citizens (Kastenholz & Erdmann, 1994:16). Teachers can, by virtue of their status in society and their position to influence thousands of students during their professional careers, play a crucial role in environmental education. In this context, an understanding of the level of environmental literacy of teachers is very essential to help students become responsible adults who may be willing to maintain a healthy environment. Teachers can provide important insights into creating a community which lives in a healthy environment for the present and future generations. Encouraging students to take an active role in the protection of their environment is one way in which the critical balance may be preserved. Educating younger children is extremely important given that most attitudes are set and difficult to change by the time they are in high school. According to Leeming, Porter, Dwyer, Cobern, & Oliver (1997:33) younger children are of particular interest because, they are less likely to have well-established environmentally harmful behaviours to "unlearn", they have a longer period to influence environmental quality. A study by Leeming, Porter, Dwyer, Cobern, & Oliver (1997) indicated that children who participated in the caretaker programme influenced their parents to adopt more pro-environmental behaviours. This may mean that children may serve as effective agents to promote environmentally responsible behaviours in others including their parents. Therefore, environmental education programmes developed for teacher training can lead to empowerment of students and often involves some degree of change in behaviour in others. That is, special emphasis is needed for educating students. This is because educating a student means educating a generation.

The basic assumption is that environmental literacy of teachers will have a positive effect on the knowledge, attitude, and behaviour of students and of others in the community. If teachers should convey basic information about the relationship between nature and people, and by learning more about the workings of the environment, students will become more aware of what they are contributing to the overall health of the earth so that the next generation will make informed choices on the basis of this information.

Teachers at all levels and subject areas have a role to play in helping students to realise that it is a collective responsibility to preserve nature. Once a high level of environmental literacy is accomplished by teachers, there is hope for an improvement in the quality of life and quality of the environment. Environmental literacy of teachers may result in empowerment of communities and is a means of reducing environmental problems.

The changes in human attitude and behaviour depend on a vast campaign of education, debate and public participation. To this end, extensive public awareness campaigns are an essential component. People should be taught to care for the environment, because by caring for it, they enhance their own quality of life, not only for themselves, but also for future generations.

7.3.3 Recommendations for Further Research

For practical reasons, the empirical investigation was conducted using only teachers from the three provinces in the RSA. A repetition of the investigation could be done using more teachers from all provinces in the RSA. In some instances, the sample was not representative of the population of teachers, especially in the learning areas, Economic and Management Sciences (EMS), Arts and Culture (AC), Life Orientation (LO) and Technology (TE). A further investigation could be conducted using more teachers from those learning areas under-represented in this study.

Contrary to the expectation, the results of this study indicate that there is no significant difference in environmental literacy in general between teachers with a degree and teachers with a Standard 10. It was also found that there is no significant difference between environmental literacy of teachers who are members of environmental education organisation and those who are not. Most surprisingly, it was found that there is no significant difference between those who received training in environmental education and those who did not receive any training in environmental education with regard to knowledge as an aspect of environmental literacy. These areas could be focus of further research.

If teachers were duly motivated and had proper training, they would be able to find ways of introducing environmental education of a high standard and at the same time by overcoming the existing obstacles to bring about some significant changes in the existing tradition, at least as far as their own teaching is concerned. So it is a challenge to undertake research to investigate in what ways teachers= professional development in environmental education may contribute to achieve desirable results. It is recommended that collaborative research associated with in-service teacher education needs to be undertaken. This research could be conducted utilising an indirect measure in which teachers are asked their perceptions regarding the need for in-service teacher education relative to discrete goals. Teachers could also be directly assessed regarding their ability to identify, teach, and implement environmental education goals.

The investigation was only carried out with teachers. The questionnaire used in this study could be presented to student-teachers in order to assess their level of environmental literacy. The researcher is also of the opinion that the questionnaire used in this study could be modified to assess the environmental literacy of people in other professions. It should be possible to develop instruments that can be used to assess the level of environmental literacy more effectively and accurately, as the term "environmental literacy" is better clarified and "levels of environmental literacy" are well established in educational programs.

7.4 Conclusion

People need to be able to make their own moral decisions about environmental matters. Teachers should encourage learners to think positively about the environment as our future is dependent on the environment and its resources. It is the responsibility of the teachers to ensure that learners have all the tools necessary to make responsible environmental decisions. The first step towards teaching learners to be aware of their environment is to train their teachers.

To accomplish the aims and objectives of environmental education, environmental education programmes must be continuous, must pervade all learning areas at all grade levels, and must offer learners experiences which are as concrete and direct as possible. Learners must become involved in an active problem-solving process, investigating real environmental issues and problems in their own community and from a position of neutrality, with no position being advanced in favour over another. It is an apparent necessity to "prepare prospective teachers to make valuable contributions to creating environmental awareness and responsibility" (Pettus, 1982:182). This may mean that teachers of all academic disciplines should bear a responsibility for environmental education.

Most teachers in the present study had received no previous formal training in environmental education, as environmental education was not offered in the teacher education curriculum of the recent past. The results from this study should provide a base for curriculum design and development of environmental education in pre-service and in-service teacher education.

"The planet undoubtedly can survive without our species but we cannot survive without the life support system of the planet. If environmental illiteracy burgeons increase more rapidly than environmental literates, it is reasonable to doubt the survival of human civilisations and to expect ever increasing amounts of human suffering" (Roth, 1992:32).

If each one does a more effective job of nurturing and fostering environmental literacy within the opportunities provided, increasingly more individuals will achieve higher degrees of competency on the environmental literacy continuum.

The end product of developing environmental literacy is a properly informed citizenry, sensitive to environmental concerns at all levels, and empowered to take responsible action to ensure a healthy environment for the present and the future. Our future, and the future of generations yet unborn, depends on choices we make on a day to day basis. It is essential that our educational system develops and nurtures environmental literacy for sustainability.

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APPENDIX A - QUESTIONNAIRE TO TEACHERS

QUESTIONNAIRE TO TEACHERS

INFORMATION TO TEACHERS

Please read the following carefully before you answer the questionnaire.

1. Your honest opinion is of great importance.
2. There is no way in which you can be identified.
3. Please attempt all the items in this questionnaire.
4. Please do not write anything on the questionnaire.
5. Do not write above the red line on the Survey Response Page. Start below the red line next to number 1.
6. For each item indicate your response by means of a single stroke with an HB pencil on the appropriate number on the Survey Response Page, for example

   1 [1] ~~[2]~~ [3] [4] [5] [6] [7] [8]
7. Please make sure that the answer number on the Survey Response Page corresponds to the question number on the questionnaire. Indicate your response to Section B1 (items 1-120) on Survey Response Page 01 and to Section B2 (items 1- 27) on Survey Response Page 02.
8. Kindly return the completed Survey Response Pages and the questionnaire to me.

SECTION A - BACKGROUND INFORMATION

Indicate your response (1, 2, 3, etc) to each item (1-12) on Survey Response Page 01.

For example:

Question number on the questionnaire 3. Location of your school.

Urban = 1
Rural = 2
Semi-urban = 3

If your answer is "Semi-urban" mark on the Survey Response Page 01 as follows:

3. [1] [2] ~~[3]~~ [4] [5] [6] [7] [8]

1. Gender:

Male = 1
Female = 2

2. In which age category are you?

24 Years or less = 1
25-29 Years = 2
30-34 Years = 3
35-39 Years = 4
40-44 Years = 5
45-49 Years = 6
50-54 Years = 7
55 Years or older = 8

3. Location of your school.

Urban = 1
Rural = 2
Semi-urban = 3

4. Location of your home.

Urban	= 1
Rural	= 2
Semi-urban	= 3

5. Please indicate your highest academic qualifications

Standard 10	= 1
B.A	= 2
B.Sc	= 3
B.Comm	= 4
Other	= 5

6. In which learning area is your highest qualification?

Language, Literacy and Communication	= 1
Human & Social Sciences	= 2
Mathematics, Mathematical literacy & Mathematical sciences	= 3
Natural Sciences	= 4
Arts & Culture	= 5
Economics & Management Sciences	= 6
Life Orientation	= 7
Technology	= 8

7. Please indicate your professional qualifications

J.S.T.C	= 1
P.T.C	= 2
P.T.D	= 3
S.T.D	= 4
U.D.E	= 5
Other	= 6

8. Teaching experience in years

3 Years or less	= 1
4-7 Years	= 2
8-11Years	= 3
12-15 Years	= 4
16-19Years	= 5
20-23Years	= 6
24-27 Years	= 7
28 Years or more	= 8

9. In which Phase are you teaching?

Foundation Phase (Grade 1-3)	= 1
Intermediate Phase (Grade 4-6)	= 2
Senior Phase (Grade 7-9)	= 3
Further Education & Training Phase (Grade 10-12)	= 4

10. Please indicate the learning area in which you offer tuition.

Language, Literacy and Communication	= 1
Human & Social Sciences	= 2
Mathematics, Mathematical literacy & Mathematical sciences	= 3
Natural Sciences	= 4
Arts & Culture	= 5
Economics & Management Sciences	= 6
Life Orientation	= 7
Technology	= 8

11. Have you received any training in environmental education?

Yes	= 1
No	= 2

12. Do you belong to any environmental education organisation?

Yes	= 1
No	= 2

SECTION B

Consider each statement below and indicate to what extent you agree or disagree with each one. Use the following scale for your responses.

Strongly Agree	=1
Agree	=2
Disagree	=3
Strongly Disagree	=4

SECTION B1

Indicate your response to items 13-120 on Survey Response Page 01.

No Item

13. The particular place living organisms live provides the resources it needs to survive.
14. Food, water, shelter and space are all necessary for the survival of life.
15. Plants and animals depend on each other in many ways.
16. The earth has a limited capacity to recycle materials naturally.
17. Burning of coal release gases into the atmosphere which affects the survival of living organisms.
18. Intensive farming has changed air, water and land as life support systems.

people

19. Humans must live in harmony with nature in order to survive.
20. I am not concerned about overgrazing because it is not always harmful to the environment.
21. I do not worry about too many wild animals being killed because in the long run things will balance.
22. I am happy to offer help on a free afternoon to take air samples to test the level of air pollution in a nearby industrial area
23. I am willing to be involved in a project to develop a school garden.
24. I will stop using aerosols containing harmful gases.
25. The earth is like a spaceship, with only limited resources on board.
26. Indigenous trees have no advantages for human beings.
27. Wildlife is important in the cultural heritage of all regions and groups of people.
28. If a drought exists in a certain area and plants die off, predators such as lions in the area will also be in danger of extinction.
29. In an ecosystem there are producers, carnivores, herbivores, omnivores, and decomposers.
30. Ecosystems consist of people and other animals, plants and other life forms, and non-living factors interacting and interdependent in a wide variety of ways.

Strongly Agree =1 Agree =2 Disagree =3 Strongly Disagree =4

31. Loss of the particular place where it lives has contributed to many species of wildlife to become endangered.
32. Tree planting days will increase public awareness of the necessity of trees.
33. I think there is too much fuss about pesticides entering the food chain.
34. I would be interested to know what kind of little creatures live in ponds.
35. I enjoy talking about the TV programmes I watched about nature.
36. I am willing to participate in recycling paper at my school.
37. When shopping, I avoid buying products made from animal furs or skin.
38. At present, most of the energy used in South Africa comes from burning coal and wood.
39. Energy from the sun is passed on to animals through food chains and food webs.
40. Trees in plantations cause lower water flows into rivers.
41. Only very little of the sun's energy reaches tertiary consumers such as human beings in an ecosystem.
42. Carbon dioxide produced by burning coal causes a warmer climate.
43. Earthworms play an important role in a food chain.
44. We should save plants and animals from extinction.
45. When natural fires occur within national park boundaries it is better to have a "let it burn" policy.
46. Individual actions such as collecting cans for recycling have no effect on the environment.
47. I shall support a campaign to kill all snakes because snake bites can be fatal.
48. I am willing to be involved in a tree planting campaign.
49. I will strive to study problems in nature.
50. The energy from sunlight absorbed by plants may be utilised by animals which eat plants.
51. High concentrations of sewage in an area result in a serious depletion of dissolved oxygen in water.

Strongly Agree =1 Agree =2 Disagree =3 Strongly Disagree =4

52. There is continuous environmental pollution from industry.

Family planning

53. Limiting the size of the family is important to avoid overpopulation.
54. All of the following factors will contribute to the pollution of the atmosphere: Veld fires, braai fires, smoke from factories, smoke from cars.
55. Abundant resources and low death rates stimulate rapid growth in a population of organisms.
56. It is important to repair leaking taps.
57. When humans interfere with nature, it produces disastrous consequences.
58. Factory waste may be disposed of in rivers because it has little effect on biological life in the rivers.
59. I encourage others to limit the size of families to avoid overpopulation.
60. I would be willing to write letters asking people to help reduce pollution.
61. I encourage people to start using electricity for cooking so that smoke pollution from homes will be reduced.
62. I feel responsible to teach about environmental changes brought about by urbanisation in the normal classroom situation.
63. All animals, including human beings have basic needs.
64. Some resources, once used, are unavailable to future generations.
65. Coal is an inexhaustible natural resource.
66. Harmful gases in the atmosphere can be reduced if people do not use aerosols.
67. If the hole in the ozone layer gets worse more ultra-violet sun rays will reach the earth.
68. If the number of people in the world rises at a faster rate, we will no longer be able to maintain a healthy environment.
69. Waste materials cannot be used in a positive manner by organisms in meeting their basic needs.
70. Scarcity of factors essential for survival of organisms limits population growth.
71. Community education can counteract the effect of misuse of natural resources.

Strongly Agree =1   Agree =2   Disagree =3   Strongly Disagree =4

72. In order to provide food for human beings, forest must be cleared so that grains can be grown.

73. I would be willing to use public transport in order to reduce air pollution.

74. Every time I go shopping, I am willing to take a bag so that there is no need to get a plastic one from the shop.

75. When shopping, I avoid buying products known to be harmful to the environment.

76. The more people there are, the fewer resources are available per person.

77. The overuse of resources often result in environmental problems such as the destruction of the particular place where living organisms are found.

78. Conservation is the wise use of the environment to achieve sustainable environmental quality.

79. Depletion of the ozone layer causes heating of the earth.

Wild animals

80. Certain animal and plant species can be saved from extinction by the establishment of nature reserves.

81. Energy, its production, use, and conservation is essential in the maintenance of a sustainable society.

82. Illegal hunting is harmful to the environment.

83. It is important to make compost with biodegradable home wastes.

84. I am not interested in learning about the reasons behind the disappearance of forests.

85. It is important for all of us to reduce the consumption of material goods.

86. I always switch lights off when I don't need them anymore.

87. I often buy products made with recycled materials.

88. I normally leave the water running when I brush my teeth.

Save

89. Whenever possible, I take a shower instead of a bath in order to conserve water.

90. I make compost with biodegradable wastes.

91. Environmentally responsible behaviour includes personal action that benefits the environment.

Strongly Agree =1 Agree =2 Disagree =3 Strongly Disagree =4

92. Misuse of natural resources will not affect human beings.
93. The quantity of water on earth is constant and may be used over and over.
94. Environmental quality is the net sum of the consequences of individual and group actions.
95. Individual lifestyles such as mode of transport affect the environment directly or indirectly.
96. Many factories contribute to the formation of acid rain.
97. Green revolution is a programme focussing on the propagation of fast growing plant species to grow more food.
98. Only science teachers should know how the environment works.
99. I get upset when I see other people littering. throwing papers & litter
100. I try to behave in an environmentally responsible manner.
101. It is necessary for us to know about the environmental problems of people in other countries.
102. I will vote for or against a political candidate because of his/her on environmental issues.
103. I encourage my students to use both sides of a paper.
rubbish
104. I encourage my students to pick up litter at school.
105. Consumers need to be able to evaluate benefits as well as drawbacks for the environment when purchasing goods.
106. Recycling paper will result in fewer trees being cut for commercial purposes.
107. Increased consumption of natural resources results in increased environmental pollution.
108. Advertising tends to ignore the drawbacks of a product on the overall health of the environment.
109. Use of unleaded petrol will reduce air pollution.
110. A reduction in the consumption of material goods will reduce the amount of wastes.

Strongly Agree =1 Agree =2 Disagree =3 Strongly Disagree =4

111. I do not think it is my responsibility to teach environmental issues in the normal classroom situation.

112. If I make an attempt to regulate my actions with respect to air pollution, I am sure this will have a effect on air quality.

113. When I see smoke from chimneys, I think of air pollution.

114. Even if I stop buying environmentally harmful products, it would make little difference because others are still buying these products.

115. I support the modification of the environment to provide comfort and leisure.

116. I am making personal sacrifices for the sake of slowing down pollution even though the immediate results may not be significant.

117. I am an active member in an environmentalist group.

118. I have changed some of my behaviours during the past few years to protect the environment.

integrating

119. I am infusing the study of environmental aspects into my teaching.

120. When pesticides are used to kill insects, other animals are not affected.

SECTION B2

Consider each statement below and indicate to what extent you agree or disagree with each one. Use the following scale for your responses.

Strongly Agree =1
Agree =2
Disagree =3
Strongly Disagree =4

Indicate your response to items 1-27 of Section B2 on Survey Response Page 02.

1. Economic development often produces more environmental problems than benefits.
2. Social values and customs influence personal conservation behaviour.
3. The use of technology for disease prevention has resulted in rapid increases in the human population.
4. Ozone gas protects life on Earth from damaging effects of ultraviolet radiation.
5. The green house effect is an increase in carbon dioxide.
6. People have the right to change nature whenever they want to.
7. The benefits of modern consumer products are more important than the pollution that results from their production and use.
8. It is solely the government's responsibility to solve environmental problems. only
9. A goal of my teaching is to increase the level of environmental responsibility in students.
10. I would like to discuss the influence of political decision making on the environment with my students.
11. I discuss relationships between economic development and a healthy environment with other people.

Strongly Agree =1 Agree =2 Disagree =3 Strongly Disagree =4

12. Human society has not developed sustainable feedback mechanisms for the use and reuse of basic materials.
13. The management of natural resources to meet the needs of future generations demands long-term planning.
14. Humans tend to select short-term economic gains, which often result in long-term environmental loses.
15. In a food chain energy is supplied by green plants.
16. Individual citizens should be stimulated to become well informed about the environment.
17. It is important to protect all useful animals.
18. The better we understand earth, the better we can manage our resources.
19. Humans have a responsibility to develop respect for the rights of others.
20. Educators must help students develop concern for the environment.
21. Because humans are more intelligent than other living beings, they have the greatest right to live.
22. We must set aside more land to support endangered plants.
23. I will try to persuade others to take part in environmentally responsible behaviour.
24. Because of my teaching my learners have a concern for the environment.
25. It is my conviction that I should point out to others not to smoke.
26. I discuss with my family ways to protect the environment for future generations.
27. I believe my teaching contributes to the development of environmentally literate citizens.

Thank you very much for your cooperation

APPENDIX B - SURVEY RESPONSE PAGE

UNIVERSITEIT VAN SUID-AFRIKA
Opname Respons Blad

UNISA

UNIVERSITY OF SOUTH AFRICA
Survey Response Page

ONDERWERP/SUBJECT

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

BELANGRIK

1. GEBRUIK SLEGS 'N HB-POTLOOD OF SWART PEN
2. MERK U ANTWOORDE SOOS VOLG
3. MOENIE VOU NIE

IMPORTANT

1. USE ONLY AN HB PENCIL OR BLACK PEN
2. INDICATE YOUR ANSWERS WITH THE FOLLOWING MARK
3. DO NOT FOLD

1	1 2 3 4 5 6 7 8	41	1 2 3 4 5 6 7 8	81	1 2 3 4 5 6 7 8
2	1 2 3 4 5 6 7 8	42	1 2 3 4 5 6 7 8	82	1 2 3 4 5 6 7 8
3	1 2 3 4 5 6 7 8	43	1 2 3 4 5 6 7 8	83	1 2 3 4 5 6 7 8
4	1 2 3 4 5 6 7 8	44	1 2 3 4 5 6 7 8	84	1 2 3 4 5 6 7 8
5	1 2 3 4 5 6 7 8	45	1 2 3 4 5 6 7 8	85	1 2 3 4 5 6 7 8
6	1 2 3 4 5 6 7 8	46	1 2 3 4 5 6 7 8	86	1 2 3 4 5 6 7 8
7	1 2 3 4 5 6 7 8	47	1 2 3 4 5 6 7 8	87	1 2 3 4 5 6 7 8
8	1 2 3 4 5 6 7 8	48	1 2 3 4 5 6 7 8	88	1 2 3 4 5 6 7 8
9	1 2 3 4 5 6 7 8	49	1 2 3 4 5 6 7 8	89	1 2 3 4 5 6 7 8
10	1 2 3 4 5 6 7 8	50	1 2 3 4 5 6 7 8	90	1 2 3 4 5 6 7 8
11	1 2 3 4 5 6 7 8	51	1 2 3 4 5 6 7 8	91	1 2 3 4 5 6 7 8
12	1 2 3 4 5 6 7 8	52	1 2 3 4 5 6 7 8	92	1 2 3 4 5 6 7 8
13	1 2 3 4 5 6 7 8	53	1 2 3 4 5 6 7 8	93	1 2 3 4 5 6 7 8
14	1 2 3 4 5 6 7 8	54	1 2 3 4 5 6 7 8	94	1 2 3 4 5 6 7 8
15	1 2 3 4 5 6 7 8	55	1 2 3 4 5 6 7 8	95	1 2 3 4 5 6 7 8
16	1 2 3 4 5 6 7 8	56	1 2 3 4 5 6 7 8	96	1 2 3 4 5 6 7 8
17	1 2 3 4 5 6 7 8	57	1 2 3 4 5 6 7 8	97	1 2 3 4 5 6 7 8
18	1 2 3 4 5 6 7 8	58	1 2 3 4 5 6 7 8	98	1 2 3 4 5 6 7 8
19	1 2 3 4 5 6 7 8	59	1 2 3 4 5 6 7 8	99	1 2 3 4 5 6 7 8
20	1 2 3 4 5 6 7 8	60	1 2 3 4 5 6 7 8	100	1 2 3 4 5 6 7 8
21	1 2 3 4 5 6 7 8	61	1 2 3 4 5 6 7 8	101	1 2 3 4 5 6 7 8
22	1 2 3 4 5 6 7 8	62	1 2 3 4 5 6 7 8	102	1 2 3 4 5 6 7 8
23	1 2 3 4 5 6 7 8	63	1 2 3 4 5 6 7 8	103	1 2 3 4 5 6 7 8
24	1 2 3 4 5 6 7 8	64	1 2 3 4 5 6 7 8	104	1 2 3 4 5 6 7 8
25	1 2 3 4 5 6 7 8	65	1 2 3 4 5 6 7 8	105	1 2 3 4 5 6 7 8
26	1 2 3 4 5 6 7 8	66	1 2 3 4 5 6 7 8	106	1 2 3 4 5 6 7 8
27	1 2 3 4 5 6 7 8	67	1 2 3 4 5 6 7 8	107	1 2 3 4 5 6 7 8
28	1 2 3 4 5 6 7 8	68	1 2 3 4 5 6 7 8	108	1 2 3 4 5 6 7 8
29	1 2 3 4 5 6 7 8	69	1 2 3 4 5 6 7 8	109	1 2 3 4 5 6 7 8
30	1 2 3 4 5 6 7 8	70	1 2 3 4 5 6 7 8	110	1 2 3 4 5 6 7 8
31	1 2 3 4 5 6 7 8	71	1 2 3 4 5 6 7 8	111	1 2 3 4 5 6 7 8
32	1 2 3 4 5 6 7 8	72	1 2 3 4 5 6 7 8	112	1 2 3 4 5 6 7 8
33	1 2 3 4 5 6 7 8	73	1 2 3 4 5 6 7 8	113	1 2 3 4 5 6 7 8
34	1 2 3 4 5 6 7 8	74	1 2 3 4 5 6 7 8	114	1 2 3 4 5 6 7 8
35	1 2 3 4 5 6 7 8	75	1 2 3 4 5 6 7 8	115	1 2 3 4 5 6 7 8
36	1 2 3 4 5 6 7 8	76	1 2 3 4 5 6 7 8	116	1 2 3 4 5 6 7 8
37	1 2 3 4 5 6 7 8	77	1 2 3 4 5 6 7 8	117	1 2 3 4 5 6 7 8
38	1 2 3 4 5 6 7 8	78	1 2 3 4 5 6 7 8	118	1 2 3 4 5 6 7 8
39	1 2 3 4 5 6 7 8	79	1 2 3 4 5 6 7 8	119	1 2 3 4 5 6 7 8
40	1 2 3 4 5 6 7 8	80	1 2 3 4 5 6 7 8	120	1 2 3 4 5 6 7 8

APPENDIX C - COMMUNICATIONS

Private Bag X002
Tuinplaas
0437

13 October 1999

Dear Participant

THE NATURE AND MEASUREMENT OF ENVIRONMENTAL LITERACY FOR SUSTAINABILITY

At present I am involved in a research project addressing the environmental literacy of teachers. The project examines the level of environmental literacy of teachers. This study is undertaken as a requirement for my doctorate degree in didactics at the University of South Africa.

Your participation in this project will provide useful information on this topic. Without your assistance and opinion, this project can never be successful. You will be asked to complete Section A (Background information) and Section B1 and B2 (Environmental literacy) which will take approximately 50 minutes.

Participation in this study is strictly voluntary. All data from this project are anonymous and will be used for research purposes only.

Thank you for your willingness to get involved in this study.

C. C. Chacko

Tel : 012-724 3192/3 (W)