CHAPTER 1

INTRODUCTION

1.A. THE PURPOSE

In 1991 Goodwin (Goodwin 1991) investigated whether different approaches to the teaching of certain biological concepts brought about a conceptual change in the students' understanding and application of these concepts. The two approaches investigated were the LECTURE APPROACH and the INDIVIDUALIZED GUIDED APPROACH. The effect that each had on the understanding and the application of the concepts "seeds, germination and seedling development", were evaluated in a sample of prospective primary school teachers. The overall gains of the INDIVIDUALIZED GUIDED APPROACH group were slightly higher than those of the LECTURE APPROACH group indicating that the INDIVIDUALIZED GUIDED APPROACH tended to be a better overall method of instruction in bringing about conceptual change in the understanding of the certain botanical concepts.

With the introduction of Curriculum 2005 (C2005) (Tiley, 1997), it was decided to revisit this research and draw on some of its results and recommendations. The INDIVIDUALIZED GUIDED APPROACH has many characteristics that are similar to those advocated in C2005. Two facets that could be investigated were outcomes-based education and teachers fulfilling the role of facilitator in the classroom.

1.B. THE ORIGIN OF THE STUDY

The African National Congress of South Africa (the governing party) chose a strategy for transformation of the educational system as far back as 1994. This strategy, referred to as C2005, was compiled to help support teachers during the transformation. It was to be a planned process and strategy of curriculum change underpinned by elements of redress, access, equity and development. The central approach of the new curriculum is derived from Spady's (Spady 1994) concept of "Outcomes Based Education" which employs the methodologies used in progressive pedagogy such as student centeredness, teachers as facilitators, relevance, contextualized knowledge and co-operative learning (Centre for Education Policy Development, 2000).

While running workshops in various regions of South Africa, it was noticed that the introduction of Curriculum 2005 caused considerable anxiety amongst the South African teaching community. Many teachers appeared to be confused, insecure, lacked confidence and appeared to feel unprepared for the transformation they were expected to make. This

transformation requires many teachers to make conceptual and practical changes. According to many teachers that have been spoken to in many other contexts, there has been little or no support to help them make these changes (Rogan, 2000). The main problems experienced by teachers revolved around the C2005 training being too abstract and insufficiently focused on what the theory meant in practice. A study by Jansen (1999) on implementation of outcomes-based education in Grade 1 found that teachers uniformly expressed views consistent with the assessment that their preparation for C2005 was inadequate and incomplete. Another by Hiralaal (2000) found that whereas the majority of teachers felt that training had given them some understanding of C2005, mainly African teachers expressed uncertainty about the Foundation Phase policy document (Tiley, 1997) as well as the policy on assessment. Vinjevold and Roberts (1999) found that Grade 7 teachers had been unable to apply their new understanding to classroom practice. The Khulisa study in 1999 [Khulisa Management Services & MBM Change Agents (1999)] found that training was too short and there was insufficient hands-on training. Training had provided increased levels of understanding of outcomes-based education (OBE) but there were real difficulties with what it meant in practice for designing learning programmes, integration and continuous assessment.

For Spady (1994) outcomes-based education (OBE) meant clearly focusing and organizing everything in an educational system around what was essential for all students to be able to do successfully at the end of their learning experiences. This meant starting with a clear picture of what was important for students to be able to do, then organizing curriculum, instruction, and assessment to make sure this learning ultimately happened.

The Department of Education's *Teacher's Manual for Grade Seven* (2000) adapted Spady's ideas to describe a "South African" version of outcomes-based education. It similarly defined outcomes-based education as "in essence… defining, organizing, focusing and directing all aspects of a teaching system in relation to what we want ALL students to demonstrate successfully when they exit the system…." (p. 11). Outcomes-based education considers "WHAT (outcomes) and WHETHER students are learning well, as more important than WHEN and HOW they learn it" (p. 10).

Outcomes-based education underpins the National Curriculum Policy. In October 1997, through the National Education Policy Act of 1995 the Minister of Education promulgated the new national curriculum policy. As a result, in terms of the National Education Policy Act (Act No. 27 of 1996) an outcomes-based curriculum was published in the Government Gazette No. 18400, dated 31st October 1997.

In this research project an attempt was made to try to:

- create a practicing culture of science learning with educational relevance to see if this promoted professional development

- determine whether the development of a gardening project that helped to create a learning environment in which science was relevant to the participants fostered a positive attitude amongst the participating teachers
- create an alternative assessment tool (the development of the school garden) rather than the traditional test or examination assessment scenario and investigate whether this improved the teachers' botanical knowledge and planting skills
- investigate the factors that impeded the changes where changes did not take place.

The research was undertaken with the objective of investigating whether the production of a school garden and a booklet on how and what to plant in the school garden could improve:

- ignorance of the environment i.e. make teachers more environmentally literate
- teaching i.e. implement change in teaching methods by introducing outcomes-based teaching
- the lack of teaching resources
- the general negative attitude towards plants
- the lack of botany knowledge and
- the lack of a cultivated school garden.

The overall question posed in this research was:

Could teachers who actively participated in the development of a school garden and the booklet, "Gardening with Flora", be enabled to develop professionally by:

- becoming more environmentally literate?
- gaining more botany knowledge?
- gaining the skills necessary to develop and maintain a garden?
- being able to design and implement outcomes-based lessons?
- improving their attitude towards the environment?

1.C. THE NEED FOR THE STUDY

Flowering plants form a large part of many students', teachers' and the man-in-the-street's environment and yet their knowledge of them seems very poor. Goodwin (1991) found that most teachers resorted to teaching botany by demonstrations while the students took down notes. This tended to generate a negative attitude towards plants on the part of the students. Teachers approached their teaching with very little thought of practical work, and often explained this by claiming that no resources were available. Only a few schools had developed their school grounds into areas that were aesthetically pleasing and at the same time could provide plant material for the teaching situation.

Some school gardens have a great amount of the same plant material, which is often not suitable for use in teaching. This lack of variety could have arisen because the teachers do not know what to plant to help them in their teaching. Another reason their school gardens are not developed could be due to their lack of knowledge about how to plant the actual plants .

This research then looked at the topic “plants” as the biological content in the context of developing a school garden, which is an environmental system. The school garden could be considered a local environmental issue that each and every teacher could relate to. In developing the school garden the teachers had to see it as having the potential to be used as a resource for teaching so that their teaching methodology could be improved. The project should be able to help them to learn more about plants in a relevant way. The choice of plant material to be included in the garden would need to be considered very carefully so that the garden could remain sustainable for as long as possible.

Goodwin (1991) showed that biology, especially the study of plants, in the prescribed curriculum (prior to C2005) dealt mainly with the acquisition of knowledge, but not necessarily the understanding of that knowledge. In contrast content knowledge was initially conspicuous by its absence in C2005 policy documents. This absence was largely because C2005 designers tried to break with the traditions of the old education system as reported by the Centre for Education Policy Development (2000) and Chisholm, L. (2000). An aim was that teachers would generate their own content and use their specific environment as the basis for their teaching. Teachers could not think that because the curriculum was not content-based then “any content was fine”. Curriculum 2005 was to be a participatory curriculum that would be relevant and address local issues while helping students internalise required knowledge and skills. It also expects skills to be defined clearly, communicated to the students and to be assessed fully.

1.D. THE CONTEXT OF THE STUDY

To determine what knowledge, skills and attitudes regarding plants and the environment, the group of rural primary school teachers might possess, a preliminary study with 25 practicing foundation and intermediate phase teachers from Siyabuswa was conducted. After analysing the completed questionnaires it became apparent that many teachers needed help in acquiring more knowledge about plants and the environment if they were to teach the Natural Sciences in an outcomes-based fashion. This group may be expected to be indicative of most teachers in South Africa, especially in rural areas.

Discussions with participating teachers during the preliminary study showed that the majority of them had never been involved in producing learning programmes although they had attended workshops on curriculum development. *This research investigated whether the*

subsequent (main) intervention brought about a change in the participants' ability to produce learning programmes.

Questions posed to these teachers revealed that their own learning of the topic "plants" had been limited to information obtained from their students' textbooks and no more. *This research sought to determine whether the main intervention brought about a change in the teachers' plant knowledge.*

The participants tended to stick strictly to the syllabus presented to them and only three out of the 25 questioned its relevance. For them to look upon questioning as an accepted and expected mode of thinking was very difficult. They had also not been encouraged to reflect on their own teaching and so for them to analyse their own performance was a novel and difficult experience. *This research probed into whether the intervention was able to bring about a change in the teachers' professional development specifically with regard to them assessing their own teaching.*

The group had tended to teach by the traditional "chalk and talk" method. This method encouraged students to read and repeat. It is a memorization-based method, with the deliberate avoidance of giving meaning. Very few of them had ever used demonstrations in their lessons. Most aspects of plant study had been undertaken using only the textbook. If one looks at current school biology syllabi, this situation is not supposed to be the case (refer to the Gauteng biology syllabus -2003, Appendix B). Actual plant material had not played a prominent role in their teaching methodology. Because they knew so little about plants some of them had even glossed over some parts that needed to be taught. Very few had worried about a school garden and if their school had one, they had not been involved in developing it. They also had not made suggestions as to what plants should be included in it. Only four members of the group actually had a garden at home, which they had developed. *This research would try to determine whether the intervention was able to bring about a change in the teachers' method of presenting plant material to their students*.

Most teachers from the Siyabuswa community had very little knowledge of the environment and certainly did not teach with an environmental underpinning. *This research would look at whether the development of a school garden and a booklet giving the skills to do this would be sufficient to bring about a change in the participants' environmental literacy.*

The majority of teachers did not have English as their home language. The general community in Siyabuswa was very poor and the majority of parents worked in Pretoria (some 120 km distant) and returned home at the end of the month, hopefully bringing with them their hard-earned salary. The children were in most cases looked after by the grandparents. Although there were no squatter houses, very few houses had gardens although there was

space for them. On talking to some of the inhabitants the main reason for this was that the free time that was available to the members of the household, was spent trying to sell produce from door-to-door to try to make ends meet. The produce sold was actually bought specifically for this purpose. This shows that the horticultural skills which the teachers would be able to impart to the community, if successfully learned, would have a local relevance, within the intentions of the C2005 OBE designers.

1.E. THE UNFOLDING OF THE MAIN STUDY

The intention of the "Gardening with Flora" project was to pilot an environmental education curriculum development process through the production of a booklet called "Gardening with Flora" and a professional development model which could enhance educational transformation in South Africa. Teachers from the Siyabuswa district of Mpumalanga participated in the project. They had already been formed into a cluster and had been attending mathematics and general science workshops during a proceeding 3-year period. The issues here were both the availability of good teaching resources and whether and how teachers were prepared and motivated to create and use learning resources in their teaching. *A question underpinning this research was the teachers' capacity to create their own materials.* In the majority of contexts, teachers stated that they did not have the time, resources or often skills to develop their own materials.

Teachers were required to contribute ideas to a booklet called "Gardening with Flora". It was designed to support the implementation of environmental education and teaching plants in an outcomes-based fashion in the formal education system while supporting teachers involved in teaching grades 1 to 7. The "Centre for Science Education of the University of Pretoria" and "Progressive Environmental Projects" funded the project. *The research would attempt to determine whether there was an increase in the use of resources for teaching and whether the teachers were facilitative after the intervention of the main study and were more competent and skilled to teach about plants in a hands-on way.*

Thus this research investigated whether the development of a school garden was a contributing factor to the implementation of an educational change, which would produce biology teachers who were more environmentally literate.

1.F. RESEARCH QUESTIONS

To do all of the above the following questions were asked:

QUESTION 1: Can a school garden be improved aesthetically by attending botany workshops in which the necessary skills are learnt?

QUESTION 2: Can the participants' professional development, specifically with respect to botany teaching, be improved with the development of a school garden and the production of a booklet on how and what to plant in a school garden?

This question gave rise to hypothesis 1 and 2:

Hypothesis 1: The participating teachers have improved their plant knowledge.

Hypothesis 2: The participating teachers are using outcomes-based teaching methods due to their involvement in developing their own school garden and the "Gardening with Flora" booklet.

QUESTION 3: Can the attitude towards plants be changed by participation in the production of a booklet on what to plant in a school garden and the actual development of a school garden?

QUESTION 4: Can knowledge, skills and attitudes towards the environment be changed with active engagement in these dimensions through (i) the production of a booklet on what to plant in a school garden and (ii) the actual development a school garden?

This question gave rise to hypothesis 3:

Hypothesis 3:
The participating teachers have become more environmentally literate due to their active involvement in developing the "Gardening with Flora" booklet and their own school garden.

1.G. SUMMARY OF FUTURE CHAPTERS

Chapter 2 is dedicated to the literature review of the preliminary and main studies. The concepts environment, environmental literacy and environmental education were investigated in detail as well as barriers to the implementation of environmental education in schools. The links between biological and environmental education were studied with respect to their common knowledge, skills and attitudes. Different teaching, learning and assessment styles were investigated to see whether they could be used as means of tackling the lack of school gardens. Some existing programmes were examined to find characteristics that could be included in the "Gardening with Flora" programme. The background to and nature of educational change in South Africa was then outlined and the latest strategy, known as Curriculum 2005 was highlighted. This strategy, prescribed by outcomes-based education, underpins the present educational curriculum reform in South Africa. The issue of the

availability of good teaching resources and whether and how teachers were prepared and motivated to create and use learning resources was also studied. Finally gardening was viewed as a change vehicle.

Chapter 3 describes the general methodology of the research. It outlines the research design for the various phases of the project.

Chapter 4 describes the specific methodology, observations and results of the preliminary study. It also illuminates the conclusions drawn from this preliminary study.

Chapter 5 looks at the specific methodology, observations and results of the main study. It traces the intervention, results of assessments and observations while teachers went about developing their school gardens and compiling a booklet called “Gardening with Flora”. It details the quantitative and qualitative analysis of the four research questions with their hypotheses and assumptions. It also encompasses a discussion on what was learnt from the project, which changes the participants underwent and which factors were responsible.

Chapter 6 is the concluding chapter and reflects on the purpose of the study and some assumptions made at the beginning and draws general conclusions on the effectiveness of the change mechanism used during the main intervention. It makes recommendations for establishing continued teacher assistance by using this model in pre-service and in-service teacher education in future.

CHAPTER 2

THE LITERATURE RELATED TO THE PRELIMINARY AND MAIN STUDIES

This research was undertaken to investigate whether a conceptual change in the understanding of certain botanical concepts could be achieved by using an outcomes-based approach. It also attempted to evaluate whether the teachers developed professionally by developing their school garden and creating a booklet “Gardening with Flora”.

The literature discussed here sets the scene and forms the foundation for determining what knowledge, skills and attitudes regarding the environment and plants, teachers generally possess and the best way to obtain them. Literature elucidating outcomes-based education, Curriculum 2005, the formation of resource materials and programmes involved in the solving of environmental issues especially the development and use of school gardens is included.

2.A. THE ENVIRONMENT

The environment is not an easy term to define as it is widely used and often with different connotations. The word “environment” has as its root “to environ”, which means to form a circle or ring around. The concept of “environment” has become broader over time. Loubser (1996a: pp. 6-7) mentions two holistic models of the environment. The first model, FIGURE 2.1, reflects a view of the environment, which emphasises sustainable management use of life support systems and which develops 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 biophysical support systems – soil, water, air, plants, animals and the ecosystems in which they interact. The centre of FIGURE 2.1 shows the environment as interacting social, economic and political dimensions, resting upon a base of biophysical life support systems.

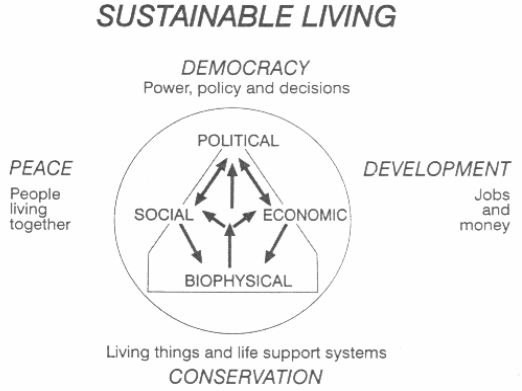

FIGURE 2.1. A DIAGRAMMATIC REPRESENTATION OF THE ENVIRONMENT (LOUBSER, 1996A: p. 6)

In the second model, FIGURE 2.2, 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.

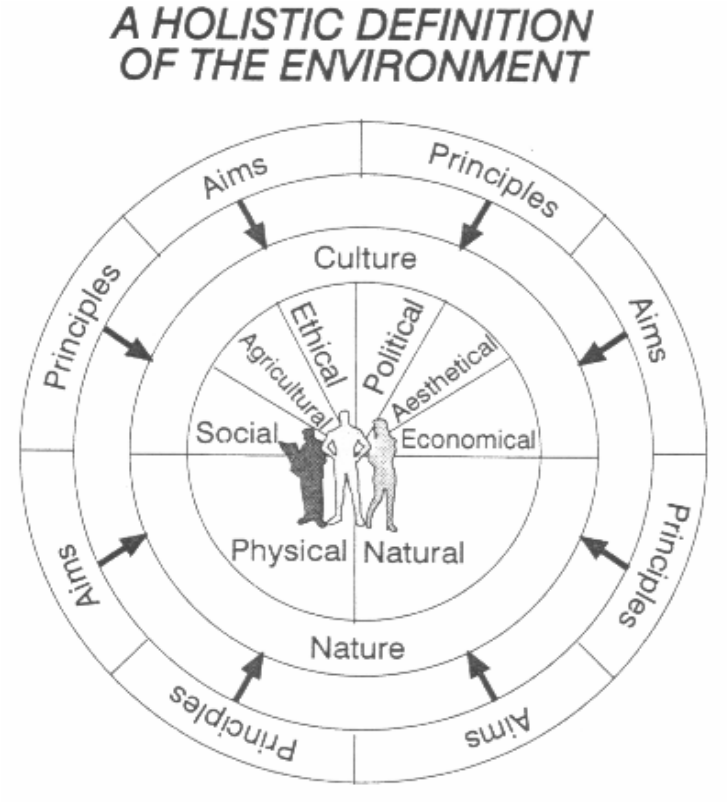

FIGURE 2.2. A HOLISTIC REPRESENTATION OF THE ENVIRONMENT (LOUBSER, 1996A:p 7)

The current definition for the "environment" in South Africa may be found in the National Environmental Management Act, (Act 107 of 1998). This is incorporated into the White Paper on Environmental Management Policy, 1999: p. 7. It reads:

"environment" means the surroundings within which humans exist and that are made up of:

i. the land, water and atmosphere of the Earth
ii. micro-organisms, plant and animal life
iii. any part or combination of (i) and (ii) and the interrelationship amongst and between them and
iv. the physical, chemical, aesthetic and cultural properties and conditions of the fore-going that influence human health and well being.

For the purpose of this study the "environment" is defined as:

> "all things in the local surroundings including all that affects them".

Because people construct their own concept of "environment" there can be many different interpretations and this is explored in the questionnaire given to the participating teachers at the start of the actual project.

2.B. ENVIRONMENTAL LITERACY

According to Hurry (1982), Roth (1992), Loubser (1996a) 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: pp. 8-9) recognised an environmentally literate citizen as one who:

- "recognises environmental problems when they arise
- takes action to correct environmental imbalances
- continues to gather information about environmental issues throughout his life
- is continually examining and re-examining the values of his or her culture in terms of new knowledge about humankind and resources".

Subbarini (1998) and Chacko (2001) both consider that these characteristics are needed to take appropriate actions to improve the quality of life and the quality of the environment. Environmental literacy draws upon six major areas: environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement (Disinger & Roth, 1992). From the six major areas, Disinger & Roth (1992) created four strands - knowledge, skills, affect and behaviour to be addressed in education for environmental literacy. These four strands are very similar to the Critical Outcomes deemed essential for the successful assessment of Outcomes-Based Education.

In this study, the following definition of environmental literacy was used. "Environmental literacy is the ability to observe and interpret the relative healthiness of environmental systems and to take appropriate action to maintain, restore or improve the state of these systems". A fundamental aspect of this project was the participants' ability to assess the state of their school gardens and then to develop competency in the skills necessary to improve and maintain these gardens.

2.C. ENVIRONMENTAL EDUCATION

Environmental education is also difficult to define owing to the nature of its content, the different approaches and the differing attitudes among environmental educators (Singletary, 1992). This confusion with the actual definition has often resulted in slow progress and vagueness within the field especially as far as environmental education being an actual school subject or integrated into other subjects.

The following definition of environmental education is proposed as it captures and expresses the key points:

> "Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems. This process is intended to produce a population that has the knowledge, skills and attitudes to work individually and collectively towards solutions of current problems and the prevention of new ones".

2.C.1. THE OBJECTIVES OF ENVIRONMENTAL EDUCATION

The objectives were set out by the United Nations Educational, Scientific and Cultural Organization (UNESCO) at the Belgrade Workshop in 1975 and endorsed by the Tbilisi Conference in 1977. The latter was the world's first UNESCO organised intergovernmental conference on environmental education. It was held at Tbilisi, Georgia in the USSR.

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: pp. 8-9).

2.C.2. THE INTERDISCIPLINARY NATURE OF ENVIRONMENTAL EDUCATION

The interdisciplinary nature of environmental education was documented at the Tbilisi conference for the first time. It was stipulated that although biological and physical factors form part of the human environment, the ethical, social, cultural and economic dimensions must play a part in determining the approach to better use of natural resources.

Despite these and similar recommendations, a proper understanding of the interdisciplinary nature of environmental education is still not sufficiently evident in South African teacher training institutions (Loubser, 1992). Many teachers received their education long before the availability of interdisciplinary courses in environmental studies and the development of critical approaches to teacher education (Fien, 1995). Singletary (1992) emphasises that teachers are often trained in only one discipline, making it difficult to incorporate the range of perspectives needed for a comprehensive coverage of environmental issues. From personal discussions held with the participants of the preliminary workshop, it was apparent that initially they had a very rudimentary understanding of environmental education.

2.D. THE LINKS BETWEEN BIOLOGICAL AND ENVIRONMENTAL EDUCATION

Biology can be seen as the study of the environment without the social and personal aspects. Plants form an integral part of the environment. The usual teaching of facts can be regarded as teaching ABOUT the environment and sometimes takes place IN the environment. Biology teachers may, therefore be criticized for not teaching FOR the environment.

2.D.1. THE CONTENT OF BIOLOGY AND ENVIRONMENTAL EDUCATION

Plants are important and it is critical that students gain both an understanding of plant function and appreciation for all that plants do. Many teachers neglect plants and tend to favour animals. According to Wood-Robinson & Cook (1992), plant science is important in dealing with the problems that have arisen due to the size and rapid increase in the human population. If young people are to be convinced of the importance of plants their interest must first be captured.

Wandersee (1986) undertook some research to determine which science topic junior high school students preferred to study – plants or animals? He found students prefer animal topics to plant topics. According to Novak (1977), a child is ready for meaningful learning in a subject area when he/she has some specific, relevant subsuming concepts. Ausubel et al. (1978) stress that learners who have little need to know and understand, quite naturally, expend relatively little learning effort. Educators are encouraged to capitalize on existing

interests and motivations. With this in mind it is necessary to formulate a biology curriculum that is enlightening, interesting and relevant. Samuels (1995) indicated that school students are disappointed about the fact that the content of biology is not relevant to everyday life.

According to Loubser (1996b), biology, as a school subject should reconsider its boundaries, rethink its role in the context of everyday life and change its content so that it is relevant. To make biology more relevant, it could be taught by means of “issues” which will then mean it will encompass environmental education. This is a requirement of the White Paper on environmental education (National Environmental Management Act [Act 107 of 1998]). In this regard this study set out to determine whether the intervention produced a change in the teachers approach to environmental education which is a process through which people are taught to respond to environmental issues in ways that bring about change towards sustainable community life in a healthy environment.

The biological content being investigated in this research is “plants” while that of the environment is a “school garden”.

2.D.2. THE ATTITUDE REQUIRED IN BIOLOGY AND ENVIRONMENTAL EDUCATION

Persons possessing a positive attitude towards biology will show a desire to handle plants and to be surrounded by them. A commitment to maintain and improve the quality of the environment and display feelings of concern for the environment are indicative of positive environmental attitudes. These can be achieved by participating in environmental maintenance and improvement. The intervention sought to deliberately create opportunities to acquire this attitude. The assessment of attaining these attitudes is determined by observing whether the participants are sensitive to the total environment and its problems.

Carin and Sund (1980) express the feeling that traditionally, primary school teachers who teach science have emphasized the cognitive parts of science. However they have failed to keep in mind that science is dynamic and engaged in by people who have emotions, biases and moralities. These people also develop values and attitudes. Although a lot is known about the affective domain, this knowledge has not always been incorporated into science programmes and this research attempts to determine whether by including the affective domain which deals with attitudes, interests, appreciations, values, and motivation into the programme, there will be a change in the teachers and students attitude towards plants.

Educators have known about the influence of the affective domain on learning from researchers such as Benjamin Bloom (1956) and Jean Piaget (1964) yet some science teachers have avoided or ignored it. Howard Birnie (1978) gives these reasons why:

- entering the world of personal values is seen as indoctrination or brainwashing

- many methods and materials have been ineffectual in reaching affective goals
- we do not have evaluation techniques and instruments to tell us whether or not we have been successful in achieving affective outcomes.
- we believe that behaviour is the only thing that really matters in education; that affect is an unfit subject for scientific study
- we have assumed that there is a direct relationship between knowing and behaviour (that, for example, the child can list endangered species and will, therefore, be concerned with their survival).

Harvey (1970) found that like scientists, teachers are human, and they bring to their classrooms all that they have experienced. Just as their students do, they enter their classrooms with their own belief systems and cultural values. This research will investigate the teachers' belief systems initially and then after receiving the intervention and determine whether the intervention was able to change their beliefs.

2.D.3. THE SKILLS OF BIOLOGY AND ENVIRONMENTAL EDUCATION

To be active in the learning process makes it possible to exert the necessary control over one's own learning. This immediately brings to mind meta-learning. Spring (1985) states that meta-cognition is an awareness of learners to know how they know and so regulate their learning process constantly. This research tried to determine if meta-cognition occurred through the intervention. According to Potts (1994), critical thinking skills figure prominently among the goals for education. In fact, one of the most important practical thinking skills one can acquire is knowing how to identify a problem. Critical thinking needs to become an integral part of teaching for the environment and this research determined if this has been achieved.

2.E. THE IMPLEMENTATION OF ENVIRONMENTAL EDUCATION IN A SCHOOL SETTING

Samuel (1993) carried out a case study of a secondary school in the process of developing and implementing an environmental education programme. The purpose of the study was to assess an attempt to put environmental education into practice, in the hope that this information will contribute to understanding how best to implement environmental education in schools. This was *also an objective of this present research*. Teachers in Samuel's case study discovered that focusing on awareness and responsibility for the immediate environment, including the school and its grounds, and acting as role models for the students were effective ways to promote environmental values. Samuel (1993) found that despite progress in implementing the project and recognition that it was still in its infancy, there was a general feeling of apathy among many teachers. The teachers' understanding of

environmental issues and their concepts of environmentalism were limited. This situation existed because teacher training and assistance were minimal, and very few materials had been collected to aid or inspire teachers. The literature reinforces this assessment, specifying that teacher training and assistance are essential for an innovation to be put into practice (Hungerford & Volk, 1984). Although it may seem obvious that if teachers are to develop and implement an innovation they must know something about it, it was not obvious to those involved in Samuel's project, perhaps because environmental education was seen as something that everyone should be aware of. Most teachers were aware of the well-publicized issues, although they may not have known about them in much depth. In the majority of cases, most of their knowledge originated from the media. Many teachers did not realize how little they knew and did not request training.

An outcome of Samuel's study was that its implementation required an awareness of how to manage change. Providing a forum for teacher participation and for communication among students, teachers, heads of departments, administrators, and others involved in the project could have established unity of direction.

Fullan's (1991) work provides a useful general framework for both understanding and affecting change. He stresses that '*change is a process, not an event*'. His simplified model for the change process is illustrated in FIGURE 2.3. The change process results from the interaction of each phase in the change process.

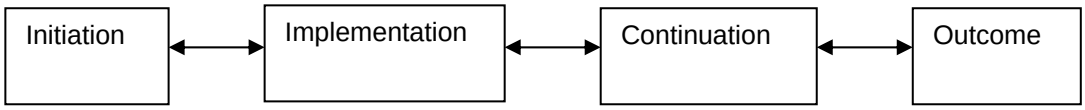

FIGURE 2.3. CHANGE PROCESS MODEL (FULLAN, 1991)

Fullan (2000) claims that before environmental education is integrated into a curriculum, it must be related conceptually to a given subject matter so that it is presented in a way that makes sense pedagogically. This research was of an evolving design and utilised Fullan's change process model. Each step was thought out, implemented, altered if necessary, then redone, reassessed and an outcome achieved.

2.F. BARRIERS TO THE IMPLEMENTATION OF ENVIRONMENTAL EDUCATION

Good science teaching emphasizes process skills or higher order thinking skills. These process skills are implicit in the "scientific method". Experimental biology is the ideal place to teach the scientific method. A question that was asked at the beginning of this research was whether environmental awareness could be raised with garden projects. Neathery et al. (1997) showed that over time, with repeated observations, students became conscious that

the environment was something to respect and think of all the time. It may take multiple years to develop "awareness" fully, but each garden along the way can contribute to the overall result. *This research attempted to duplicate these results.*

According to Fien (1995) if environmental education is to be one of the agencies of transformation to an ecologically sustainable society then the role of teachers as agents of change is vital. The attitudes and skills of teachers, therefore, become central in determining the mix of different knowledge, skill and affective objectives in environmental education programmes and the social and political interests that they serve.

Some of the barriers to the implementation of issue analysis as a teaching strategy include:

2.F.1. AFFECTIVE AND PSYCHOLOGICAL FACTORS OF TEACHERS

Many researchers have found that teachers shy away from social critique and action strategies as they feel unqualified and under prepared in these areas (Ham and Sewing, 1988; Singletary, 1992; Lane et al., 1994; Janse van Rensburg, 1995). This research set out to see whether this was true. On the local scene Janse van Rensburg (1995), a supporter of participatory curriculum development, says that teachers should participate in changing the system. The response from teachers is that they do not know how to participate. The pre-1994 highly autocratic South African education system has denied them the knowledge, confidence and opportunity to make this contribution. It is interesting to note that Canadian research (Hart & Robottom, 1990) experienced a similar dilemma when attempting to involve teachers in decision-making and change. Many Canadian teachers, it appears, feel equally disempowered to bring about change even within the educational structures of which they are a part. *This research investigated whether the participants could contribute to changing the curriculum.*

2.F.2. TEACHER PREPAREDNESS WITH REGARD TO SKILLS

Some research has indicated that a lack of in-service training and skills to deal with the problem solving and action orientation of issue analysis is an important barrier to implementation (Lane et al., 1994). The more progressive pedagogical theory underlying goals of value transformation and social change in environmental education are in contrast to the practical classroom theories of many teachers, which stress academic knowledge, didactic teaching and classroom order (Robottom, 1990). *The skills that the teachers had with regards to the issue of developing a school garden were investigated in this research.*

2.F.3. TEACHER PREPAREDNESS WITH REGARD TO KNOWLEDGE

Samuel (1993) has emphasized that the implementation of a sound environmental education programme requires that teachers understand the philosophical and pedagogical nature of environmental education in order to be able to relate it to their subject areas. *The knowledge of the environment that the participating teachers had initially and then after an intervention was measured in this study.*

A 1975 and 1985 survey of 500 randomly selected Indiana teachers also revealed that teacher environmental/energy literacy was far from optimal. Although teachers had become more familiar with the environmental terms over the ten-year period, little had changed regarding their conceptual understanding (Buethe and Smallwood, 1987). *The present research was conducted over only a nine-month period and it was of interest to see whether the participants underwent conceptual change.*

An area of knowledge that appears to be conspicuously under-utilized by environmental educators is that of student misconceptions. Munson (1994) represents a summary of research literature on students' ecological misconceptions. Together with other authors, (e.g. Brody, 1990) he concludes that since misconceptions prevent understanding and thus informed decision making, this area of study is critically important to environmental education and researchers. *This research investigated the participants' understanding of many environmental concepts.*

2.F.4. CULTURAL FACTORS WITH RESPECT TO TEACHERS

Vulliamy et al. (1990) attribute observed discrepancies between curriculum in action and curriculum as planned, to second language learning problems and cultural context in Botswana. The most striking aspect observed was "the passive nature of the students" - most work involved "chalk and talk" using either lecture technique or simple question and answer routine that demanded only basic recall. *This aspect was also looked at in this research.*

2.F.5. HEGEMONIC FACTORS WITH RESPECT TO TEACHERS

Robottom (1987) highlights the contradiction of a curriculum promoting critical praxis within an educational setting advocating social control. The institutionalized practices of many schools run counter to the interdisciplinary, issue-based, values and action-orientated characteristics of environmental education. This contradiction is based on many attempts to transpose programmes and pedagogy.

According to Papadimitriou (1995: p. 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 the environment and life. *One of the aims of this research was to see whether the environmental experiential garden could be used successfully as a professional development tool for teachers and also whether this artificial "laboratory" environment could be used to assess change.*

2.G. TEACHER DEVELOPMENT

Teachers are a vital part of the transformation of our education system and thus true transformation can only occur in the classroom. At the confluence between curriculum development and evaluation is the professional growth of teachers. The mid-career professional development of environmental educators is particularly important because of the historical inattention given to environmental education in pre-service programmes and the failure of many in-service education programmes to date to adopt a critical agenda (Robottom, 1987; Hungerford, Peyton and Wilke, 1980).

The Department of Education, in its 1998 Norms and Standards for Educators document, describes 7 roles for teachers which are key to their professional performance and development. This document states that a teacher will be required to act as a:

- learning mediator
- interpreter and designer of learning programmes and materials
- leader, administrator and manager
- community, citizenship and pastoral role model
- scholar, researcher and lifelong learner
- learning area and phase specialist
- assessor

It further states that these roles require that teachers develop practical, foundational and reflexive competencies. This research looked at some of these teaching standards in order to assess teacher development. The professional development assessment of this group of teachers from Siyabuswa was also based on the American Professional Development Standards. The Professional Development Standard for Learning Science Content requires that teachers of science learn science content through the perspectives and methods of

enquiry (AAAS, 1989). The members of the group in this research were to be exposed to guided activities that would help them to make sense of the subject matter being learnt i.e. plants and the development of a school garden. The intervention would include ongoing opportunities to reflect on these topics and the outcomes of the learning. As the teaching and learning progressed, the booklet “Gardening with Flora” would be compiled to act as a resource to be used in the classroom. The intervention would also provide the opportunity for teachers to experience the value and benefits of co-operative work.

Effective science teaching is more than knowing science content and some teaching strategies. Skilled teachers have special knowledge and talents that integrate their understanding of science content, curriculum, learning, teaching and students. Such knowledge allows teachers to create learning situations that tailor the needs of individuals and groups to the science to be learned. This special knowledge, called "pedagogical content knowledge" distinguishes the science knowledge of teachers from that of scientists McCormack & Yager (1989). It is what defines a professional teacher of science.

A lack of skills development in South Africa has been borne out by the country’s unfavourable ranking (last out of 41 countries in every category of the mathematics and science tests) of the Third International Mathematics and Science Study (TIMSS) (1998). As mentioned earlier in other programmes studied, if students are to show that they have mastered certain skills, the method of teaching has to change from “chalk and talk” to outcomes-based. Thus “Gardening with Flora” project was intended to be very “hands on” and the participating teachers were exposed to actually being responsible for planting up part of a garden at each of their schools.

2.H. THE BACKGROUND TO AND NATURE OF EDUCATIONAL REFORM IN SOUTH AFRICA

As early as January 1994, the African National Congress (ANC) listed curriculum change as one of its major initiatives in its education policy framework (The Department of Education, [1997b]). It expressed the view that the acquisition of skills was imperative if South Africa was to produce a nation which could cope with change. This curriculum reform policy was referred to as outcomes-based education (OBE). Outcomes-based education transfers the curricular emphasis from prescribed content knowledge to a learner centred, teacher-facilitated, activity-based style of education. Teaching in this way requires confidence on the part of the teacher, as well as good subject knowledge.

2.H.1. OUTCOMES-BASED EDUCATION (OBE)

As mentioned in Chapter 1 (page 15) Spady (1994) has had a major influence on curriculum thinking in South Africa since 1994, specifically with regards to outcomes-based education. The general aim of assessing learners in outcomes-based education is for growth, development and support. The purpose of assessment is to monitor a learner's progress through an area of learning so that decisions can be made about the best way to facilitate further learning in terms of expected knowledge, skills, attitudes and values. It is important to note that the outcomes include more than tangible products. They include attitudinal, affective, motivational, and relational elements that also contribute to overall performances (Spady and Marshall, 1991).

2.H.2. CURRICULUM 2005

Curriculum 2005 is a planned process and strategy of curriculum change underpinned by elements of redress, access, equity and development which will help transform the education system. Critical thinking will be encouraged at all times, in terms of reasoning, consideration, reflection and action. In Curriculum 2005 the content or knowledge covered should encourage teachers and students to explore knowledge that is relevant, localized, contextualized and which is integrated with skills and attitude development. Through applying these skills in context, Lotz et al. (1998), believe that understanding about the local environment and the world around us will be developed.

The new policy for education and training in South Africa moves from the traditional aims-and-objectives approach to transformational outcomes-based education. Transformational outcomes-based education is a response to the need for rapid social change. It focuses on the kind of qualities citizens need to have. The "critical" outcomes and “specific” outcomes derived from these qualities have determined Curriculum 2005. Learners will be able to:

1. Identify and solve problems and make decisions using critical and creative thinking
2. Work effectively with others as members of a team, group, organization and community
3. Organize and manage themselves and their activities responsibly and effectively
4. Collect, analyse, organize, and critically evaluate information.
5. Communicate effectively using visual, symbolic and/or language skills in various modes
6. Use science and technology effectively and critically by showing responsibility towards the environment and the health of others.
7. Demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation.

In order to contribute to the full personal development of each learner and social economic development at large, it must be the intention underlying any programme of learning to make an individual aware of the importance of:

- Reflecting on and exploring a variety of strategies to learn more effectively
- Participating as responsible citizens in the life of local, national and global communities
- Being culturally and aesthetically sensitive across a range of social contexts
- Exploring education and career opportunities and
- Developing entrepreneurial opportunities.

According to Fullan's educational reform categories (1991) Curriculum 2005 was of the large-scale reform type and many previous large-scale reforms gave curriculum innovation a bad name, as did this one. Fullan (1991) concluded that a curriculum could not/should not be imposed from the outside. Local ownership and development seemed to be preferable. He also suggested that there were three components of curriculum implementation at the classroom level – changes in materials, changes in teaching practice and changes in beliefs or understandings. His research investigated whether these changes were possible with the implementation of a specific intervention. In 2000 Fullan capitulated on this statement and stated that to achieve large-scale reform you could not depend on people's capacity to bring about substantial change in the short run, so you needed to propel the process with high quality teaching and training materials.

As an evaluation of the implementation of C2005 in Grade 1 the Eastern Cape Education Department (1999) suggested that the paradigm shift required of C2005 could not be accomplished in a few weeks of training, as curriculum change was an ongoing process that took many years to achieve. The results of this research would confirm or refute this. The decentralisation of the curriculum process placed a greater responsibility, as well as greater freedom, in the hands of teachers and local education authorities. For teachers, C2005 has introduced major changes in roles and responsibilities. These major changes are being asked of a teaching force where the majority of teachers are under-qualified and/or unqualified and who have mostly passed through a teacher education system that has been largely didactic, authoritarian, and hardly relevant to improving teaching practice. With reference to subject mastery, Taylor and Vinjevold (1999: p. 139) concluded:
"… one of the most consistent findings of a number of projects points to the teachers' low level of conceptual knowledge, their poor grasp of their subjects and the range of errors made in the content and concepts in lessons". There have been problems with learning support materials for C2005. The present research would determine to what extent this is true with respect to the participating teachers.

2.I. BRINGING ABOUT EDUCATIONAL CHANGE

C2005 was designed to set in motion a transformation which requires many teachers to make conceptual and practical changes. Fusco (2001) stated that science could be used as one of the means to produce change and that situating science in daily community life offered an optimal site for expanding the boundaries of science. He concluded that levels of potential change in the interface between youth, community and science could be achieved at the personal level, the environmental level (physical and social) and in the culture of science and science education level. This research questioned participating teachers' students and these students' parents to determine whether the intervention that they underwent brought about change in their attitude.

2.J. THE DEVELOPMENT AND USE OF RESOURCE MATERIAL

A key issue in classrooms is the availability of good teaching materials. This underpins the teachers' capacity to create their own materials. The quality of the science curriculum materials used impacts professional development and classroom implementation. There was an overall low use of learning materials. In the majority of contexts, teachers did not have the time, resources and often skills to develop their own materials. All three areas - quality, use and availability - accordingly require attention.

In order to ensure successful classroom implementation of innovative materials, support structures should be implemented (Valencia and Killion, 1990; Shroyer 1990). Lumpe et al. (1998) looked at the introduction of science kits into some elementary schools in their "Local Systemic Change" project. Lumpe was also introducing a new resource material that would require the necessary support for use in teaching at a later stage. The kit-based approach to teaching science was new to many of the teachers yet these sessions appeared to help prepare them for using the kits. After attending the sessions, 86% of the teachers indicated that they were comfortable with the kits, a remarkable improvement from 10% before the sessions. *Very relevant to the current study is the evidence this provided for an early assumption that the current development project would have to actually enable the teachers to participate in the activities of the booklet if they were to be comfortable teaching the content of it*.

Prior to participating in professional development activities, the teachers indicated that they did not feel prepared to teach science. This is fairly typical of elementary teachers throughout the United States. In order to address this content inadequacy, the professional development sessions for classroom teachers were designed so teachers learned science content as they participated in the activities of the curriculum materials they were to use in the following academic year. *South Africa is no better than the United States as far as content adequacy is*

concerned and the participating teachers were required to learn botany content as they developed the booklet or even used it in later years. The booklet was to produce a vehicle for teaching the relevant botany concepts. The participants that were developing the booklet, needed to understand the content and be familiar with the skills it covered. Its development also emphasised the need for active participation.

2.K. CURRICULUM INNOVATION UNDERPINNING THE RESEARCH

2.K.1. LEARNING METHODOLOGIES FOR BIOLOGY AND ENVIRONMENTAL EDUCATION

Several methodologies for supporting adult learning were investigated. These include the "learning cycle", particularly that of Bybee, (1993) and "constructivism" by Novak (1977) and Saunders (1992). The "learning cycle" is a methodology that suits the development of lessons and this is used as one of the methodologies in the "Gardening with Flora" project. "Constructivism" means that as students experience something new they internalise it through their past experiences or knowledge constructs they have previously established. These past experiences are also referred to as their worldview. This definition assumes that they actually "experience" something. It implies the opposite of rote learning which is passive. Both biology and environmental education presume that the students need to be actively involved.

2.K.2. TEACHING METHODOLOGIES FOR BIOLOGY AND ENVIRONMENTAL EDUCATION

Carin and Sund (1980) advocated discovery science teaching/learning because it incorporated the best of what was known about the processes and products of science, how students learn best, the goals and objectives of science and the relationships among science, humanism, values and the concerns about the environment. Discovery is the process by which the learner uses the mind in a logical and mathematical way to discover and internalize concepts and principles. The learner becomes mentally involved in logical and mathematical types of experiences in discovering. Learning how to learn is called "heuristics". John Dewey (1910) fostered the idea of "learning by doing" and then reflecting upon what was done. The research of Jean Piaget (1964) and Jerome Bruner (1966) stimulated renewed interest in discovery learning in the latter part of this century.

Some of the advantages of discovery teaching/learning are that the student learns how to learn. Learning becomes self-rewarding and learners become active participants. It is more transferable and builds positive self-concepts. Learning by discovery avoids rote memory, and learning helps individuals become more responsible for their own learning and, as a result, helps them become autonomous persons. In discovery teaching, the teacher functions as a

resource person and gives only enough aid to keep the students moving toward the solution of their problems.

The present researcher has presented many workshops to teachers over the past few years and found that presenting ad hoc. once-off sessions has been of very little value. The review of the literature revealed the “spiral model” which is a process and cluster-based model that provides teachers with the opportunity to develop professionally over extended time periods as opposed to "once-off" courses or workshops. Within the spiral model, professional development is viewed as a process that enables teachers to respond to and gain a better understanding of their professional practice over time. The spiral represents the journey made by an individual teacher over time. The time between group meetings offers an important space for practical experiments and actual development of the topics being covered. The regular group meetings provide structured opportunities for reflection, professional dialogue, peer support and mediation of the learning process. The spiral model could be modified and act as the basis for this programme’s methodology.

In an article “Classroom Questions”, written by Brualdi (1998), she noted that it has been estimated that approximately eighty percent of a teacher's school day is spent posing questions to students. In the author’s experience teachers appear to spend most of their time asking low-level cognitive questions that concentrate on factual information that can be memorized. Good questions recognize the wide possibilities of thought and are built around varying forms of thinking. They should be directed toward learning and evaluative thinking rather than determining what has been learned in a narrow sense. In fact it would be useful if the actual questions that the teachers want to ask in a lesson should be included in the lesson plan, so that they are thought out carefully and designed to determine the desired answer. *This research investigated how competent the participants were in asking questions.*

2.L. PROGRAMME DEVELOPMENT

The research was in essence to see whether the development of a programme with regard to plants and the environment would enable the participating teachers to improve professionally. It has been stressed that both biology and environmental education should encompass what is relevant to the student’s real world and this could be achieved by investigating science related to technology and the society as well as education for sustainability.

2.L.1. SCIENCE-TECHNOLOGY-SOCIETY

According to Bybee et al. (1980) science education should produce informed citizens prepared to deal responsibly with science related societal issues. It appears however that students are not being trained to deal with science-technology-society issues and Harms &

Yager (1981) suggest that existing science courses are not giving the students the knowledge and experience they need to become active citizens. Various authors have emphasized the importance of real life situations and real environmental issues facing local communities and the development of cognitive and other skills required, to identify problems and find creative solutions (Ramsey 1993). Based on the erroneous assumption that skills evolve naturally from knowledge, an issue analysis strategy without a real life action component will also fail in the objectives of environmental education (Hines et al., 1986/1987). Ramsey (1993) and Klinger (1980) present strong evidence of this position.

According to Doidge (1995) science-technology-society calls for a major paradigm shift in the thinking of biology teachers, because it brings new goals, approaches, methodologies and skills to the teaching and learning situation and she proposes an issue-based approach. This approach uses an "enquiry" approach. The students however now learn how to enquire into personal, environmental and social problems rather than focusing on enquiry into pure science (Bybee & Landes, 1990). Issue-analysis or issue investigation is widely used in environmental education as a teaching strategy. Many teachers are apprehensive about introducing new approaches to their teaching. Evaluation studies repeatedly illustrate how difficult it is to change established traditions of teaching and learning (Ogunniyi, 1996). Most teachers are not familiar with the "issue approach" to teaching even though it is considered to be a particular characteristic of environmental educational programmes (Ramsey et al., 1992). The reason could be that environmental education has, as such, not been taught in South African schools and at the present moment it is not a separate subject but is seen as the underlying philosophy for all education. Achieving the environmental educational objectives of transformation/reconstruction and empowerment have been shown to be possible using an issue analysis approach in local initiatives amongst previously disenfranchised rural communities (Irwin, 1993; O'Donoghue & McNaught, 1991). Issue analysis has also provided a model for constructivist teaching in environmental education. The issue analysis technique provides a mechanism that allows students to organize information into a sound conceptual framework, thereby allowing them to understand the anatomy of an issue (Ramsey et al. 1992).

2.L.2. EDUCATION-FOR-SUSTAINABILITY

According to Tema (1999: p. 221) "sustainable development addresses the needs of the present generation while simultaneously securing survival and a good healthy environment for the future generations. Education-for-sustainability deals with environmental issues and its primary goal is to involve students in the issues surrounding the environment and development problems. *This present research has the same goal.* Tema (1999) identified relevance, holism and value education as the elements of education-for-sustainability.

Education-for-sustainability's primary goal is to involve students in the issues surrounding environment and development problems. These issues have been identified as depletion of natural resources, climatic change, land use management, deforestation, desertification, waste disposal, water, air, land and noise pollution, mass extinction of species, population growth, poverty and famine (UNESCO, 1992). Education-for-sustainability is not merely about discussing solutions in order to enhance awareness. It is about the active exploration of issues, about identifying potential solutions and acting upon them. Education-for-sustainability has been defined by Agenda 21 as a "basis for action". Students must be effectively equipped with a variety of action skills to participate in the resolution of these problems. *This research investigates whether the intervention equips the participants with the skills to do just this.*

2.L.3. SOME EXISTING ENVIRONMENTAL PROGRAMMES

2.L.3.a. THE "LEARNING FOR SUSTAINABILITY" PROJECT

An actual example of a programme utilizing the "spiral model" for professional development is the "The Learning for Sustainability Project" (Sguazzin and Mhoney, 1999). The project is aimed at supporting the implementation of environmental education in the formal education system in South Africa by piloting ways in which holistic and integrated environmental education with a cross-curricular approach can best support the implementation of outcomes-based education. According to Sguazzin and Mhoney (1999) professional and resource material development support the project's major activities. The resource materials are designed, developed, supported and used to build capacity and broaden the spectrum of learning aids. Professional development encourages action and reflection. *This project contributed many aspects to the current programme.*

2.L.3.b. THE "DESIGNING SUCCESSFUL LEARNING" PROGRAMME

The mission statement for the Gwinnett County Public Schools in Georgia (Mitchell et al., 1993) is to "guarantee individual student success in creating and exercising life choices". This led to the creation of a staff development programme called "Designing Successful Learning" (DSL) which focuses teachers' attention on the use of cooperative learning, outcomes-based design, interdisciplinary instruction, performance assessment, student diversity and instructional technology as interdependent means of guaranteeing student success. The common thread throughout DSL was the list of student outcomes which explains what students should know, do and be like when they leave the Gwinnett Schools. The major goal of the Gwinnett restructuring effort was that all teachers would design instruction based on significant outcomes and that participants monitored the major outcomes of the workshops on a daily basis through self-evaluation. *This aspect of self-evaluation was incorporated into the current professional development programme.*

2.L.3.c. THE "ACTION ECOLOGY" PROJECT

Another project that demonstrates a method that teachers can use to develop curriculum material is the "Action Ecology" project. The conventional "research, development, dissemination and adoption" model (RDDA) was applied by the project. Despite highly commended workshops, it was found that the curriculum packages were not widely used. O'Donoghue and McNaught (1991) consequently undertook an action-research evaluation process to get to the root of the problems that were inhibiting the project. The investigation highlighted that competing concepts of environmental education emerged in differing social contexts and in response to specific problems, both curricular and environmental. This realization led the project developers to conclude that environmental education could not function, either as an alternative concept of education or as a discrete fieldwork methodology. It could, however, be seen as a necessary approach to education and thus as a focus for curriculum innovation. Environmental education was consequently treated as a "sensitizing construct" for curriculum reconstruction in a society under threat from environmental degradation. The problems presented earlier successively disappeared with the application of a participant-centred approach to curriculum development. *The "Gardening with Flora" research project used certain aspects of this method.*

2.L.3.d. THE "THRESHOLD PROJECT"

In 1987 Mac Donald and van Rooyen instituted "The Threshold Project" for learning primary science (see FIGURE 2.4). This project adopted a transitional model with a teacher-centred discovery- or enquiry-method. The teacher still has visible control and closely manages the class, but at the same time the students are given the opportunity to develop their process skills. In the Threshold Project Interim Report (Mac Donald, 1990) there was some discussion about the nature of the primary student's school-based experiences. It was also deemed necessary that efforts be focused on the need of the students to develop their communicative as well as their process skills. This style involves an orientation to science as a problem-solving activity and the teacher challenges the students with a comprehensive array of questions. This is a teacher-centred enquiry approach which has been attested in the United Kingdom, Canada and Australia and it appears more suitable for South Africa's classroom situation than a fully-fledged student-centred one would.

View of learning	learning through developing process skills for inter-acting with the environment ⟷	to help children construct new knowledge and develop effective learning methods	Aim of primary science science
Learning experiences	pupils working on tasks which are meaningful and purposive, which develop the process skills of the child, whether in practical or written work the productive language skills of the pupils being developed by tasks such as those above, to enable the child to develop the necessary vocabulary, discourse and interactional skills		
Classroom roles and procedures	*Pupil's role* to become involved in developing their process and language skills to provide teacher with information about understanding	*Teacher's Role* to find out about pupils ways of viewing the world to help pupils reflect on their own ideas to promote process and communicative skills development to guide the children through a set of experiences that may initially be primarily structured by materials, and restructured in time by the teacher	*Role of resources* to provide structured learning experiences to stimulate process and communicative learning
Evaluation criteria	*Children's learning* the extent to which structured experiences have promoted the use of process and communicative skills in dealing with content	*Teacher mediating* the extent to which the teacher understands where her children are "at", including helping pupils reflect on their own ideas the extent to which the teacher gains a growing understanding of the nature of process skills so that she can ultimately initiate them spontaneously	*Learning opportunities* the extent to which the teacher manual and the pupil workbook enhance the learning of process and communicative skills

FIGURE 2.4. THE TRANSITIONAL MODEL FOR LEARNING PRIMARY SCIENCE (MAC DONALD AND VAN ROOYEN, 1987)

2.M. RESEARCH PARADIGMS IN ENVIRONMENTAL EDUCATION

According to Janse van Rensberg (1995) national and international research in the social sciences (specifically environmental education) highlights four traditions, each with its own epistemological and ideological underpinnings. She categorizes these four as "positivist, interpretavist, critical and reflexive philosophies".

- **Positivist research** - research in this paradigm tends to concentrate on "manifesting observable behaviours that are readily quantifiable and that allow for statistical analysis and well defined conclusions that are generalisable" e.g. the use of measurable indicators such as knowledge, skills, attitudes and beliefs as predictors of responsible environmental behaviour. Positivist research results in generalisable knowledge *about* the environment.

- **Interpretavist research** - this paradigm focuses on individuals in society, their actions and the implications of those actions. It tries to make people understand their behaviour in the environment. It helps them evaluate the beliefs, attitudes and values that lead to a non-sustainable lifestyle. This research is *for* environmental awareness and interpretation.

- **Critical research** - this paradigm tries to explain the world in terms of the underlying structures, mechanisms and events that activate it. It endeavours to show how environmental education has been used or can be used to empower people to become agents of social change and sustainable development. Critical praxis can be described as an action orientated critical, problem-solving approach. As such it is said to lend itself to a natural association with participatory research and a constructivist epistemology.

- **Reflexive research** - this research investigates the understandings emerging from the dialogue with one's world of experience and with significant others with learners being led into a direct experience of the learning context and in that context become able to examine and restructure their own understandings.

Janse van Rensburg (1995) regards much of the current environmental educational research as research that has remained top down, inadequately communicated and not grounded in action. In response to this failure of research to properly inform policy she advocates the emerging paradigm in environmental education be one of participatory and/or action based research. Carr & Kemmis (1986) suggest that (participatory) action research creates the condition under which the participants can take collective responsibility for the development

and reform of their education. Thus action research is a participatory and democratic form of education.

Lotz (1996) noted that participatory research is deceptively difficult to conduct and in light of the calls for educational and social transformation in South Africa, she emphasises the importance of true participant centred research most especially for the purpose of practitioner development**.** *From the above, and after completing the preliminary study, it was decided to use the "participatory action research" model for the main study. The rationale for the choice being that the teachers would continually participate in a project which had a specific setting (the school garden), and so they would become empowered with the necessary skills, attitudes and knowledge to teach plants in a hands-on way. The degree of success would then be gauged by measuring the change in the participants' skills, attitudes and knowledge to teach plants in a hands-on way.*

Education should not affect the ethical basis of people rather give them the critical thinking skills to make "correct" judgements – so changing their own ethics. However environmental education clearly is meant to change a value system. At the Tbilisi Conference (1977) it was recommended that environmental education be incorporated into the national education system of all countries. The principles of effective environmental education were accepted. *The "Gardening with Flora" project was developed using these principles.*

2.N. GARDENING AS A CHANGE VEHICLE

According to the "Teacher Enhancement Programme" at Wisconsin University (2003) research has shown that children who garden have better social interactions with peers and adults, and have fewer discipline problems at school. School gardens help students to assimilate core science concepts by having real world experiences with living things in nature. The school garden learning experience has little value to an educator unless it can be used to evaluate and assess student learning. The teacher must determine the strategies and tools to be used to document student learning before digging in. These will need to relate directly to the learning goals. *For each gardening activity the participating teachers in this research needed to write a report so that an assessment could be done on the value of the exercise.*

The National Gardening Association (2000) staff of "2000Kidsgardening.com" researched work on school gardens and revealed the following:

- underachievers grow literacy skills and self-esteem
- gardening improves environmental attitudes
- gardening improved nutrition
- growlab programme participants scored significantly higher than control classrooms in students' understanding of key life science concepts and science enquiry skills

- self-esteem, social skills, behaviour improved
- gardening meets special needs.

A literature survey was carried out to determine the effect of different gardening instructional models and to investigate if any of their methodology could be used to produce the "Gardening with Flora" model.

2.N.1. THE "REAL" PROJECT

Fusco (2001) developed a gardening model which he called "REAL" - Restoring Environments and Landscapes" *and aspects of it were used in the "Gardening with Flora" project.* The "REAL" project investigated ways in which an urban planning and community gardening project helped to create a learning environment in which science was relevant. Fusco (2001) expressed the opinion that it was not *what* students learn but *how* they learn it that was fundamental to a relevant and quality education. His methodology was grounded in action research and had the explicit agenda of pursuing research for social change. Fusco's action research followed a cyclical process of action and reflection. *This is the same in the current project and research.* The "REAL" project was not science as found in a textbook. It was science in creation and within the context of a broader community. *The results of the research in the "Gardening with Flora" programme indicated whether change had occurred, just as in the similar situation of the "R.E.A.L. project.* Situating science in daily community life offered an optimal site for expanding the boundaries of science (Stevenson 1995).

2.N.2. THE "GROWING" PROJECT

According to the "Garden-based learning scores" researched by the National Gardening Association staff of "2000 Kidsgardening.com" (The National Gardening Association, 2000), new Kentucky Educational Reform act teachers were mandated to ensure that learning experiences were relevant and helped students make connections to their own lives. One teacher decided to start a "growing project". Her first activity was to plant bulbs. The teacher realised that it was fine that she didn't know all of the answers, but rather acted as a facilitator and guide. This really helped the students recognize that they were all lifelong learners. The feedback she received from parents spoke volumes. Student test scores also confirmed the power of learning in a relevant context. *The present research also set out to determine whether the participants underwent a change towards lifelong learning and whether the students were eager to learn more about plants.*

2.N.3. THE “LASERS” PROJECT

The “LASERS” project (Language Acquisition in Science Education for Rural Schools) attempted to improve student language through the use of gardens. Sarah Coburn from Carmel reported that due to this initiative her students' science enquiry and language development were sharpened in the school's Life Lab garden. *In the present research, English was not the home language of the teachers or students, and as the actual teaching was done in English a lot of time was spent explaining the meaning of words. The current research investigated how the lack of English prowess affected classroom practice.*

2.N.4. THE “S.E.E.D.” PROGRAMME

S.E.E.D. is the acronym for “School Environmental Education Development” whose stated aim is, “Planting the seeds of environmental awareness” - B. Bezuidenhout (personal communication, September 10, 1999). Selected teachers received training in small-scale intensive organic food gardening techniques and these teachers became the “seed” trainers in their respective areas where this knowledge was disseminated not only to other partner schools but also to any school in the same area who wished to obtain the knowledge. In 1999 the programme was running in 55 schools in three provinces in South Africa.

Each school that formed part of the programme initiated and maintained an environmental project. Each project needed to be sustained and ongoing and a new additional project or expansion of an existing project had to be started in the following year. Projects have included food gardens, development of the sports fields, combating soil erosion and beautifying the school grounds. These projects have provided all the elements of outcomes-based education and solid support platforms for C2005. One of the main criteria of the project was the community impact. The new skills that the students learnt cascaded into the community and the trend was that the community members not only work in the schools but also improve their own home environments. *These aspects are investigated in the research reported here.*

2.N.5. THE “GARDENING” PROJECT

The Department of Environmental Affairs and Tourism coordinates this gardening project in conjunction with the Caretakers of the Environment International Organization (Department of Environmental Affairs and Tourism, 2000). The idea was to encourage youth in the secondary schools to participate in solving their local problems by adopting a local area or green space in the city or village. Here they were encouraged to promote the concept of gardening, thereby contributing to the aesthetic beauty of the area or improving the household food security. Such gardening projects could also serve both the environmental and educational

benefit. *The methodology of this project was used as a guide for the "Gardening with Flora" project.*

2.N.6. THE "HABITATS AND THEIR CONSERVATION" PROGRAMME

Neathery et al. (1997) undertook the reporting of this programme, which investigated professional development. Professional development is viewed as a process in which teachers regularly increase their academic knowledge and pedagogical understandings in the context of the changed environment of the school (NRC, 1996; Kyle, 1995). It encompasses formal and informal learning experiences in order to provide the connections between school science and real-life science (NRC, 1996). *Programmes focused on professional development should prepare teachers to use new instructional materials (NRC, 1996) and this is important for the "Gardening with Flora" project.*

In the "Habitats and their Conservation" programme the assessment tools used to evaluate the teacher-participants' acquisition of knowledge and performance, were self-reflection and questionnaires, as recommended by the NRC (1996). Incorporated with the sequence of content activities was an emphasis on the "learning cycle". The learning cycle afforded the teacher-participants with opportunities to become familiar with the content of environmental science and the teaching strategies for enquiry-based science. The "Habitats and their Conservation" programme provided teachers with opportunities to increase their depth of knowledge with environmental science topics. Most importantly, the hands-on, participatory design of the programme provided participants with opportunities to develop the confidence needed to apply the new concepts learned in their classroom settings. *The programme "Habitats and their Conservation" exemplified a professional development project that could be drawn on for the methodology of the present programme.*

As can be seen there are many different school gardening programmes and it appears that there are just as many different reasons for developing these gardens. Aspects regarding the garden that this research attempted to answer include:

- Whether environmental awareness could be raised with garden projects? This question formulates the attempt to ascertain whether the nine month intervention was long enough to effect change in the participants' attitude towards the environment.

- How can having a garden be justified? Will classes' test scores improve as a result of doing garden-based education projects? One justification can be found in the data that "practice by doing" lessons have a 75 percent content retention rate. The Web site, http://www.outdoorclassroom.org/ (1997) presents a "Retention Pyramid" rating the various content delivery methods with retention rates. Its data shows teaching

others or immediate use with 90 percent. With focused efforts, the garden can become a hands-on delivery model of instruction. Test scores should improve if students retain higher content knowledge levels and from the data cited, one would expect that they would if involved in the garden. And if the "teaching others/immediate use" statistics are correct, the teacher can expect to learn about school gardening much more fully than he or she could any other way. *The current research also looked into whether the intervention enabled the participating teachers to hand over their newly found knowledge to their peers.*

- Can a garden be used to teach academic content? The current research in learning points to the superiority of "hands-on" learning for fully engaging a student. A garden is a good example of this type of teaching setting and the results of the development of the garden would determine whether the skills that were to be learnt in the intervention promoted "hands-on" learning.

- What is needed to have a successful garden experience with this class? All garden projects should meet the curriculum goals. From the curriculum decide which units would benefit from the "hands-on" experience of gardening. This may lead to a specific garden theme or size, such as a butterfly garden or a container garden. Once the site is ready, prepare the class inside with lessons that are oriented to what will happen in the garden. Vocabulary and gardening procedures are very important parts of the project. Supervise the actual planting and after planting, ensure that the students water the garden.

This in a nutshell encapsulates the whole "Gardening with Flora project and how it could be of benefit if introduced into as many schools as possible.

2.O. OVERVIEW OF CHAPTER TWO

The concepts that were assessed have been defined, namely:

- The environment, environmental literacy and environmental education (sections A, B and C). A proper understanding of the interdisciplinary nature of environmental education is still not sufficiently evident in South Africa.
- The links between biological and environmental education (section D). One of the most important practical thinking skills one can acquire is knowing how to identify a problem and for this, critical thinking needs to become an integral part of teaching for the environment and this research determined if this has been achieved.
- The implementation of environmental education in a school setting and its barriers (sections E, F and G). A question that was asked at the beginning of this research was whether environmental awareness could be raised with garden projects. To

achieve this improved awareness the participants would have to alter their pedagogy. This change is a process and if the students are to show that they have mastered certain skills, the method of teaching has to change from “chalk and talk” to outcomes-based. Thus “Gardening with Flora” project was intended to be very “hands on” and the participating teachers were exposed to actually being responsible for planting up part of a garden at each of their schools

- Bringing about educational reform in South Africa (sections H and I). C2005 was designed to set in motion a transformation, which required many teachers to make conceptual and practical changes and this research investigated whether participants were up to making these changes.
- The development and use of resource material (section J). The development of the booklet was to produce a vehicle for teaching the relevant botany concepts. The participants needed to understand the content and be familiar with the skills it covered thus its development emphasised the need for active participation.
- The curriculum innovations underpinning the research (sections K, L, M and N). Different learning and teaching methodologies as well as some existing environmental programmes were perused to give insight into the aspects needed to produce an environmental educational package that would change value systems for the better. Gardening was seen as the vehicle which would provide this change.

In the next chapter the detailed research design is discussed. A guide is also given for the evaluation and assessment of environmental education programmes while the choice of research methodology is highlighted.