

- Parental involvement needs to be encouraged by principals, teachers and students.
- The professional conduct of teachers and students has to be reinforced and teachers should know their responsibilities.
- The principals must encourage teachers, parents and students to work hard so that the COLT slogan, which says, "Teachers teach, students learn and parents co-operate", can become a reality (Lethoko, 1999:157).

Finally: it is hoped that this article will contribute, albeit in a very small way, to the prevention of what Saunders (1996:19) refers to as "one lost generation after another". As Chisholm and Vally (1996:5) so aptly state: South African schools will simply have to shift from "a culture of resistance" to "a culture of reconstruction and development".

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References

- Bailey KD 1987. *The practice of social research*. Belmont, California: Wadsworth.
- Behr AL 1988. *Education in South Africa. Origins, issues and trends 1652-1988*. Pretoria: Academica.
- Chisholm L & Vally S 1996. *Report of the committee on the culture of teaching and learning*. Gauteng: Ministry of Education.
- Cullingford C 1988. School rules and children's attitudes towards discipline. *Educational Research*, 30:3-8.
- Dean J 1993. *Managing the secondary school*. London: TJ Press.
- Dekker E & Van Schalkwyk OJ (eds) 1995. *Modern education systems*. Durban: Butterworth.

- Hartshorne K 1990. Look back in anger. *Indicator SA*, 7:71-74.
- Hartshorne K 1991. Back to the future: African Grade 12 results 1989-1990. *Indicator SA*, 8:67-72.
- Heystek J 1999. In-service training for school managers in disadvantaged areas. Research project. Pretoria, SA: University of Pretoria.
- Heystek J & Louw E 1999. Parents as partners in schools — so important but why so inefficient? *South African Journal of Education*, 19:21-27.
- Kitchen H (ed.) 1988. *The Washington papers: South Africa in a transition to what?* Washington, DC: Praeger.
- Lethoko MX 1999. Restoring the culture of learning and teaching in secondary schools in the Pretoria area. Unpublished MEd dissertation, University of Pretoria, Pretoria.
- Lukhwarieni MH 1995. The issue of roles for the school management team revisited: a challenge to the democratic education system. Unpublished MEd dissertation. Pretoria: University of Pretoria.
- Mashile EO & Mellet SM 1996. Political and social factors related to secondary pupils' attitude towards school. *South African Journal of Education*, 16:223-226.
- Masitsa MG 1995. The establishment of a learning culture as a prerequisite for academic achievement. Unpublished DEd thesis, University of South Africa, Pretoria.
- Mnisi N & Shilubane M 1998. From the spectator to an active participant: a joint effort towards the development of a culture of teaching and learning (Unpublished paper).
- Monyoo LA 1998. Transforming the culture of learning and teaching: a South African perspective. Paper presented at the *Annual Conference of EASA*, Broederstroom, South Africa, 21-23 January.
- Moon B & Mayes AS 1994. *Teaching and learning in the secondary school*. London: The Open University Press.
- Nxumalo B 1995. The culture of learning: a survey of Kwa-Mashu schools. *Indicator SA*, 10:55-60.
- Republic of South Africa 1996. *South African Schools Act*. Pretoria: Government Printers.
- Saunders W 1996. One lost generation after another. *Frontiers for Freedom*, 18-19.
- Smith DPJ & Schalekamp S 1997. Restoring a culture of teaching and learning: Results of a phase one project in the West Rand Department of Education. Paper presented at the *EASA Conference*, Johannesburg, 1-13.

Concept formulation for environmental literacy

C.P. Loubser

Faculty of Education, University of South Africa, P.O. Box 392, Pretoria, 0003 South Africa

C.H. Swanepoel

Faculty of Education, University of South Africa

C.P.C. Chacko

Faculty of Education, University of South Africa

Various studies have shown a lack of understanding of environmental concepts amongst individuals of all ages. Teachers can play a substantial role in uplifting the level of environmental literacy of the population. There is, however, concern whether teachers do actually have the necessary basic knowledge of environmental concepts which they have to teach. In this article we address the concepts which relate to environmental literacy of individuals. We focus on the way in which concepts are formed and how these could have an impact on teaching of environmentally related issues. The role of teacher education to ensure that teachers are environmentally literate and concepts, which should be enhanced during teacher education to ensure an environmentally literate population, are discussed.

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). According to Schreuder (1995:3) the establishment of such a clean and healthy environment depends on the provision of quality education. The 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, however, doubtful whether it is possible to improve or maintain a healthy environment through the same kind of content-oriented education offered by the previous education departments in the RSA.

When the advancement of a healthy environment is discussed, reference is made to various concepts or aspects. These aspects include the behavioural patterns of people (Grieve & van Staden, 1985:135), attitudes of people (Firth, 1995:59), knowledge of ecology (Rockcastle, 1989:8; Schaefer, 1992; Orr, 1992), the nature of control and power exercised by human beings on the environment (Plant, 1995:26), environmental ethics (Firth, 1995:58) and the environmental literacy of people (O'Neal & Skeleton, 1991/1992:158; Shongwe, 1997:3). The latter could be seen as the overarching aspect which is essential to achieve a sustainable future for all so that the present and future generations can share the resources of the environment. A clean and healthy environment is therefore dependent on the environmental literacy of people.

Teachers can play a substantial role in uplifting the level of environmental literacy of the population. The effectiveness of teaching in the classroom is, however, influenced by the background knowledge of teachers (Prawat, 1992:356) and this obviously gives meaning and direction to classroom practice (Ballantyne & Tooth-Aston, 1987:3; Beatties, 1995:59). It is also obvious that teachers are the ones who

select the ways in which environmental education goals and objectives are met (Shuman & Ham, 1997:25). On the other hand it has been 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 are 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).
- (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).

Teachers cannot assist their students to become environmentally literate if they themselves lack environmental literacy. There is, therefore, 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 the implementation of innovations in any school 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). Schulze (1994:165) quoted Sterling who pointed out that "the key to environmental education lies with teachers".

In the light of the above accentuation of the importance of environmental literacy and environmental education the following question arises: Which concepts are important for environmental literacy and environmental education?

Environmental literacy

Although there are many viewpoints about environmental education, environmental education can be seen as 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 and Roth (1992:165) the creation of an environmentally literate citizenry is an important aim of environmental education. They further noted that environmental literacy is 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 with a will to take action" (Volk, Hungerford & Tomera, 1984:10). In order to establish a legacy which we would 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 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 programme" (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 to the concept 'environmental literacy' appeared in an article by Roth in the Massachusetts Audubon in 1969 (Roth, 1992:ix). Since then, the concept environmental literacy has crept into environmental education (Subbarini, 1998:244), but very few attempts have been made to define the term or provide ways of measuring environmental literacy. In the following paragraphs an attempt will be made to determine what environmental literacy entails.

It is important to notice that very little reported research really tried to demystify and clarify the concept environmental literacy and furthermore, many of these views can be regarded as positivistic.

According to Roth (1992:1) environmental literacy is essentially the capacity to perceive and interpret the relative health of the environmental systems and to take appropriate action to maintain, restore or improve the health of those systems. To be environmentally literate, a sound knowledge of 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 (Wisconsin Department of Public Administration, 1991:77).

Although we identify with the preceding description, we are aware that the term 'environmental literacy' does not mean the same to everyone. Problems exist in defining environmental literacy as is the case with the definitions of environmental education (Singletary, 1992:35). It may be possible that an understanding about an environmentally literate person can provide a clearer definition of environmental literacy. Therefore, in the following paragraphs the concept 'environmentally literate person' will be discussed.

A society can be regarded as environmentally literate if a substantial proportion of the individuals in the society is environmentally literate. The characteristics of an environmentally literate person suggests that an environmentally literate person should

- have a sound knowledge about the environment (Harvey, 1976:76; Hurry, 1982:44; Roth, 1992:8-9; Subbarini, 1998:245),
- be 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 (Harvey, 1976:76; Hurry, 1982:44; Roth, 1992:8-9; Subbarini, 1998:245),
- be aware of the environment and its resources, have some understanding of renewable resources, has feelings for the interrelationship in nature, is sensitive towards environmental problems, has positive attitudes and values, gathers information as environmental problems arise, investigates environmental issues, finds solutions to basic environmental problems, is willing to sacrifice individual privileges, and possesses basic skills and takes part in active and thoughtful action (Clacherty, 1992:26; Hurry, 1982:44), and
- explore how culture, social and political organisations and the stages of development of groups of people contribute to environmental effects, explore ethical issues involved in environmental protection and management, and explore decision making on environmental issues in scientific, economic, legal, social, and political context (Nickerson, 1991/92:170).

The level or the degree of environmental literacy of a person is, however, 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.

Levels of environmental literacy

As mentioned in the introduction, a large proportion of the population is 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). In other words, people should be able to demonstrate in an observable form a continuum of competencies such as understanding, 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.

Nominal environmental literacy

This 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).

Functional environmental literacy

It indicates a person with a broader knowledge and understanding of the nature of interactions between human social systems and other natural systems. They are aware and concerned about the negative 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 observe a personal investment and motivation to work towards remediation using their knowledge of basic strategies for initiating and implementing social and technological change (Disinger & Roth, 1992:166-167; Roth, 1992:16).

Operational environmental literacy

It indicates that a person has moved beyond functional literacy in both the breadth and depth of understandings and skills which routinely evaluate the impacts and consequences of 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).

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

- Nominal environmental literacy indicates the ability to recognise 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.

Identification of concepts important to environmental education and environmental literacy

There are many concepts which seem to be important when environmental literacy and environmental education are the subjects of consideration. The question arises 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. An analysis of different statements show that these words are indeed used as synonyms. For example, biodiversity is a concept to Wals and van Weelie (1997:4), but is an environmental issue to Palmer, Suggate and 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 the ozone layer and its depletion is an environmental issue (Boyes, Chambers & Stannisstreet, 1995:133). For Palmer, Suggate and Matthews (1996:301) deforestation is an environmental issue. Brody (1990:25) mentioned population growth as a topic and pollution as a concept. Roth (1992:37-38) recognised the difference between terms, concepts and events to be understood by environmentally literate citizens.

It can be assumed that there is a close link between words such as problems, issues, etc. used by many people. However, in general, concepts are understood as having a logic core, which is surrounded by an associative framework. Words have personal meanings and are difficult to define in most instances. A concept is defined as a basic idea and has some features in common, but may also be different in some instances.

There is no general agreement as to which concepts are important for environmental education. In the United States of America (USA) substantial progress has 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) though. As there is no agreement on concepts important for environmental education and environmental literacy, it is necessary to identify concepts as basis for further research such as the measurement of environmental literacy. 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 (Table 1) from a 50-item list by Cherrett. He is of the opinion that these ecological concepts would be recognised 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 1 The 20 most important ecological concepts (Munson, 1994:31)

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

Odum (1992) developed a list of 20 great ideas in ecology that might be included in courses designed to improve environmental literacy (Table 2). According to Odum (1992), concepts such as the ecosystem, human ecology and the relationships between ecology and economics mainly focus on environmental literacy.

Roth (1992:37-38) identified 135 terms and concepts to be understood by environmentally literate citizens. They are provided in Table 3. Roth (1992) did not provide a clear distinction between terms and

Table 2 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 the hierarchical organisation of ecosystems, species interactions that tend to be unstable, non-equilibrium, or even chaotic are constrained by the slower interactions that characterise 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 extinction.

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 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 the number of users and intensity of per capita use.

Concept 16:
Input management is the only way to deal with non-point pollution.

Concept 17:
An expenditure of energy is always required to produce or maintain an energy flow or a material cycle.

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.

Table 3 Some terms and concepts to be understood by environmentally literate citizens (Roth, 1992:37-38)

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
Lifestyles	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/understood by all environmentally literate individuals. According to Loubser (1994) the ten key concepts correspond with concepts selected by other authors and institutions such as the Ontario Ministry of Education. The ten key concepts are indicated in Table 4. The first sentence is usually the core of the concept.

Roth (1992) identified knowledge, affect, skills and behaviour as the four strands important for environmental literacy. For example, from the definitions of environmental literacy provided 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.

concepts important for environmental literacy. At the same time, the list of 135 terms and concepts seem too many to be used for assessment of environmental literacy.

Table 4 Ten concepts which should be known by all environmentally literate individuals (Loubser, 1994:37-38)

<p>Concept 1: The earth as a closed system: the concept of ecosystem. Factors: sunshine, rain, temperature, wind, energy, soil, plants, animals, fungi. Everything is connected to everything else. Renewable / Non-renewable resources.</p> <p>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.</p> <p>Concept 3: Cycles: Natural cycles: water, nutrients, life-death, growth-decay, carbon-oxygen, etc. Cyclic interconnection. 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.</p> <p>Concept 4: Interaction of economics, science (biology/chemistry/physics) and politics in environmental education: integration of learning about our world.</p> <p>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.</p> <p>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.</p> <p>Concept 7: Food webs and chains: biological magnification and contamination.</p> <p>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.</p> <p>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.</p> <p>Concept 10: Personal commitment for the care and respect of the environment. Reduce, Re-use, Recycle, Rethink as a way of life. Environmental ethics in your job and family life. Minimise use of substances harmful to the environment: chemicals, pesticides, insecticides, CFCs and home products. Respect for all living things.</p>

Table 5 The concepts related to environmental literacy

No.	Concepts
1	Basic understanding of the biosphere (air, water, and land) as the <i>life support systems</i> on which all living organisms <i>depend for habitability and survival</i> . Knowledge of <i>natural and man-made environment</i> . Knowledge of <i>natural laws and principles of nature</i> .
2	Understanding of an ecological perspective of nature and human beings: <i>ecological concepts and principles, concepts of ecosystems</i> .
3	Awareness of <i>human interactions</i> with the environment and interrelationships in an ecosystem . Understanding of <i>natural cycles and energy flow</i> in the ecosystem. Knowledge of <i>food chain and food web</i> .
4	Knowledge of environmental changes brought about by <i>industrialisation, urbanisation</i> . Awareness of <i>population growth issues</i> and its <i>influence on resources, population growth and control and problems of human settlement</i> . Awareness of <i>pollution and sewage disposal</i> .
5	Understanding of the activities to meet basic human needs and <i>wants</i> and <i>how it affects health, the environment and quality of life</i> . Knowledge of <i>population-resource imbalances</i> and taking <i>action to correct such imbalances</i> . Knowledge of the <i>use of resources and minimising the use of substances harmful to the environment</i> .
6	Awareness of renewable and non-renewable resources . Understanding the difference between actual and perceived risks from the <i>destruction of the environment and exploitation of natural resources and their conservation</i> .
7	Knowledge of how to maintain environmental quality and quality of life . Knowledge of how <i>organisations and groups of people contribute to environmental changes</i> .
8	An understanding about the ability to make choices . <i>Willingness to curtail individual privileges</i> . Awareness of <i>actions</i> that individuals can take to <i>protect the environment and public health. Personal commitment for the care and respect for the environment</i> .
9	Knowledge of decision making on environmental issues in scientific, economic, legal, social, and political contexts. Awareness of the <i>effect of consumer and market forces</i> and rejection of <i>short term gains</i> . Knowledge of the relationships between high <i>productivity, modern technology, economic development and a healthy environment</i> .
10	Knowledge of environmental ethics as a way of life. <i>Respect for all living things</i> . Knowledge of ethical issues involved in <i>environmental protection and management</i> . Management of environment and resources for <i>sustainable development</i> .

- Types and examples of interactions between humans and nature.
- Basic components of social systems.

Have affective sensitivities 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 in:

- Identifying and defining problems.
- Recognising issues surrounding identified problems or proposed solutions.

Demonstrate:

- Organisational activities and habits aimed at maintenance of environmental quality.
- Responding and coping behaviours.

It must be noted that knowledge/understanding 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 purpose of this research, 10 concepts related to the environment literacy were formulated from the definition of environmental literacy, the levels of environmental literacy, the characteristics of an environmentally literate person and the environmentally literate society and from the concepts outlined by Munson (1994), Odum (1992), Roth (1992) and Loubser (1994).

As the concepts indicated by Munson, Odum, Roth and Loubser relate mainly to the natural environment, an attempt has been made to include other perspectives of the environment in the group of concepts that were identified. The 10 concepts were therefore selected mainly from major areas such as ecology and interactions in the environment (Concepts 1–6), but also to include participation in the identification and prevention of environmental problems (Concepts 7 and 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. Due 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. The concepts related to environmental literacy selected for this article are indicated in Table 5. In each concept, the basic idea (logic core) is in bold and the associative framework is in italics.

The concepts outlined in Table 5, each has a basic idea (indicated in bold), share some features with other concepts due to the inter-relationship between concepts but 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 inter-relationships 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 have 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 1 to 6 as they are mainly concerned with ecology and interactions in the en-

vironment. 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 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 the 10 concepts outlined in Table 5.

The concepts outlined in Table 5, 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 rejection of 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 previously.

Conclusion

There are many concepts which are important in environmental education. However, there is no general agreement as to which concepts are important. It is often found that knowledge of biological and ecological concepts are indicated in literature as being important in environmental education and environmental literacy. However, when the holistic nature of environmental education is taken into consideration other concepts referring to the social environment, for instance, are sometimes sidelined.

In this article we have tried to indicate that it is necessary for teachers to have a grasp of certain concepts themselves before being able to teach those concepts. As environmental education is a very important means to developing environmental literacy it was necessary to identify those concepts that are important to environmental education and environmental literacy. A discussion of various models indicating lists of concepts was presented, followed by the formulation of ten concepts important to environmental education and environmental literacy.

References

- African National Congress 1994. *Reconstruction and Development Programme: A policy framework for education and training*. Johannesburg: African National Congress.
- Ballantyne RR & Tooth-Aston PJ 1987. In-service environmental education teacher training in an apartheid education system. *Environmental Education and Information*, 8:1-10.
- Beatties M 1995. New prospects for teacher education: Narrative ways of knowing teaching and teacher learning. *Educational Research*, 37:53-69.
- Blignaut JB 1992. Existing constraints and attitudes towards the implementation of environmental education in Cape schools. *South African Journal of Education*, 12:251-256.
- Boyes E, Chambers W & Stanisstreet M 1995. Trainee primary teachers' ideas about the ozone layer. *Environmental Education Research*, 1:133-145.
- Braus J 1995. Environmental education: Where we've been and where we're going. *Bioscience*, Supplement: 845-851.
- Brody MJ 1990. Understanding pollution among 4th, 8th and 11th Grade students.

- Journal of Environmental Education*, 22:24-33.
- Chou J & Roth RE 1995. Exploring the underlying constructs of basic concepts in environmental education. *Journal of Environmental Education*, 26:36-43.
- Clacherty AJ 1992. Environmental literacy: Implications for environmental and teacher education. *South African Journal of Education*, 12:25-30.
- Disinger JF & Roth CE 1992. Environmental Education research news. *The Environmentalist*, 12:165-168.
- Firth R 1995. *Postmodernity, rationality and teaching environmental education*. Geelong, Victoria: Deakin University.
- Grieve KW & Van Staden FJ 1985. Environmental concern in South Africa: An Attitudinal study. *South African Journal of Psychology*, 15:135-136.
- Harvey GD 1976. A conceptualization of environmental education. In: Aldrich JL, Blackburn AM & Abel GA (eds). *The report of the North American Regional Seminar on Environmental education*. Columbus, OH: ERIC Clearing House for Science Mathematics and Environmental Education.
- Hurry LB 1982. Directions in environmental education and their implications for the training of primary school teachers in the Transvaal: towards a synthesis. Unpublished DEd thesis. Pretoria: University of South Africa.
- Irwin PR 1982. Conservation awareness amongst White Adolescence in South Africa: A study of senior secondary pupils in Natal. MEd dissertation. Pietermaritzburg: University of Natal.
- Irwin PR 1993. Environmental Education in Bophuthatswana with particular reference to Teacher Education. Unpublished DEd thesis. Pretoria. University of South Africa.
- Kuiper J 1995. The scientist will save the world: Environmental education in an alienated society. *Southern African Journal of Environmental Education*, 15:39-48.
- Loubser CP 1994. *Environmental Education in Primary Schools in South Africa*. Department of Didactics: University of South Africa.
- Mabogunje AL 1995. The environmental challenges in sub-Saharan Africa. *Environment*, 37:31-35.
- Munson B 1994. Ecological misconceptions. *Journal of Environmental Education*, 25:30-34.
- Myburgh JA 1994. A cross-curriculum approach in the teaching of environmental education in junior-secondary phase. *Spectrum*, 32:7-9.
- Nickerson NH 1991/92. Environmental programs at Tufts university — Leading the way in environmental studies. *Journal of College Science Teaching*, 21:168-172.
- Odum EP 1992. Great ideas in ecology for the 1990s. *Bioscience*, 42:542-545.
- O'Neal L & Skeleton J 1991/92. Teaching undergraduate ecology through adventure and travel in the United States. *Journal of College Science Teaching*, 21:154-158.
- Orr DW 1992. *Ecological literacy: Education and the transition to a post modern world*. Albany: State University of New York Press.
- Palmer JA, Suggate J & Matthews J 1996. Environmental cognition: early ideas and misconception at the ages of four and six. *Environmental Education Research*, 2:301-329.
- Papadimitriou V 1995. Professional development of in-service primary teachers in environmental education: an action research approach. *Environmental Education Research*, 1:85-97.
- Pettus AM 1982. Preparing teachers for environmental education. *College Student Journal*, 16:181-186.
- Plant M 1995. Delusions of progress: A case study for reconceptualising environmental Education. *Southern African Journal of Environmental Education*, 15:26-28.
- Prawat RS 1992. Teachers' views about teaching and learning: A constructivist perspective. *American Journal of Education*, 100:354-395.
- Republic of South Africa 1996. *The Constitution of the Republic of South Africa*. Pretoria: Government Printer.
- Richards D 1985. An alternative programme for developing environmental literacy in 12 year old South African school children: A study done amongst White senior primary pupils in Natal. MEd dissertation. Pietermaritzburg: University of Natal.
- Rockcastle VN 1989. Environmental literacy: Philosophy/ Content/ Strategies. What our students should know and be able to do. *Nature Study*, 43:8-9, 22.
- Roth CE 1992. *Environmental Literacy: Its roots, evolution and directions in the 1990s*. Columbus: The Ohio State University.
- Schaefer G 1992. Thinking locally in environmental education: The Victoria, B.C. experience. *Journal of Environmental Education*, 24:5-8.
- Schreuder DR 1995. Environmental Education at crossroad: Rethoric and reality in educational construction in South Africa. Paper presented at the *NAEE conference*, Portland, Maine, USA, September 1995.
- Schulze S 1994. The current status of educating teachers in environmental education by means of distance education. *South African Journal of Education*, 14:165-168.
- Shongwe DK 1992. Environmental education in primary schools in Bophuthatswana: A case study in curriculum implementation. MEd dissertation, Grahamstown: Rhodes University.
- Shongwe D 1997. Environmental education in business and industry. *Environmental Education Bulletin*, 14:3-4.
- Shuman DK & Ham SH 1997. Toward a theory of commitment to environmental education teaching. *The Journal of Environmental Education*, 28:25-32.
- Simmons DA 1989. More infusion confusion: A look at environmental education curriculum materials. *Journal of Environmental Education*, 20:15-18.
- Simmons D 1993. Facilitating teachers' use of natural areas: Perceptions of environmental education opportunities. *Journal of Environmental Education*, 24:8-16.
- Singleton TJ 1992. Case study of selected high school environmental education classes. *Journal of Environmental Education*, 23:35-40.
- Stone JM 1990. Preparing teachers as environmental educators. *The Education Digest*, 55:43-45.
- Subbarini MS 1998. Philosophical, epistemological, doctrinal and structural basis for international environmental education curriculum. Proceedings of the *Best of Both Worlds Conference*, Pretoria, South Africa.
- Volk TL, Hungerford HR & Tomera AN 1984. A national survey of curriculum needs as perceived by professional environmental educators. *Journal of Environmental Education*, 16:10-19.
- Wals AEJ & Van Weelie D 1997. Environmental education and learning of ill-defined concepts: The case of biodiversity. *Southern African Journal of Environmental Education*, 17:4-11.
- Wisconsin Department of Public Instruction 1991. *A guide to curriculum planning in environmental education*. Madison: Wisconsin Department of Public Instruction.