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AN EXPLORATION OF FACTORS FACILITATING AND HINDERING CHANGE IN THE TEACHING OF BOTANY IN PRIMARY SCHOOLS

THESIS
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ABSTRACT

An exploration of factors facilitating and hindering change in the teaching of botany in primary schools.

This is a report of an analysis of a project that aimed to pilot an environmental education curriculum development process and professional development model in a rural and historically educationally and economically disadvantaged area. The research looked at the topic “plants” as the biological content in the context of developing a school garden, which was an environmental system in this instance. The school garden was considered to be a local environmental issue that each and every teacher could relate to. The intention of this research was to determine which factors facilitated and hindered change in the teaching of botany in primary schools.

The format of the research involved a preliminary study (to determine the participant’s initial environmental and plant knowledge) and then the main study, which followed the pre-post test format with interventions in between. This research is an example of a case study and the methods used to conduct the ”fieldwork” were guided workshops, compiling a booklet and developing a school garden.

The main study’s starting point was that “active engagement promotes change”. Throughout this project active engagement was carried out to determine whether knowledge, skills and attitudes towards the environment could be changed by (i) the active participation of teachers in the production of a booklet on what and how to plant in a school garden and (ii) the actual development of a school garden.

The initial findings of the main study were compared to the final findings to determine whether the active interventions resulted in change, be it positive or negative. One of teacher education’s most challenging tasks is to prepare botany teachers to enable them to deliver active participation instruction. The results of the research showed that the participating teachers had not become more environmentally literate although they did improved their plant knowledge. They had given lessons in the garden and utilized some of the activities from the booklet in their teaching. They had shared these with their colleagues and when materials from the garden were used they did have a positive effect on the classroom interaction. Thus they all saw the value of planting up their school garden and the merits in using actual plant material from these gardens. The Heads of the participating schools expressed the opinion that the project had been a success and many of the participants’ colleagues said that they had also changed their teaching to outcomes-based teaching and that their learner’s attitude was now positive towards plants. Most of the student group said that they had told their

parents about the project and their parents said that they approved of them working in the garden thus learning life skills in a hands-on practical way.

The overall impression of the school gardens at the end of the programme was one of general improvement and even nine months after the project, the participants remembered the majority of planting skills that they had accomplished during the year and still found it important for students to learn these skills. Thus the research findings support the idea that active engagement promotes change.

DECLARATION

I declare that this dissertation is my own work. It is being submitted for the Degree of Doctor of Philosophy at the University of Pretoria. It has not been submitted for any degree or examination at any other university.

Dianne Edith Goodwin

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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.

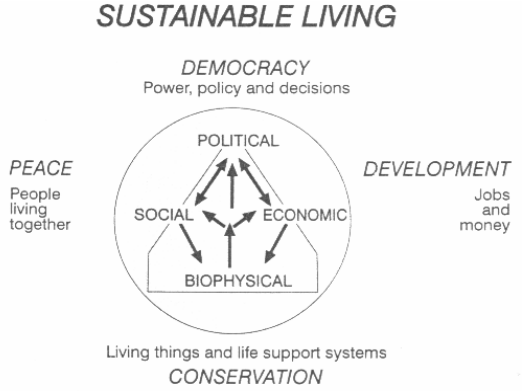

FIGURE 2.1. A DIAGRAMMATIC REPRESENTATION OF THE ENVIRONMENT (LOUBSER, 1996A: p. 6)

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.

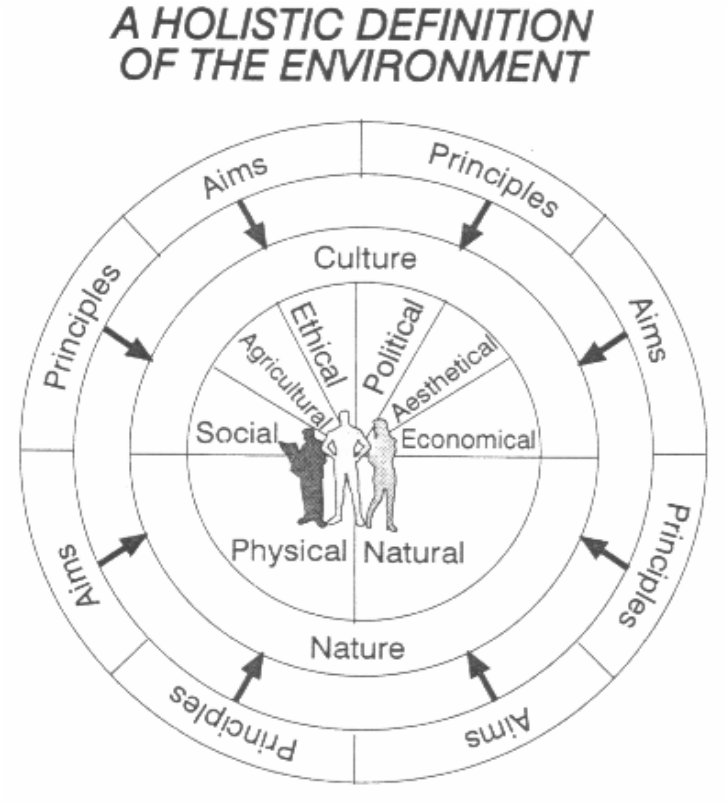

FIGURE 2.2. A HOLISTIC REPRESENTATION OF THE ENVIRONMENT (LOUBSER, 1996A:p 7)

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.

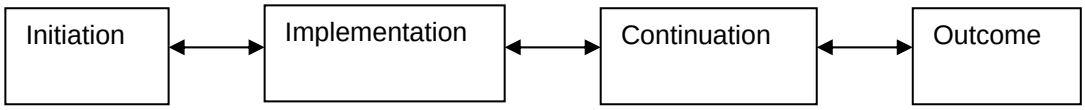

FIGURE 2.3. CHANGE PROCESS MODEL (FULLAN, 1991)

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.

CHAPTER 3

GENERAL RESEARCH METHODS

Research design is defined as a framework that directs the researcher in the process of assembling, analysing and interpreting information. It proves that the information collected has been carried out in a manner as to reduce the subjectivity of the conclusions and is thus a true reflection of the research done (Nachmias and Nachmias, 1981).

This chapter looks at research methodology in general i.e. qualitative and quantitative in the context of a case study (section A). It then goes on to look at different measuring instruments such as questionnaires, interviews and observations (videos and matrixes) which were used in this research (section B). The literature has shown that environmental educational has shifted towards a participant centred approach to materials development and an action research orientation to research and evaluation. Thus due to the participatory nature (of the researcher) and the dual purpose of the activities used to measure the professional development of the participating teachers (the intervention and the research), the day-to-day activities of the intervention itself are described (section C.1).

3.A. CHOICE OF RESEARCH METHODOLOGY

Information collected can either be analysed qualitatively or quantitatively. Qualitative research involves assessing the quality of things whereas quantitative research involves measuring quantities of things, more especially numerical quantities (Reaves, 1992). Merriam (1991) agreed with Reaves and indicated that qualitative researchers are predominantly concerned with process rather than outcomes or products. The emphasis in qualitative research is on processes and meaning. Another difference between qualitative and quantitative research is the notational system utilized to report the findings. Quantitative data are represented by figures, numbers and inferential statistics. Qualitative research tends to be presented like a story.

For this particular research project both methods of collecting the results were used. The qualitative approach was more suitable in describing the process of developing the school garden, formulating the booklet and observing the conducting of lessons using videos and the observation matrix. It was difficult to assign a numerical value to people's experiences and opinions. The quantitative approach was appropriate in this research where the participants were involved in pre- and post-test situations such as the completion of "Chacko's environmental literacy" questionnaire and "the knowledge of plants and the environment" questionnaire. There has been concern that it is difficult to measure development efforts,

particularly of the social dimension using the traditional tools (James *et al.*, 1983). The best method to overcome this is to use the interpretative approach (Marsden & Oakley 1999) which is a form of qualitative analysis.

Qualitative research defined by Mertens (1998) is "multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them." This definition is similar to that of a case study by Stenhouse (1998).

The objective of a case study is to investigate the characteristics of a particular system of the community (Huysamen, 1994). Case studies are described by Stenhouse (1998) as "…naturalistic, qualitative, descriptive, responsive, interpretative" and the "…collection of data on site is termed fieldwork." The current research is an example of a case study and the methods used to conduct the "fieldwork" were guided workshops, developing a booklet and a school garden. This fieldwork was done at the Siyabuswa Educational Development Trust Centre (SEIDET) and the relevant schools. This methodology was adopted in order to understand what was happening out in the field.

3.B. RESEARCH METHODS TO ADDRESS ENVIRONMENTAL LITERACY AND BOTANICAL SKILLS, ATTITUDES AND KNOWLEDGE

Certain measuring instruments such as questionnaires, interviews and observations (using videos and matrixes) were used in this research.

3.B.1. QUESTIONNAIRES

In many studies in environmental education, for example, Bogner & Wiseman (1997), Ryan (1991), and Thompson & Gasteiger (1985), questionnaires were used to investigate environmental awareness, knowledge, attitude, concern, behaviour, etc of the respondents. A questionnaire is one of the most commonly used methods of obtaining information that cannot be obtained personally from a wide range of sources. According to Sax (1979) by asking questions, responses can be obtained about the knowledge, values, preferences, interests, attitudes, opinions, judgement, behaviours, etc. of the respondents. A questionnaire may possibly be regarded as a reliable instrument for collecting data for this study.

It is often difficult to assess the sincerity of a verbal commitment by using a questionnaire. It has been shown by Hines et al. (1986-87) that what people indicate on a questionnaire is often inconsistent with their actual behaviour. Actual commitment infers behaviour in which

the individual is currently engaged. It must be noted that what people say their attitudes are and what their attitudes really are may not be the same. Responses to the questionnaire used may reflect an individual's perception of how he or she should respond rather than his actual personal commitment. The question arises whether it is possible to assess, for example, the attitude of respondents that they may not otherwise divulge. There may be variations in the extent to which people, even if they wish to be truthful, can give accurate responses to statements about themselves. With regard to environmental behaviour, many human beings hold two positions, the one they talk about and the one they act on. Therefore, higher scores in "verbal" than in "actual" commitment would reflect the general expectation. Verbal commitment may normally be somewhat preferable for individuals to the actual commitment levels of engagement. In terms of social desirability, probable behaviour in the future is more likely to be expressed in terms of what one "ought" to say than are descriptions of one's true behaviour. One would normally expect that we are verbally much more in favour of environmentally oriented behaviour than in our actual reported behaviour (Bogner & Wiseman, 1997). According to Leeming et al. (1993), it is not always easy to collect follow up data to determine whether the reported behaviour persisted over a period or not. In this study the verbal commitment of the respondents is seen as an intention to act.

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

3.B.1.a. VALIDITY OF A QUESTIONNAIRE

In general terms, validity refers to the extent to which a test measures what it is intended to measure as defined by Mulder (1996:215). Chacko (2000) developed and validated a questionnaire. It was validated for a rural population in Mpumalanga similar to the population of teachers which participated in the "Gardening with Flora" project. The validation performed by Chacko is described in Appendix C.1, Table C.1.1

3.B.1.b. RELIABILITY OF A QUESTIONNAIRE

According to Leedy (1990:28) "reliability" means "consistency" while Reaves (1992:8) says it means "repeatability or consistency". Perhaps the best way to look at reliability is the extent to which the measurements resulting from a test are the result of characteristics of those being measured. A questionnaire is considered to be reliable if the reliability coefficient is 0,8 or higher. The nearer to 1, the higher the reliability. Again Chacko's questionnaire which was

used in this instance had been tested for reliability. As shown in Appendix C.1, Table C.1.2 the reliability coefficient for the questionnaire as a whole was 0,945.

Questionnaires alone have shortcomings. However, Leeming et al. (1993) reported that many researchers used only Likert-type questionnaires to assess environmental knowledge, attitude, behaviour, etc. Another form of assessment such as the development of a school garden was also used to assess environmental literacy as awareness and solving of environmental issues are skills indicative of environmental literacy.

3.B.2. INTERVIEWS

Interviews are an ideal tool for gathering information for qualitative research (Krathwohl, 1998). Qualitative interviews usually "…refer to in-depth, semi-structured" types of interviews that "are characterized by a relatively informal style". The interview questions were centred on topics relating to the research (Mason, 1996:38).

In the current research the semi-structured interview method, where structured questions were interspersed with unstructured conversations and variations on the prepared questions, was used. These questions were used to initiate discussion on the topic and where necessary the researcher was be able to clarify information as the conversation unfolded.

While the advantages of the interview method are many, there are certain limitations. These include a high demand on time, energy and money and problems of quantification of qualitative data obtained. Another problem that might occur using interviews and not questionnaires is that although interviews allow for greater depth than is the case with other methods of data collection, they can be prone to subjectivity and bias on the part of the interviewer.

Interviews are verbal reports that are subject to common problems of bias, poor or inaccurate recall and poor or inaccurate articulation. All opportunities need to be taken to reduce bias and increase reliability.

3.B.3. ADDITIONAL METHODS

Observations and videos were also used in the present study in addition to questionnaires and interviews.

3.B.4. TRIANGULATION

In reviewing each of the questions raised in Chapter 1 different combination of all the above instruments were used. The main advantage of using multiple methods is that it allows for triangulation. Triangulation is essential in the analysis of information where the reliability is often a concern. It gives the opportunity to compare the sources and if they correspond, they cross validate each other and if they disagree, the reason therefore must be explored as it may explain certain things in the investigation (Robson, 1993: 383). Patton (1990:470) sees triangulation as "…a process by which the researcher can guard against the accusation that a study's findings are simply an artefact of a single method, a single source or a single investigator's bias."

3.C. METHODS MEASURING THE PROFESSIONAL DEVELOPMENT OF TEACHERS

In reviewing the literature on effective professional development, the following framework was found. This framework, proposed by Haney and Lumpe (1995), included three primary components: planning, training, and follow-up:

- In the Planning Phase, training should be planned to be concrete, teacher specific, and extended over a long period of time (Valencia and Killion, 1990). Also in the Planning Phase, teachers' beliefs should be identified and addressed (Haney et al. 1996). Positive teacher beliefs and attitudes toward science teaching provide a strong foundation for the reform process. However, these beliefs must be maintained and nurtured during classroom implementation through the use of support structures. By learning about the images of science that teachers bring to professional development activities, those experiences can be shaped to meet their needs.

- In the Training Phase, teachers need opportunities to engage in hands-on learning experiences, preliminary activities, observe successes of others, and reflect upon their progress (Valencia and Killion, 1990 and Etchberger and Shaw, 1992).

- Finally, the Follow-up Phase should include classroom assistance from teacher leaders, evaluative feedback, and revisions of the programme (Valencia and Killion, 1990 and Glickman et al. 1992).

This Haney-Lumpe framework was a model for the present research. Both aspects of the development and implementation of the project and the analysis of the results obtained in different tests carried out during the project were accommodated for in this framework. To achieve the stated objectives of this research using the Haney-Lumpe framework a time-line of activities was designed.

3.C.1. TIME-LINE FOR THE MAIN STUDY

This time-line outlines the methodology of the research and the actual activities that were carried out during the duration of the project, performed from 14th April 2000 until the 1st June 2001.

PLANNING PHASE

14/4

- Give participants time to complete environment literacy questionnaire **(APPENDIX C)** (1hour)
- Divide participants into groups according to the grades they teach
- Ask them to record in a diagram what they feel needs to be covered with respect to plants at the grade they are teaching (30 minutes)
- Flesh out Syllabus Grade Sheet (30 minutes). Alter their diagrams afterwards
- Discuss the structure of schooling phases and learning programmes
- Discuss the learning programmes for the different phases
- Discuss the Specific outcomes for all the eight learning areas
- Look at the sheets for the botanical aspects for each grade to identify actual plant material to be used and how? (45 minutes) - homework
- Ask them to plan how they would go about developing their school garden (not done) - homework
- Write letter for sponsorship - homework
- Get buy-in from headmaster, staff and pupils – homework
- Develop a lesson plan (learning programme) on plants for your particular grade – homework (none actually handed in at next session)

TRAINING PHASE

14/4 – 12/5 teachers need to actually carry out the planning of their school garden i.e.

- Get permission
- Appeal for funding
- Map out garden
- Take photos
- Look at the sheets for the botanical aspects for each grade to identify actual plant material to be used and how it will be used and what is needed for it to be used
- List requirements
- Work out costing
- Check water availability
- Tools
- Prepare lesson for specific grade using plants.

FOLLOW-UP PHASE

12/5

- Go over buy-in and try to sort out problems (30 minutes)
- Discuss and take in letter of sponsorship (15 minutes)
- Discuss and take in map of garden and photos (30 minutes)
- Discuss and take in the sheets that identify actual plant material used, the methodology used with the plants and what is needed to use these plants (45 minutes)
- Discuss each lesson plan presented – actual material used? (not actually handed in)
- Look again at learning phases (15 minutes)
- Again link learning phases to learning programmes (15 minutes)
- Link learning phases and learning programmes to grades
- Discuss the development of school-based learning programmes (45 minutes)
- Go over the critical outcomes again (15 minutes)
- Go over the specific outcomes again (30 minutes)
- Again discuss the level statements in each group (30 minutes)
- Develop a school-based learning programme using a specific topic e.g. “SEASONS” – the effects on plants for grade 2 (45 minutes)
- Discuss record keeping for assessment i.e. the specific outcomes that should be achieved in each activity (15 minutes)
- Choose a specific topic with a specific activity for your grade and develop a school-based learning programme according to C2005 (60 minutes)
- Give your interpretation of the specific outcomes

- Curriculum 2005 modified at this point and most of the stages used in developing a school-based learning programme have been abandoned except for the Critical Outcomes.

- Choose a specific topic with a specific activity for your grade and develop a school-based learning programme (60 minutes)
- Hand out sheet on “how to plan an activity” and discuss that the earlier conventional way of doing lesson plans was still very relevant today.

TRAINING PHASE

12/5 – 2/6 Researcher to visit each school. Participants start preparation of garden for what they are still going to teach this year and actually plant with the pupils

- Decide what is the most important plant for your grade to be planted in your school ground

- Revisit your school garden map and redraw it
- Develop another school-based learning programme using a specific topic for your grade (with the other members of your school staff). List the problems and the successes (NOT DONE).

PLANNING PHASE

2/6

- Take in plan of school garden and check labels for photos to use as examples of before intervention (30 minutes)
- "Design a Plant" **(APPENDIX I)** – need: glue, sheet of paper, monocotyledon and dicotyledon plants (60 minutes)
- Go over one of their learning programmes done for homework for the 2/6 (15 minutes) NOT DONE
- Hand out and go over critical outcomes sheet (15 minutes)

On the 1/6/2000 it was announced by the Minister of Education, Kader Asmal, that the implementation of Curriculum 2005 was to be revisited and that specifically the format of learning programmes was to be changed. This led the researcher to refrain from asking the teachers to produce further learning programmes in the existing format. She was not too surprised that the authorities had decided to review this particular aspect as she had had first hand knowledge of the difficulties that the teachers were experiencing with the formulation of these programmes. As an exercise she had asked the participants to explain in writing their understanding of the specific outcomes of the Natural Science Learning area and found that the teachers could not explain them, as they did not understand the English. None of the teachers have English as their home language and the specific outcomes were certainly not expressed in basic, plain English (see results on Specific Outcomes).

TRAINING PHASE

Give gardening skills questionnaire **(APPENDIX G)** – one section at a time

- Actually prepare a garden bed
- Record on the back of the sheet how it was actually done (30 minutes)

- Actually water the prepared bed
- Record on the back of the sheet how it was actually done (15 minutes)

- Actually sow seeds in seed trays and give them extra to plant for homework at school
- Record on the back of the sheet how it was actually done (30 minutes)

- Actually water the sown seeds

- Record on the back of the sheet how it was actually done (15 minutes)

- Actually sow seeds in situ and give them extra to plant for homework at school
- Record on the back of the sheet how it was actually done (30 minutes)

- Actually water the sown seeds in situ
- Record on the back of the sheet how it was actually done (15 minutes)

- Actually sow seedlings in soil and give them extra to plant for homework at school
- Record on the back of the sheet how it was actually done (30 minutes)

- Actually water the planted seedlings
- Record on the back of the sheet how it was actually done (15 minutes)

- Hand participants a Mulbry booklet to use as reference when developing their garden at school. The Mulbry project is an initiative started by the South African Nursery Association to encourage children to garden.

2/6 – 21/7 With your class:

- make tools (see Mulbry's newsletter)
- prepare an area at school in which you can grow things during the year
- plant your seeds into seed trays
- show your pupils how to water in a water-wise way
- plant you seeds directly into the ground
- plant your seedlings into the ground.

For each of the above activities write a report mentioning:

- date you did the activity
- who was involved
- the participants attitude to the activity
- how long it took
- problems that you had
- any other points of interest.

Start to prepare your garden listing every step you take and the time spent on each step (this activity was only handed in by Betty and Mandla from Buhlebuzile School)

Do a plan of your own garden at home
List the names of the plants that you have in your own garden

Ask your pupils whether they have a garden at home – make a list with names and yes/no

21/7

Give knowledge on plants and the environment test **(APPENDIX D)** (30 minutes)
Give attitude to plants and the environment test (20 minutes)
Give skills related to plants and the environment test (15 minutes)

FOLLOW-UP PHASE

Go over all the work which was to be done for homework.

TRAINING PHASE

Next give the gardening skills questionnaire – one section at a time

Actually plant a groundcover (VERBENA) and give an extra one to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the planted groundcover. Record on the back of the sheet how it was actually done (15 minutes)

Hand out notes on how to make new plants from old ones and show participants how to make a cutting of VERBENA

Actually plant a perennial (DIETES and AGAPANTHUS) and give an extra one to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the planted perennial. Record on the back of the sheet how it was actually done (15 minutes)

Write thank-you letter to Mayford (a South African based seed producer) for generous donation of “Meadow Mix” perennial seed mixture

Show them how to split a perennial

Give notes on bulbs
Actually plant a bulb and give an extra one to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the planted bulb. Record on the back of the sheet how it was actually done (15 minutes)

Write thank-you letter to Hadeco (a local bulb producer) for generous donation of bulbs

Actually plant a shrub (VIBURNUM and DAISY BUSH) and give an extra one to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the planted shrub. Record on the back of the sheet how it was actually done (15 minutes)

Show them how to make a cutting of a DAISY BUSH

Actually plant a tree and give extra to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the planted tree. Record on the back of the sheet how it was actually done (15 minutes)

Write thank-you letter to Gardena (a producer of irrigation equipment) for generous donation of hose pipe fittings

Actually plant lawn and give extra lawn to plant for homework at school. Record on the back of the sheet how it was actually done (30 minutes)

Actually water the lawn. Record on the back of the sheet how it was actually done (15 minutes)

Write thank-you letter to S.A. Gardening (a publisher of Horticultural magazines) for generous donation of their magazines
Write thank-you letter to “The Smallholder” (a community magazine) for generous donation of their magazines

21/7 – 18/8 Prepare and plant the given plants in their school garden and maintain them
With your class:

- continue preparing an area at school in which you can grow things during the year
- plant your groundcover, perennials, bulbs, shrubs and “Meadow mix” at school
- show your pupils how to water in a water-wise way
- if you need to plant lawn at school get the area ready and start to plant – check first that you have water.

For each of the above activities write a report mentioning:

- date you did the activity

- who was involved
- the participants attitude to the activity
- how long it took
- problems that you had
- any other points of interest

Write up two lesson plans on the topics given to you in class, to be included in the book (remember that you are going to need to show evidence of using plants in your teaching)

Do for homework what is required

18/8

Go over the reasons C2005 has been modified (distribute "The Star" newspaper article – stress that outcomes-based teaching is still the way to go)

Take in homework. Spend a lot of time here going over what the teachers presented –is it what they actually do or what they would like to do in the classroom?

Take individual photos and names for the booklet

Show article from "The Hardware Retailer" (an advertising brochure) where the Siyabuswa Hardware (a local hardware shop) has a write-up. This business could be a source of possible sponsorship or perhaps one of their staff could come to talk to the group to try to resolve their problems such as no fence, no tools etc. This business enterprise is committed to community upliftment.

Research the book by brainstorming the topic "plants". Produce a mind map of what should be included in the book. Start to hone in on what content should be included along with the relevant activities.

Hand out syllabus sheets for grade 1 – 7

- Initial plan of school premises – design your own school garden
- Investigate water including the building of a pond - write thank-you letter to Graemark (a distributor of plastic) for generous donation of plastic sheeting
- Investigate soil and mulches
- Investigate fertilizers – write thank-you letter to Bayer (a chemical company) for generous donation of fertilizers
- Tools needed to develop a garden. Take photos of improvised tools such as: watering equipment, digging equipment, raking equipment, tool carrier and plant protector
- Skills needed to develop a garden – prepare a bed

- Touch on herbs. What is a herb? – need to redo in more detail – bringing in traditional healing
- Investigate vegetative reproduction by actually making daisy bush (herbaceous) cuttings – still hand out sheet on “new plants from old”
- Illustrate how to prune a rose

18/8 – 8/9

Plant herb in school garden

Actually produce a pond and plant around it.

For homework:

- write a page on how you have gone about developing the booklet
- research an activity on each of the following topics: water, soil, seeds

8/9

Collate the different activities into the following topics:

- map and problems – Patricia, Marcus and Tsepho
- water – Mavis, Betty and Frank
- soil – Bobo, Clara, Florence and Sam
- fertilizers – Anna, Queen and Althathea
- pesticides
- tools - Thoko
- vegetative reproduction – Grace and Emily
- seeds - Moela and Alfred
- perennials (ground covers) - vegetative reproduction – Grace and Emily
- seeds, germination, fruits, dispersal - Moela and Alfred
- seedlings – roots, stems, leaves, flowers, pollination
- fungi
- algae
- moss
- ferns
- gymnosperms

Choose the best activities and set them out as if on a page of the book

Brainstorm what should be included at each grade by using flipcharts from Chart Studio (an advertising agency) produced by D. Goodwin. Use all resource material provided to give ideas for book

8/9 - 21/9

- prepare and plant more plants in the garden and maintain it
- continue teaching using plants
- prepare lesson to give in front of all the other teachers illustrating your ability to teach in an outcomes based fashion using plant material got from school garden

21/9

Video five actual candidates teaching in an outcomes-based fashion

Let teachers who are observing the lesson critique it according to Form 1 and Form 2 **(APPENDIX K)**

Give each teacher the sheet of definitions and go over them

Give each teacher the sheet on "how to plan an activity"

Give each teacher the sheet showing the inter-relationships between attitudes, awareness, manual and thinking skills, knowledge and understanding and the environmental implications

Give each teacher the sheet defining primary science process skills

21/9 - 15/11

- prepare and plant more plants in their school garden and maintain it
- continue teaching using plant material obtained from the school garden
- continue compiling book

15/11

Give participants time to complete environment literacy questionnaire **(APPENDIX C)** (1hour)

Give knowledge on plants and the environment test **(APPENDIX D)** (30 minutes)

Give skills related to plants and the environment test with an extra question - (6) - "What skills do you feel you need in order to develop a school garden?" (15 minutes)

The pre-test "attitude to plants and the environment" was not given as a post-test but rather each teacher was asked to evaluate the course and hand in on the 18/11/2000

Hand out sheet on "Pesky pests"

Hand out "Alien Buster" package and discuss weeds

Hand out to all teachers a questionnaire for their:

- heads **(APPENDIX L)**
- peer teachers **(APPENDIX M)**
- students **(APPENDIX N)**
- own evaluation of their school garden
- own evaluation of usage of the booklet "Gardening with Flora"
- visit all school gardens for post photos

18/11 – 19/11

End of year get-together at Segwati Ranch

Graduation ceremony held on Saturday evening with Professor John Rogan as Guest of Honour. He handed out:

- Certificates of participation to successful candidates
- Chart Studio series of 17 Botany Charts
- Booklet, **"Gardening with Flora"** which is the compilation of all the year's activities that the teachers undertook.

FOLLOW-UP PHASE

1/6/2001

This was to be viewed as a feedback session. The participants were told that they would be videoed, recorded and filmed. They were given a short questionnaire to complete regarding the present state of their school garden. These were then verbalized and a great deal of discussion arose.

Another short response questionnaire was given out which dealt with the participants' use of the booklet and the project in general.

It was felt that the booklet could cover more with regards to "water" and that it should include a chapter on "air" and "pollution".

The participants were then asked who would like to have the researcher view their school grounds and 4 volunteered, which was an ideal number for the time allocated to this task (Appendix F - photos).

3.C.2. RESEARCH QUESTIONS

Using the Haney and Lumpe framework, in the **PLANNING PHASE** the base-line information of the participants and their school gardens was gathered from the preliminary study, the "Design a Plant" activity, photos of the school gardens taken at the beginning of the main study and the pre-tests. The training to be provided was planned and was to be concrete, teacher specific, and extend over a long period of time (see Question 1, Question 2 and Hypothesis 1 and 2 and Question 4 and Hypothesis 3). Also in the Planning Phase, teachers' beliefs were identified (see Question 3). It was also in this phase that the research strategy was planned.

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

In a series of studies, (Hines et al., 1986/1987). Ramsey (1993) and Klinger (1980) found that treatments employing both knowledge and cognitive skill components significantly increased in “numbers of actions” as opposed to those with only knowledge component. They concluded that skill in the application of action strategies to issues combined with appropriate knowledge endowed individuals with the ability to take action. It was my intention to see whether this research would corroborate these findings. The development of the school garden was used to assess whether planting skills had been achieved. The differences in the state of the gardens before and then after the intervention and the reasons for these differences were used for the research.

The competencies required in environmental education include being able to initiate a project to enhance the quality of life and exhibit the necessary skills to identify, investigate and contribute to the solving of environmental problems (Robottom & Hart, 1993). Botanical knowledge is necessary to enable the participants to understand plant requirements so that energy put into initiating this particular project will not be in vain and the project will be sustainable. In the project reported here the participants were required to actually develop a garden in order to develop these skills. The assessment of achieving the skills was measured by the degree to which the participants actually developed their garden.

The school garden is thus seen as fulfilling two roles:

- as a vehicle for engagement and context for learning (its progress contributed to the development of the participants)
- as an assessment tool (its reliability was backed up by interviews and written response questionnaires)

Question 2: Can the participants’ professional development, specifically with respect to botany teaching, be improved with 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.

“Knowledge on plants and the environment” test (see Appendix D) was used to assess plant knowledge qualitatively. This test consisted of 36 questions all of which covered basic botanical knowledge that the teachers should have been using in their teaching. The test also included basic questions about plants and the environment. When scrutinized for “content” the topics covered in the test matched the botany syllabus that the participating teachers were supposed to be teaching i.e. the questions revolved around the syllabus content thus the test could be regarded as being valid for content.

Looking at the individual question differences between the pre- and post-test scores in the "plant and environmental knowledge" questionnaire a huge problem arose here in that the group number was often reduced, as not all of the participants answered every question in the pre- and post-tests. The group was small to start with and this factor reduced it even more, sometimes to the extent that the statistics were no longer meaningful. However because the test has items that are scored with just zero or one, the Kuder-Richardson formula 21 was used to test for internal consistency. Internal consistency focuses on the degree to which the individual items are correlated with each other and is thus often called homogeneity. Requiring only the test mean, standard deviation (or variance) and the number of items, the Kuder-Richardson formula 21 is a simple reliability formula which is useful for evaluating some classroom-developed tests. This test given to the participating teachers could be looked at as such a test and as such does not need to have an exceptionally high reliability coefficient. As more students master the content, the test variability will go down and the coefficient for internal reliability will go up. In this instant a reliability coefficient of 0.50 or 0.60 may suffice.

TABLE 3.1. RELIABILITY OF "PLANT AND ENVIRONMENTAL KNOWLEDGE" QUESTIONNAIRE

OBS	BTOT = X	X=X-mean	x^2	ATOT = Y	y=Y-mean	y^2
1	53	-0.5	0.25	60	-2.9	8.58
2	57	3.5	12.25	70	7.1	50.01
3	60	6.5	42.25	59	-3.9	15.43
4	52	-1.5	2.25	55	-7.9	62.86
5	61	7.5	56.25	63	0.1	0.01
6	47	-6.5	42.25	71	8.1	65.15
7	52	-1.5	2.25	66	3.1	9.43
8	64	10.5	110.25	65	2.1	4.29
9	59	5.5	30.25	77	14.1	198.01
10	45	-8.5	72.25	50	-12.9	167.15
11	49	-4.5	20.25	59	-3.9	15.43
12	48	-5.5	30.25	60	-2.9	8.58
13	44	-9.5	90.25	57	-5.9	35.15
14	58	4.5	20.25	69	6.1	36.86
	749		**531.5**	881		**676.93**
Mean	53.5			62.9		
Variance	36.96					47.35

X = total score for pre-test
Y = total score for post-test
BTOT = pre-test total scores for each participant
ATOT = post-test total scores for each participant
On the actual test there were 99 items

The Kuder-Richardson formula 21 for the pre-test was 0.33 and for the post-test 0.53. It appears that the participants guessed many of the answers in the pre-test hence the low reliability whereas in the post-test, the answers showed more understanding hence an increase in reliability.

The "Design a plant" activity was also used to assess plant knowledge qualitatively (hypothesis 1). This tested the participant's plant knowledge directly, in particular:

- the parts of a plant
- the reproductive mechanism of the plant
- the different types of plants i.e. monocotyledon or dicotyledon

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

The "Science Observation Matrix" (Appendix K) and videos were used to account as accurately as possible exactly what happened in the classroom (21/9) after the intervention had occurred. As the new educational policy (Centre for Education Policy Development, 2000) stipulated that teachers should be able to devise their own teaching resources this project, it was hoped, would enable the participants to learn how to produce a resource about flowering plants that they could use in their teaching.

The production of the booklet would highlight all the aspects needed to develop the school garden. The completed booklet would show how these and other activities could be used to teach a specific aspect from the curriculum for a particular grade. Its development was used to assess qualitatively whether the participants were using outcomes-based methods.

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.

To investigate question 4 and hypothesis 3 Chacko's (2001) "Environmental literacy" questionnaire (see Appendix C) was used. It assessed environmental literacy quantitatively. This questionnaire consisted of environmental concepts and for each concept there were items to test awareness, knowledge, attitude and participation in environmental issues. Chacko developed this environmental literacy questionnaire to be used as a standardized test for environmental literacy for rural areas in South Africa.

The questionnaire was considered to be a valid and reliable instrument to measure environmental literacy of teachers. Chacko had the content validation verified before the questionnaire was presented to the teachers in his study by submitting it to eight specialists in environmental education, ecology and sustainable development (see Appendix C.1, Table C.1.1).

Although the group in the present research was small, the results can be compared to Chacko's results as his sample was taken from the same geographical area in which the present group of teachers live and work. The environmental literacy questionnaire assessed direct *self-reported* performance of *behaviour* and *intention* to engage in a given behaviour rather than *actual behaviour* by teachers.

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

The attitude questionnaire (see Table 5.12) was used to assess attitudes to plants qualitatively. A competency required in environmental education is the ability to cultivate positive values and attitudes about aspects of the environment, and plants are seen as one such aspect.

The training in the **TRAINING PHASE** was to be concrete, teacher specific, and extend over a long period of time. The teachers needed opportunities to engage in hands-on learning experiences and both the development of the booklet and the school garden provided these (see the Time-line pages 53 - 63).

Finally, in the **FOLLOW-UP PHASE**, evaluative feedback and revisions to the programme were made from input gleaned from the questionnaires given to peer teachers, students and heads of participating schools, Chacko's Environmental Literacy questionnaire, the

Knowledge of Plants and the Environment questionnaire and the development of the booklet and the state of school gardens.

3.D. EVALUATION AND ASSESSMENT FOR ENVIRONMENTAL EDUCATION PROGRAMMES

Stake (1977) ascribes most problems of evaluation failure in curriculum development projects to poor funding and management, but also alludes to serious conceptual and communication problems. Stenhouse (1975) had, however, previously revealed that underlying flaws in the entire curriculum development and evaluation enterprise might be at the root of these problems. He concluded that evaluation should, as it were, lead development and be integrated with it. Then the conceptual distinction between development and evaluation is destroyed and the two merge as research. His idea of “research-based teaching” (p. 141) as critical curriculum development suggests that innovation should be viewed as reflective processes of re-constructive action (action research). If diverse intuitive, reflective and discursive critical processes (evaluation) have a central and integrated role in curriculum change, evaluation cannot simply be treated as external and rational processes to establish the value and effectiveness of a curriculum project. Evaluation thus came to be seen as reflective critical processes that give both meaning and direction to re-constructive action. This aspect is fundamental to this research and the reason why this project was of an evolving nature.

Environmental educational has shifted towards a participant centred approach to materials development and an action research orientation to research and evaluation (Lotz, 1995). This approach is evident in the present research in the development of the booklet and the evolving design of the intervention.

Lotz & Janse van Rensberg (1995) describe the various approaches to evaluation in environmental education:

- early approaches evaluated only specific products or outcomes of the programme (i.e. numbers or behaviours).They were usually conducted by experts.
- a later trend was for those who ran the environmental education courses to do their own evaluation perhaps in conjunction with an outside expert and to evaluate both the products and processes. This is the approach used in the present research.
- a third approach emerged from the critical social perspectives of environmental education. It makes no distinction between environmental education and evaluation, because it treats environmental education itself as a critical reflective process. This would have been the approach of choice for the current research, but this was not possible and because of distance and time constraints very little time could be spent in the schools observing the actual planting. This approach can be utilized when the

intervention is used in future where the facilitator is perhaps more involved at the schools observing each planting activity in order to record the time at which the action is carried out correctly and then effect the necessary changes in the intervention to accommodate this progress.

The implication for research is that environmental education becomes its own instrument of ongoing evaluation and development with students and teachers participating in directing their own learning. If continuous assessment is driven by the participants, then the evaluation becomes self-reflective, self-critical and empowering (Lotz & Janse van Rensberg, 1995). Evaluation should, as it were, lead development and be integrated with it. Then the conceptual distinction between development and evaluation is destroyed and the two merge as research (Stenhouse, 1975).

Continuous programme assessment is required that captures the perspective of all those involved, uses a variety of formal and informal strategies, focuses on the process and effects of the programme and feeds directly into programme improvement and evaluation

3.E. SUMMATION

It was desired that the approach to environmental education followed in the current project approximate the situation where learning and teaching was an interpretive, reflective process. In other words the participants would continuously assess their practice as advocated by Stenhouse (1975), Lotz & Janse van Rensberg (1995) and Glover & Thomas (1999). 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".* This current research which was carried out over a period of time, researches the changes that the participants' undergo while an intervention is in progress. The monitoring of the participants' knowledge of plants before and after the intervention relied on pre- and post-test situations. The process of developing the school garden, formulating the booklet and observing the conducting of lessons, used guided workshops, questionnaires, photographs, videos and the observation matrix to obtain these results. This research does not illustrate the exact time the competency occurred but rather whether the competency was either evident or not at the end of the project. The value of the programme was measured by the feedback obtained from peer teachers, heads of schools, parents of participating learners and learners themselves in interviews and questionnaires.

The research methodology employs triangulation to substantiate results. For example a pre-test, "knowledge on plants" test and the "design a plant" activity was give to ascertain the participants plant knowledge initially. The method used to develop the school garden was planned after researching the literature which reviewed other gardening programmes such as the "Real" project, the "Growing" project, the "Lasers" project and the "Habitats and their

conservation" programme. Taking photographs at the different stages, as well as having the participants report on the actual hands-on planting of the material with their students undertook recording the process of developing the school garden.

The formulation of the booklet was deliberately and carefully planned e.g. the participants were asked to research the booklet by brainstorming the topic "plants", produce a mind map of what should be included as well as relevant activities and write a page on how they have gone about developing the booklet.

After the intervention some participants were videoed presenting lessons. This was done to assess their ability to teach in an outcomes-based fashion using plant material from the school garden. Hand in hand with the video went the observation matrices where the participants who where not presenting observed the lessons and critiqued them by using the "Science Observation Matrix".

In Chapter 4 the methods used in the preliminary study and the results and conclusions obtained are outlined and discussed.

CHAPTER 4

METHODS AND RESULTS OF THE PRELIMINARY STUDY

This chapter reports the knowledge, skills and attitudes regarding plants and the environment a specific group of teachers in South Africa possessed as investigated in a preliminary study. This preliminary study was conducted with 25 practicing foundation and intermediate phase teachers from Siyabuswa with the purpose of establishing the foundation for the intervention that would form the main part of this research. Grades 1 to 7 were represented in the group. The participants in the main study were drawn mainly from these participants. These results provide a reference level or baseline as a snapshot of the participants prior to the major part of the development intervention. The insight gained from these results assisted in the design of the main intervention, as well as contributing to the research questions

4.A. METHODOLOGY

The preliminary study consisted of an analysis of responses obtained from the participating teachers at a seven-hour biology workshop which 25 teachers from 17 different schools in Siyabuswa attended. These teachers had already been involved in a guided process of developing three small pamphlets of single experiments for elementary electricity, magnetism and chemistry and were enthusiastic about being given the chance to tackle something bigger. This biological workshop was conducted at the Siyabuswa SEIDET centre on the sixteenth of September 1999 to judge the teachers' level of professional development. The workshop contained three major clusters of activity:

i. A discussion of what characteristics a teacher who could achieve good class control needed

ii. A series of questions and activities designed as 11 worksheets which would give a clear picture of:

The participants' level of environmental literacy and understanding of the environment, environmental education and plants and be used to design the intervention of the main study

iii. The status quo of school gardens to see whether they needed improving and whether their products were being used in teaching.

i. Characteristics of a teacher with good classroom control

At the start of the workshop the article "Establishing A Network For Environmental Education – the Twelve Principles of Class Control (plus One) by Al Janulaw in "California Classroom

Science" - March 1999 (Appendix E), was read to the group. It was then discussed in the light of "what characteristics a teacher needed for good class control".

Janulaw (1999) found that if the curriculum is relevant and engages the pupils in activities that involve them in decision-making about and active participation in, the learning process then the need for discipline falls away because they enjoy the learning process. Question everything you do. If students do not see the relevance of the curriculum, maybe it is not relevant. Let the students teach you. Learn what motivates them by watching and listening. Then plan content-rich units that are in a style that works. Students who are given curricular opportunities that they consider interesting or, in their words, "fun" will provide the energy of twenty or thirty people pulling in the same direction. A powerful force indeed! This being the case the need for "class control" will disappear. Janulaw's thirteen characteristics are indicative of professional development which relates to Question 2 in the main study.

ii. Environmental understanding of the group

In order to determine the group's botanical knowledge and understanding of the environment and related issues the participants were required to complete 11 activity sheets (see Appendix A - Question 4.1 – 4.11). This study reports on answers to the questions which were asked of the participants and the results would be used to design the intervention of the main study.

Questions 4.1-4.3 are precursors to Question 4 of the main research (what is the understanding of "environmental education" i.e. the environmental literacy level of the participants?):

- Brainstorm the environmental issues in your area. (Question 4.1 - Sheet 1)
- What do you understand by the phrase "environmental issues"? (Question 4.2A - Sheet 2A)
- What experience have you had in solving a local community environmental problem? (Question 4.2B - Sheet 2B)
- How is your school encouraging environmental education? (Question 4.3 - Sheet 3)

Question 4.4, 4.5 and 4.6 are linked to Question 1 of the main study:

- Draw a map of your own school grounds (Question 4.4 – Sheet 4)
- List the areas you feel should be included in your ideal school garden (Question 4.5 – Sheet 5)
- Taking the SEIDET centre garden as an example, brainstorm how you would improve it (Question 4.6 - Sheet 6)

Question 4.7 – 4.9 relate to Question 2 of the main study i.e. the participants' professional growth:

Are your school grounds being used as a learning resource? (Question 4.7 – Sheet 7)

- Brainstorm what you think students in your particular learning phase should know about plants (Question 4.8 - Sheet 8)
- What knowledge do you want your students to have regarding plants? (Question 4.9 – Sheet 9)

Question 4.10 relates to Question 1 of the main study:

- What skills do you want your students to have regarding plants? (Question 4.10 – Sheet 10)

Question 4.11 relates to Hypothesis 1 and Question 3 of the main study:

- What attitudes do you want your students to have regarding plants? (Question 4.11 – Sheet 11)

At the end of the day the teachers were asked if they would like to participate in the main study the following year.

4.B. ACTUAL PRELIMINARY WORKSHEETS WITH OBSERVATIONS AND RESULTS

What came out of discussing Janulaw's article (Appendix E)? The participants expressed the view that the curriculum must be relevant to the students. The environment that everyone lives in is relevant to him or her and perhaps we can use this as our starting point for all teaching which students will then consider interesting or "fun".

The teachers were then asked to brainstorm the environmental issues in their area and try to identify the root causes (Question 4.1 - Sheet 1). Questions 4.1-4.3 are precursors to Question 4 of the main research (what is the understanding of "environmental education" i.e. the environmental literacy level of the participants?).

COMPLETE QUESTION 4.1 - SHEET 1

Question 4.1 - Sheet 1 - Brainstorm environmental issues in your area

(15 answered Question 4.1 - Sheet 1)

TABLE 4.1. LOCAL ENVIRONMENTAL ISSUES

ENVIRONMENTAL ISSUES
School not integrated into culture
POLLUTION
Safety and security
LITTER
High unemployment causes crime
Overcrowding in schools
INSUFFICIENT WATER
IMPURE WATER
Juvenile delinquency
Lack of rent payments
Damaged roads
Electricity cuts
UNCONTROLLED VELD FIRES
SOIL EROSION
No camps for livestock
Roaming animals cause accidents
DESTRUCTION OF NATURAL FORESTS
OVERGRAZING
Illiteracy
Lack of refuse removal
School buildings not repaired
Violence, house breaking, theft
No recreational centres for the youth
Unhealthy diets
Lack of public libraries
Lack of transport
Shortage of teaching resources
Vandalism
Lack of adequate sewage disposal

When the teachers were asked to brainstorm the environmental issues in their area they came up with 29 issues (see Table 4.1). Only eight of these actually had to do with the natural environment: pollution, litter, insufficient water, impure water, uncontrolled veld fires, soil erosion, destruction of natural forests and overgrazing. The other issues related to social, political or economic factors such as vandalism, safety and security, high rate of unemployment resulting in crime and illiteracy (see Figure 2.2 – Loubser 1996A). The participants were then asked to decide for themselves whether they could consider themselves environmentally literate and environmentally active.

Definition of environmental literacy:

the ability to observe and interpret the relative healthiness of environmental systems and to take the appropriate action to maintain the state of these systems.

COMPLETE QUESTION 4.2A - SHEET 2A

Have you ever had any experience in solving a local community environmental problem? If yes, detail the problem and explain how you went about tackling it.

15 answered Question 4.2A - Sheet 2A and a summary of the answers follows:

TABLE 4.2. WAYS OF SOLVING LOCAL ENVIRONMENTAL ISSUES

SOLUTION TO LOCAL ENVIRONMENTAL PROBLEM	NUMBER
Some thought environmental problems e.g. lack of water and electricity, litter and vandalism	2
Litter – youth on Saturday had a clean-up – black plastic bags sponsored by "Ellerines" – truck	1
Water shortage – encouraged people to re-use dishwashing water to water their gardens or	1
Negotiate with local water service department to deliver water at certain points in the township	1
Roads in bad repair – husband and wife filled holes in front of their house with soil and	2
Dogs rummaged through dustbins – put heavy stones on top.	1
Water wastage – students asked not to drink from open tap – measured wasted water in a	1
Litter – teacher, neighbour and students picked up litter in the street.	1
Broken tap – teacher requested the principal to invite the parents to a school meeting to explain	1
Eroded roads were repaired by a load of soil being brought in and the donga levelled.	1
Vandalism – parents were brought in and each paid R5-00 for an electrical barbed wire fence to	1
Litter from students staying after school is cleaned up in the morning and burnt.	1
Illiteracy – adult classes held twice a week.	1
Educated adults on human rights by inviting speakers from Department of Justice.	1
Removal of refuse – neighbours collected all refuse and dumped it in a communal area away	1

COMPLETE QUESTION 4.2B - SHEET 2B

Explain how you would solve the following issue: You live in an area where you do not have access to basic water services. How would you go about making sure that each person has access to 25 litres per day?

11 answered the question and the answers were then analysed in terms of issue analysis.

Again when solving this issue the participants' answers should have included the following: problem, issue, players, positions, beliefs, values and solutions. The first two points, namely the **problem** and the **issue**, were supplied in the question i.e. the problem was a lack of water and the issue was to make sure that each person has access to 25 litres per day.

When identifying the **players** the following were mentioned:

TABLE 4.3. PLAYERS INVOLVED IN SOLVING LOCAL ENVIRONMENTAL ISSUES

PLAYERS	NUMBER
All people in area	1
Indunas	2
Local government	3
Unilateral decision made by the actual teacher	1
4 men to dig borehole	1
Organize lorry to store water	3
Send out notices for mass meeting	3

What were the **positions** of the stakeholders?

None of the participants managed to identify these positions and obviously did not realize that this was important if an issue was to be solved. This could also be the reason why so few players were identified, as the participants did not realize that it is essential to get suggestions from people with as many different view points as possible.

What were the **beliefs** of the stakeholders?

Not all participants approached this issue democratically but those that did, tried to find out what people's perception of the water shortage was. This was done in the following ways:

TABLE 4.4. METHODS USED TO DETERMINE STAKEHOLDERS' PERCEPTIONS OF LOCAL ENVIRONMENTAL ISSUES

METHODS	NUMBER
Discussion	1
Pamphlets to create awareness	3

What were the **values** of the stakeholders?

The establishment of the stakeholders' beliefs was also not achieved in this exercise. The ability to do this appears foreign to the participants. What was evident from their detailed approach to this problem was that the amount of 25 litres had to be monitored very strictly so that people did not take more than that that was due to them. This seemed to be a more important issue than realistically getting the water to the individual households.

What were the **solutions** to the problem?

The following were the various strategies mentioned to solve the problem of getting 25 litres to each person:

TABLE 4.5. METHODS USED TO SOLVE THE POOR DELIVERY OF WATER

METHOD	NUMBER
Collect money to buy machine to drill a borehole	1
Support local industry and buy water from donkey cart at 25c per 100	1
Each family pay R20-00 and this will enable the Induna to hire a	2
Educate the community on how to save water	4
During the rainy season collect as much water as possible for future use	1
Get men from community to dig borehole	1
Elect people to monitor the amount of water taken by each person	3
Ask big business to donate money to sink a borehole	1
Organize with Department of Water Affairs to supply a tanker that will be	2

From the above it is evident that “issues” is not something that the participants were familiar with and for them to see the lack of a school garden in the main study as an issue, could be difficult.

TABLE 4.6. THE DIFFERENT SCHOOLS IN THE PRELIMINARY STUDY

NUMBER	SCHOOL NAME
8	Ezwenilethu
4	Buhlebuzile
9	Kabenziwa
11	Vulindlela
6	Makopanong
10	Siyabuswa
5	Nkosiphile
17	Sibonelo
3	Thabana
16	Masuku
13	Sizamakwethu
12	Thembeka
1	Ramokgeletsane
2	Phutikwena
7	Mareleng
15	Sothhembani
14	Lungisani

School Sibonelo was represented in the preliminary study but not in the main study. Schools Ramokgeletsane, Mareleng, Ezwenilethu, Sothhembani, Phutikwena and Lungisani were represented in the main study but not in the preliminary study.

COMPLETE QUESTION 4.3 - SHEET 3

How is your school encouraging environmental education?

(15 answered Question 4.3 - Sheet 3 - 1 to 17 refer to different schools in the preliminary study- see Table 4.6)

TABLE 4.7. THE METHODS THE DIFFERENT SCHOOLS USE TO ENCOURAGE ENVIRONMENTAL EDUCATION

METHODS	SCHOOL							
Close tap tightly after using water	8	4	9	11	10	17	12	
Report leaking taps	8							
Pick up litter	8	4	9	9	11	6	3	12
Avoid causing veld fires	8							
Love and care for the environment	8	11	3	13				
Look after school property	8	17						
Report vandalism	8	17						
Close gate to prevent cows from entering	4							
Boys water planted trees	4	3						
Girls clean classrooms	4							
No smoking allowed on the school premises	4							
Ask students to bring a plant from home to plant at school	9							
Ask students to bring stones from home to stop erosion	9	12						
Ask community to stop catching birds	9							
Ask community to repair leaking taps	9							
Plant trees on Arbor Day	9	11	11	17	3	16	13	
Don't waste water when they water the flowers	9							
Involve students in campaigns on environmental issues	11	16	13					
Plant trees and grass to prevent soil erosion	11	11						
Have prizes for the best kept class environment	11							
Recycle tins, bottles, papers, plastic etc. to raise money	11	16						
Get the pupils to make posters to educate the community	11							
Give regular lessons on environmental education	11							
Repair small holes in the fence	11							
EE is not encouraged as the head sees it as a waste	6	6						
Do not waste water by irrigating where there are no plants	10							
Teach students about health	10							
Involve parents in school activities	5	17						

METHODS	SCHOOL							
Take students on educational tours	5							
Teach students how not to waste water	5							
Clean toilets	5							
Clean surroundings	17							
Plant beautiful flower gardens	17	3						
Encourage students to look after their pets	17							
Use facilities correctly-play on sports fields and not roads	17							
Discourage the chopping down of trees	17							
Use plants in demonstrations in other learning areas	3							
Plant trees and grass and flowers	16	13	12					
Put stones in footpath to prevent erosion	16							
Ensure crop rotation	16							
Avoid over grazing	16							
Encourage the use of contour ploughing	16							
Build water canals to direct excess water runoff	16							
Have a large vivarium to keep live animals	13							
Teach students how to combat pollution	13							
Don't climb trees as they may break them	12							

The participants were now encouraged to look at an issue very close to home, namely their school garden. They were asked what the status quo of their school gardens was. This could be an issue in which sustainability could be investigated. Question 4.4, 4.5 and 4.6 are linked to Question 1 of the main study.

They were asked to draw a map of their school grounds showing the buildings and the cultivated areas (not necessarily to scale).

COMPLETE QUESTION 4.4 - SHEET 4

Draw a map of your school grounds showing the buildings and the planted up areas

This was very poorly done even though large sheets of paper were provided. On discussion with the participants it became evident that they did not know how to represent the spatial arrangement of the school's infrastructure on paper. Their understanding of measurement was lacking. From their maps it appeared that the grounds were very neglected and the majority had mostly veld grass and vacant spaces. Some of them had established trees. One had well maintained lawn areas and lovely flowers (Kabenziwa Primary School – School 9) although the range of flowers was very limited. Only one had a vegetable garden that was operative (Mareleng Primary School – School 7), the others had vegetable gardens which were, however, unattended and going to seed. A reason given was that the fences were in very bad condition and the goats and cows came in and ate all the plants. Some stated that

there was a lack of sufficient water to maintain a vegetable garden. Another reason given was that the community stole the produce. This theft is not indicative of an honest community, as the fencing had probably been stolen as well. It appeared that the values of the neighbours had to be changed if the garden was to be resurrected. Also an intrinsic attitude of caring for property needed to be cultivated as the fences were probably in good condition at some stage but had been allowed to deteriorate over time. A culture of self-help needed to be instilled in the participants and hopefully they would pass it onto the community.

COMPLETE QUESTION 4.5 - SHEET 5

List the garden/nature areas that you think should be included in your ideal school garden.

The following have been extracted as areas that the group listed:

TABLE 4.8. AREAS THAT COULD BE INCLUDED IN THE SCHOOL GARDEN

AREA	TOTAL
Vegetable patch	10
Lawn	9
Rockery	3
Orchard	8
Parking	2
Grassed play ground – sports field	6
Pavement	1
Shelter	2
Flower garden	13
Fish pond	7
Nursery	4
Compost heap	6
Place where animals or plants kept	9

The following were listed as individual items that should be included:

TABLE 4.9. INDIVIDUAL ITEMS THAT COULD BE INCLUDED IN THE SCHOOL GARDEN

INDIVIDUAL ITEMS	NUMBER
Trees	10
Fencing	5
Gates	2
Jungle gym and swings	2
Taps	2
Animals like sheep, cattle and chickens	1
Statues	1
Road signs for road safety	1

The majority of these individual items were also seen to be extremely important in a school garden especially the trees and the fencing. Insecticides and gardening tools were not mentioned. The participants seemed to have a very good idea of what should be included in a school garden so why were there so few school gardens developed? The teachers mentioned the following aspects as those which hindered the formation of school gardens:

- lack of water (mentioned by the most participants)
- inadequate fencing (mentioned by the second most participants)
- vandalism and theft of plants
- no tools
- no funds to purchase plants
- no time to actually develop garden
- do not know what to plant
- do not know how to plant

COMPLETE QUESTION 4.6 - SHEET 6

PROBLEM: HOW CAN SCHOOL GARDENS BE IMPROVED?

Taking the SEIDET centre's garden as the sample, brainstorm how you would improve it

In order to determine if the participants could analyse the state of a garden they were confronted with the following scenario: "How would you improve the SEIDET centre's garden i.e. the garden of the workshop venue?" This garden was typical of many rural educational facilities. The ground was extremely hard and infertile. It was a dust bowl and almost barren with very few trees and no flowers. The trees present were Acacia karroos and they were all aggregated in one spot, far away from the educational buildings. The ground was very sparsely covered with veld grass and the soil was very poor and sandy. The buildings were in a state of disrepair and the fencing was dilapidated and full of holes. There was one tap close to the building (see Appendix F – Photos). The following were ways in which the participants thought the grounds could be improved:

TABLE 4.10. WAYS OF IMPROVING THE SCHOOL GARDEN

IMPROVEMENT	TOTAL
Fence	8
Plant trees	13
Divide the surroundings	5
Clear the surroundings of veld grass	8
Prepare the soil for planting trees, lawn and flowers	5
Make compost heap	6
Plant flowers	11
Plant vegetables	6
Plant lawn	12

IMPROVEMENT	TOTAL
Install gates	2
Acquire garden tools	3
Install extra water taps and irrigation	11
Plant fruit trees	6
Make a pond	7
Employ gardeners	3
Supply cage for vertebrates e.g. rats, rabbits, birds	1
Supply a cage for invertebrates e.g. locusts	1
Do a soil analysis	11
Build thatched shelters for visiting learners	1
Build carports	1
Erect lock up shed for tools	3
Make space for a nursery for plant propagation	2
Plant wind breakers	1
Pick up litter	1
Remove all unnecessary stones	1
Level the land	1
Draw a plan of the garden	3
Go and buy the plants	3

When the participants were asked to improve the SEIDET centre's grounds they were told that money was not an obstacle, nor was the acquisition of plants or equipment. On discussion with this group they came to the realization that they did not know how to start developing a garden nor what to plant in it. They also said that they did not know how to plant the actual plant material and that they knew very little about plants or gardening. Very few of them had their own gardens at home so this planting was not an experience that they had ever encountered. By their own admission their own education did not include hands-on activities involving planting. Only the teacher from Vulindlela Primary School had any logical plan for improving the SEIDET Centre grounds. If one person from the group had the ability to plan correctly, then the rest of the teachers should have been able to. This plan included the following steps: to improve the SEIDET Centre garden:

- test the soil in order to know what plants can be planted
- remove the unwanted weed, grass and shrubs to make way for paving where necessary
- make compost with the grass removed
- identify places to plant lawn, flowers and trees
- make provision for carports and thatched shelters for visiting learners
- start planting the lawn
- transplant seedlings to plant at various points

- make sure water is available to water the plants regularly
- have a lockup shed to place the tools in
- have some-one to care for the garden. If the school garden was being developed, the school children should take care of it themselves
- ENJOY THE GARDEN.

The last point was interesting. One would like to interpret this as showing that this teacher saw beyond all the hard work that went into establishing a garden and wanted it to be a haven to be enjoyed. If this value could be instilled in more people, they would want to have gardens where they could spend time relaxing. If this attitude could be taught to students, when they ultimately have homes of their own, they would want to establish a garden to relax in. This attitude would uplift the whole community and perhaps reduce poverty, vandalism and theft.

Question 4.7 – 4.9 relate to Question 2 of the main study i.e. the participants' professional growth. Question 4.7 - Sheet 7 (19 answered) returned the teachers to thinking about their own school grounds.

COMPLETE QUESTION 4.7 - SHEET 7

PROBLEM: CAN THE SCHOOL GARDEN BE USED IN THE LEARNING SITUATION?

Are your school grounds being used as a learning resource?

If so, state for which topic in the syllabus they are being used. If not, state why not.

TABLE 4.11. GARDEN RESOURCES USED IN THE LEARNING SITUATION

RESOURCE	TOPIC IN THE SYLLABUS	NUMBER
Soil	Air in soil	5
	Non-living and living organisms in the soil	2
	Types	3
	Uses of soil	1
	Filtration	1
Trees	To show shadow at midday	3
	To show the direction of the wind	4
	Useful plants	3
	Parts of a plant	1
	Different external structure of stem	1
	Different kinds	1
	Different types of leaves	1
	Give shade	1
Weeds	Unwanted plants - stinkblaar, blackjacks and burr weeds	3
Lawn	Prevents soil erosion	1
	Fibrous root system	1
	Seed production	1

RESOURCE	TOPIC IN THE SYLLABUS	NUMBER
	Vegetative reproduction	1
	Types of leaves	1
Flowers	Parts of a flower	3
	Pollination	2
	Uses of flowers	1
	Colours	2
	Angiosperms	1
	Give beauty	1
Leaves	Different types of leaves	2
	Different shapes of leaves	2
	Photosynthesis	1
	Vegetative reproduction	1
Stems	Monocotyledons and dicotyledons	1
	Underground stems – potato	1
	Vegetative reproduction	2
	Different types of stems	1
Roots	Different types of roots e.g. carrot and mealie	4
Seeds	Bean – dicotyledon	2
	Mealie – monocotyledon	2
	Dispersal – insects, birds	2
	Germination	3
Plants	General classification	1
	Biodiversity	1
	Different parts of the plant	1
	Wanted and unwanted plants	1
Shrubs	Parts of a plant	2
Vegetables	Root systems	1
	Wanted plants	2
	Use of water	1
Wild plants	Leaf shape and colour	1
Water	Uses of water	1
Small stones	Counting	1
Aloes	Xerophytic plants	1
Pine tree	Gymnosperms – cone bearing plant	1
Tortoise	Animal life	1
Lizard	Reptiles	1
Rats	Mammals	1
Aquarium	Fish and tadpoles	1
Fish in pond	Animals live in water	1

This sheet required the teachers to think about their own school grounds. They were asked whether their school grounds were being used as a learning resource? Although as many as 56 topics were mentioned that could be taught to their students, when it came to actual plant resources those listed were very general i.e. stems, leaves, roots, monocotyledons and dicotyledons (see Table 4.11). This exercise showed how limited these teachers' plant knowledge actually was. They had very little idea of specific plants that could be used to teach the different topics. The only ones that were actually mentioned by name were the "bean" and "mealie".

From the results it became apparent that environmental education and the utilization of their school garden did not play a prominent role in most schools in the preliminary sample. In fact, in one school, namely Makopanong Primary School (6), teaching activities in the school garden were actually discouraged as being a waste of time. It was hoped that the teachers would realize that the position of the head was important for the project to be successful and that his attitude needed to be changed. This school did participate in the main study and the intervention was able to change the head's attitude. Teachers in the school saw their lack of school garden as an issue and actually tried to solve it.

Other important aspects that arose from this question that did influence the main study were:

- teachers from only one school (3) actually used plants from their school garden in their teaching
- some schools saw the value of planting trees, grass and flowers (9 ,11, 17, 3, 16, 13, 12)
- quite a few schools participated in Arbor Day in which they were encouraged to plant trees (9, 11, 17, 3, 16, 13)
- four schools encouraged students to care for trees (4, 3, 17, 12)
- only three schools encouraged their students to conserve water (9, 10, 5)
- only one school (11) was doing anything about fixing the fence, yet it was a major cause of the lack of a school garden as the roaming domestic animals could not be kept off the school property.

Although research has shown that students prefer to study animals to plants (Yager & Tamir, 1993) only five teachers said they actually used live animal specimens in their teaching. Only one teacher used objects from the garden e.g. small stones in a subject other than general science i.e. mathematics. Again soil was used extensively in hands-on teaching. Trees and flowers were also used a lot but in a generic sense. Actual genus names were not mentioned which supports the assumption that the teachers did not know these names.

COMPLETE QUESTION 4.8 - SHEET 8

Brainstorm what you think pupils in your particular learning phase should know about plants remembering that learning should be relevant.

TABLE 4.12. PLANT KNOWLEDGE RELEVANT TO THE DIFFERENT LEARNING PHASES

Grade 2

GARDEN RESOURCE	REASON FOR INCLUSION
Trees	For shade and wind protection
Flowers	For beauty
Vegetables	For healthy food
Water	Needed by all these plants

Grade 4, 5 & 6

TOPIC
The importance of plants to man
Why it is important to take care of our plants
Is man dependent on plants and why?
How are weather patterns going to affect plants and what can be done about it?
The relationship between plants, man and animals
The external structure of a plant e.g. leaves, stems, roots, flowers, fruits and seeds
Different types of plants
Uses or importance of plants specifically their different parts – dyes, beadwork (seeds),
The different habitats of plants
Caring for plants
Seed or seedless plants
Pollination
Growing requirements for plants e.g. soil and water
Growing seasons
Plant taxonomy
Useful plants and weeds
Differences and similarities among plants
How to plant plants (3)
Different types of seeds (comparing skills)
Germination of seeds
Dispersal of seeds
Deciduous and evergreen trees
Coniferous trees
Differences between monocotyledons and dicotyledons with respect to roots, stems,
How to prune 1
How to water 1

The results indicated that the teachers were not informed about the different plant topics for the different grades (see Table 4.12). Teachers were required to teach what was relevant to their students, so Question 4.8 - Sheet 8 was also supposed to find out what the teachers thought important for their students to learn. Although not all the grades were covered in this question in the preliminary study, the results gave a fairly comprehensive picture. A closer scrutiny of the topics that the teachers thought were relevant revealed that except for three items, the rest were all knowledge and content bound. This could be the reason why teaching was still based on rote learning. Three topics showed promise for changing the style of teaching, namely: how to plant plants, how to prune plants and how to water plants. These were skills that required the students to actually perform a task if they were to correctly understand the concepts. If a syllabus of only knowledge acquisition were perpetuated then the students involved in the learning experience would probably end up possessing the same few skills as their teachers when their course was finished. What the preliminary study teachers thought should be learnt in the different grades and what had been prescribed in the actual syllabus (see Appendix B) did not appear to be very different.

COMPLETE QUESTION 4.9 - SHEET 9

Having completed Question 4.8 - Sheet 8 what KNOWLEDGE do you want your pupils to have regarding plants? Try to make a list linking a particular plant as a resource for enabling that knowledge to be imparted?

Ignoring the specific grades that the participants taught, the following is a composite list of knowledge topics and their resources that it was thought should be covered at school:

TABLE 4.13. PLANT KNOWLEDGE AND THE RELEVANT PLANT SPECIMENS

KNOWLEDGE	SPECIMEN
Leaf structure	Cabbage
Vegetative reproduction	grass, grapes, stem of flower
Medicinal plants and their uses	aloe, plantain
Edible plants (which can be eaten?)	figs, berries
Pruning	most fruit trees
Monocotyledons(grown for selling)	mealies (2)
Dicotyledons (grown for selling)	Beans, peanuts (2)
Flowering plants	?
	learn how to grow and sell
	grow garden to be used for photography
Trees and flowers	?
	make Botanical garden as a resource
Useful plants	fruit, vegetables, grass, trees, flowers
Habitat of plants	?, maize, wheat, oranges, grapes, apples

KNOWLEDGE	SPECIMEN
Seasonality	Winter – carrots; summer – mealies
Different parts of a tree	Peach, mulberry
Types of roots	grass, tree
Different parts of a flower	?, petunia
Comparison of seeds	bean (2), water lily, mealie
Seasonal changes in plants	red leaves – grape; yellow leaves –peach
Seasonal changes in plants	Shedding of leaves in winter – deciduous
Food storage in plants	roots – carrots, beetroots
	Leaves – cabbage, onion
	stem – potato
	Flower – cauliflower
	fruit – tomato, pumpkin
	seed – rice, peanuts
Shapes of leaves	thick – aloe; needle – pine
Xerophytes: function, habitat	Aloe
Hydrophytes: function, habitat	water lilies
Importance of plants	Vegetables (2), fruit
Functions of plants	trees (2)
Functions of the different parts of plants	Trees
Importance of water, air and soil to plants	Grass
Importance of plants to man and animals	Vegetables and trees
How to make compost	Leaves, waste and dung
Types of roots	?
Uses of plants	Food
Furniture (2) – Pine tree	
Wine	
Medicine	
Paper – Pine tree	
Decorations – Pine cones	
Juice – Marula	
Decorate yard – Jacaranda tree	
Wind breakers - Jacaranda tree	
Glue – gum trees	
Sugar – sugar cane	
Care of plants	?, lawn, flowers (2), vegetables (2) trees
Sowing of seeds	Bean
Names of plants	aloe, beetroot, Marula

From the results of what KNOWLEDGE the teachers wanted their students to have regarding plants, it became evident that the teachers' knowledge of plants was very superficial (see Table 4.13). Admittedly some of the participants used actual named plant material to teach a

specific plant topic especially in “uses of plants” and “food storage in plants” but these two topics hardly encompassed all that there was to know about plants at the intermediate phase. Some mentioned a plant topic that ought to be covered, but did not know which plant could be used to best illustrate the knowledge. Some of the topics listed were skills and not knowledge e.g. care of plants, making compost and pruning. There was scope to broaden the participants’ plant knowledge through increasing their repertoire of actual plant varieties which would in turn, broaden the plant resource base used in their teaching. Through discussion with teachers in the preliminary group it became obvious that all the teachers saw the necessity in developing their school garden so that they could use its contents in their teaching. It also appeared that a tremendous amount of work needed to be done to educate teachers as to which specific plants could best be used to teach which particular plant topics. The participating teachers made it known that it was necessary to teach the following core of knowledge concerning plants to their students:

- all the parts of the plant as well as its inter-relatedness to the physical environment (temperature, air, water, soil, nutrients, gravity, energy)
- specific plants and their importance to the participants (economic)
- learning about these plants in a cross-curricular way (social).

Question 4.10 relates to Question 1 of the main study:

COMPLETE QUESTION 4.10 - SHEET 10

What SKILLS do you want your pupils to have regarding plants? Try to make a list linking particular plant as a resource for enabling those skills to be imparted?

Ignoring the specific grades that the participants taught, the following is a composite list of skills with their plant resources that the teachers stated should be covered at school:

TABLE 4.14. PLANT SKILLS AND THE RELEVANT PLANT SPECIMENS

SKILL	SPECIMEN
Woodwork	Marula tree
Making juice	Marula tree
How to plant trees	?
How to care for plants	?
How to make compost	?
How to experiment	?
How to observe	
How to draw plants	?
Give	Flowers
Understand	Trees
Discuss	
Know	?
Identify	?
Appreciate	?

In Question 4.10 - Sheet 10 the participants were specifically asked what skills they wanted their students to have regarding plants. They were also asked to link a particular plant as a resource for enabling that skill to be taught. This sheet was very poorly answered with only two participants answering the question (see Table 4.14). This could be because the rest had never contemplated skill acquisition relating to plants as an option in education. They especially did not relate to the issue of knowing how to actually plant and care for different plants as being something that could or should be taught at school. They were never taught these skills and as mentioned earlier, teachers tend to teach how and what they were taught. Most of the skills listed were scientific process skills. The lack of answering of this question led to the premise that the implementation of outcomes-based education, which will be covered in the next chapter, was of the utmost importance.

Question 4.11 relates to Hypothesis 1 and Question 3 of the main study.

COMPLETE QUESTION 4.11 - SHEET 11
What ATTITUDES do you want your pupils to have regarding plants? Make a list linking a particular plant as a resource for enabling those attitudes to be imparted?

Ignoring the specific grades that the participants taught, the following is a composite list of attitudes and the resources that the teachers stated should be covered at school:

TABLE 4.15. ATTITUDE TO PLANTS AND THE RELEVANT PLANT SPECIMENS

ATTITUDE	SPECIMEN
Love	? (2), flowers (5), grass, trees (2),
Acceptance	flowers (2), grass, trees (2), fruit
Positive attitudes	? (3), flowers, grass, trees (2), vegetables,
Negative attitudes	poisonous weeds
Uses of plants	furniture, food, beautify our homes
Appreciation	? (2), flowers, trees, fruit
Healthy attitude	vegetables, fruit
Happiness	?
Love the plants for their uses	food, shade, decoration
Observe the growing plant	?
Appreciate the effort growing them	Trees
Care for them	Trees, shrubs, all plants
Enjoy working in the garden	Flowers
Joy in watching plants grow	Flowers
Respect their surroundings	Flowers
Be responsible	Trees

ATTITUDE	SPECIMEN
Love of nature	different kinds of plants
Relevance to their lives	?
Instil an interest in plants	?
A willingness to learn more	?
The value of plants	? (4)

This questionnaire was also very poorly answered (see Table 4.15). Teachers have not been encouraged to express their feelings and so found it very difficult to write them down. Most of them translated the majority of questions into knowledge questions rather than handle them in the affective domain. This could have been a result of language barriers and the fact that these types of questions are foreign to teachers. This sheet was very enlightening because in only one instance was there any mention of negativity (poisonous plants). It is generally accepted that to be surrounded by plants and to work with plants is therapeutic, soothing and relaxing. This attitude was reflected qualitatively in this set of results.

4.C. CONCLUSIONS

The preliminary study has shown that many learners find learning about plants with the current curriculum tedious, boring, difficult and irrelevant. Biology was seen by many students as the memorization of many unrelated facts, which had very little or no bearing on their lives. The emphasis in biology should not be on memorizing facts but on the understanding, interpretation and application of biological information. Fusco (2001) wrote that when young people said that biology was boring or not related to their lives or their future, he did not think that they meant the knowledge or content was useless but that the context for learning did not support their development.

OBE requires teachers need to have the necessary knowledge of plants, the skills to handle them and a positive attitude towards them, to teach about plants with enthusiasm. The preliminary study showed that these attributes were lacking in the participating teachers who were looked at as being representative of the majority of rural teachers in South Africa.

An analysis of all the preliminary sheets showed that although flowering plants formed a large part of many people's environment the knowledge, skills and attitudes related to them seemed very poor. There was definitely a need to investigate these aspects further and especially share with teachers the skills needed to choose, plant and nurture plants.

Another conclusion gleaned from the preliminary study was the fact the participating teachers did not have the necessary textual resource material describing the skills needed to develop a school garden. Curriculum 2005 has the requirement that teachers should develop resource

materials for themselves. Thus the main study was designed to include a project of developing this resource. It would involve the teachers creating a booklet which would present these skills in a logical manner. Also included in the booklet would be specific activities, relevant to the curriculum, designed by teachers. These activities needed to be outcomes-based. They also needed to be emulated in the classroom using material that could be found in the school garden. This booklet could then be used to teach a specific aspect from the curriculum for a particular grade from material collected in the school garden.

More research on the development of school gardens was justified and a sound basis for an intervention had been provided by the results of the preliminary study. This gave rise to the detailed process of development and research described in the following chapter.

CHAPTER 5

THE MAIN STUDY

5.A. INTRODUCTION

The preliminary study showed 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. They displayed inadequate knowledge of even the most elementary aspects of botany and the relationship between botany and the environment. They were not initially aware of the feasibility that the environment could be used as a resource for materials to use in their botany teaching. These teachers were a product of a science education system which did not emphasize self-exploration and a critical outlook.

Environmental literacy involves awareness of the total environment, knowledge of environmental problems, attitudes which lead to responsible environmental behaviour and participation in solving or preventing environmental problems. This literacy was initially lacking in the participants as was revealed in the preliminary study. The participants could not use their natural environments because these were denuded due to a lack of water (mentioned by the most participants), inadequate fencing (mentioned by the second most participants), theft of plants, and inadequate knowledge of what to plant in them (see results of Preliminary programme, Question 4.1 - Sheet 1). On discussion with this preliminary group they came to the realization that they did not know how to start developing a garden nor what to plant in it. They also said that they did not know how to plant the actual plant material and that they knew very little about plants or gardening. When asked whether their gardens could be used as teaching resources as many as 56 topics were mentioned that could be taught to their students. When it came to actual plant resources those listed were very general i.e. stems, leaves, roots, monocotyledons and dicotyledons (see Table 4.11). This exercise showed how limited these teachers' plant knowledge actually was. From the results of the preliminary test it also became apparent that environmental education and the utilization of the school garden for teaching botany had a small role, if any, in most schools.

The intention of this research was to determine which factors facilitated and hindered change in the teaching of botany in primary schools. The starting point was that "active engagement promotes change". Throughout this project active engagement was carried out to determine whether knowledge, skills and attitudes towards the environment could be changed by (i) the active participation of teachers in the production of a booklet on what and how to plant in a school garden and (ii) the actual development of a school garden. The initial findings of the

main study were compared to the final findings to determine whether the active interventions resulted in change, be it positive or negative.

5.B. THE DESIGN OF THE MAIN STUDY

The development of the school garden was the focus of determining whether “active engagement could promote change” and formed the basis for the main study. The design of this research was an “evolving” design, which took approximately 15 months to complete and was largely exploratory in nature. The intervention was designed to allow for the introduction of specific interventions as the year progressed while the course would unfold at the pace that the participants could handle. It was necessary to build upon the participants’ prior learning and the research therefore included elements that would establish this learning as the sessions developed. The actual paradigm used was a combination of "interpretive” and “reflexive” philosophies (see Chapter 2).

The “participatory action research” mould (which is “reflexive”, Lotz, 1996) best describes the paradigm of the main study. The teachers were required to continually actively participate in the project which had a specific setting (the school garden) and as they progressed it was possible to alter the content of the model. The researcher herself was an active participant as facilitator of the interventions, yet, as researcher, needed to recognise signs of change, determine appropriate activities and introduce suitable resources as the series of workshops progressed. Neither the participating teachers when reporting on their own learning and perceptions, or that of their peers, nor the researching facilitator could be neutral, external observers. The research interest was supposed to be emancipatory in nature, with the participants experiencing the freedom to teach the prescribed subject matter in a different way and while doing so gain clarity with respect to the content being taught but as will be borne out later, this newly given freedom was stressful to most of the participants.

A series of nine workshops was held at three weekly intervals with a group of Siyabuswa teachers during 2000 and 2001 (Chapter 3 – Time-line). As the programme progressed, the participants began to cultivate their school gardens and compile the booklet “Gardening with Flora”.

A total of twenty-seven teachers from the Siyabuswa district of Mpumalanga province participated in the project (Table 5.1). These teachers represented sixteen primary schools in the area, all of which were in close proximity to the SEIDET Centre. During the running of the project there were 21 females and 6 males in the group and of these 27 teachers, 21 (3 males) taught in the intermediate phase and 6 (3 males) taught in the senior phase. Unfortunately not all of these attended the entire course and only fifteen completed it.

TABLE 5.1. DETAILS OF THE MAIN STUDY GROUP

Participant	Phase	School
1	3	1
2	2	2
3	2	3
4	2	4
5	2	5
6	2	6
7	2	7
8	2	8
9	2	9
10	2	10
11	3	3
12	2	2
13	2	10
14	2	11
15	2	12
16	3	13
17	2	6
18	2	14
19	2	14
20	2	11
21	3	4
22	2	16
23	2	7
24	2	11
25	3	6
26	3	15
27	2	8

The research questions are now addressed.

5.C. THE METHODS, OBSERVATIONS AND RESULTS AND DISCUSSION RELATED TO QUESTION 1

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

This question addressed the skills domain and investigated whether skills could be learnt through a workshop. The development of the school garden was used to assess whether planting skills had been achieved.

5.C.1. Specific methods used to develop the gardens at the participants' schools

To establish baseline information questions were put to the participants in an attempt to find out if a particular school had or had not developed a school garden. The participants were encouraged to discuss (on the 14/4) the state of their school garden using the following questions for guidance:

Does your school have a developed garden?

If yes:

- how long has the garden been in existence?
- who suggested it be established?
- who developed it?
- where did the funding come from?
- how big is the garden?
- what does it consist of?
- who maintains it?
- is it static or does it change?

If no:

- why not?

Although on the 14/4 nothing was written down about the initial state of the participants school gardens a lot of lively debate ensued. To obtain a general idea of the gardens photographs of these school gardens were taken prior to any intervention (Appendix F). This was done before the next session on the 2/6.

The teachers were then told that for each activity that they were to do in developing their school garden, they would have to write down how they would do it. Then to assess whether they were able to do it correctly they would be taken into the SEIDET centre's garden to perform those gardening skills where their actual actions would be recorded. They would then be shown the correct way of doing the task so that they had first hand knowledge of how to do it and could convey the correct message to their students when they replicated the task in their own school garden. Thereafter they were all given extra material to take back to their schools to plant with their students.

Under close surveillance, seeds, seedlings, groundcovers, perennials, bulbs, shrubs, trees and lawn were planted in the SEIDET centre's garden over the next four months (see Appendix F, photo 8 - 13).

Every three weeks when the participants returned to the SEIDET centre for their next workshop, time was taken to study the plants and see if they could learn anything from the results for their own gardens. Appendix F photos 5, 6 and 7 show these plants after two

months while photos 8, 9, 10, 11, 12 and 13 show them after four months. The lifecycle of flowering plants was visible for all the teachers to see. The photos would be used to determine the actual results of the planting exercises. This evidence was a most important aspect of the project, namely, could the participants with their students actually start to plant up their school garden after receiving the necessary skills?

This “try it for themselves, discuss, demonstrate, actually do it the correct way and then move on to the next task” was a cycle similar to the “learning cycle” mentioned in Chapter 2. This cycle is in line with the constructivist approach, and is itself an important contributor to success.

The activities that the participants were asked to carry out were included in the booklet they were asked to compile if they felt the activities were worthwhile.

5.C.2. The observations and qualitative results appropriate to question 1 obtained by inspecting the state of the participants’ school gardens and reviewing topics for inclusion in the “gardening with flora” booklet

Table 5.2 shows the steps taken by each participant when preparing a bed for planting, sowing seeds into trays and sowing seeds in situ (see Appendix G). These activities were carried out on the 14/4.The correct sequence to follow when preparing a bed for planting should have been:

1. Choose spot and mark out bed
2. Water to soften and loosen soil
3. Turn over the soil
4. Remove weeds and stones
5. Add compost
6. Add fertilizer
7. Rake soil to level
8. Water the bed

TABLE 5.2. SKILL ORDER OF PARTICIPANTS FOR PREPARING A BED FOR PLANTING, SOWING SEEDS INTO TRAYS AND SOWING SEEDS IN SITU

		PREPARE A BED		SOW SEEDS IN TRAYS		SOW SEEDS IN SITU	
STUDENT CODE	SCHOOL NO.	ORDER OF SKILLS	SUCCESS	ORDER OF SKILLS	SUCCESS	ORDER OF SKILLS (LARGE SEEDS)	ORDER OF SKILLS (SMALL SEEDS)
1	1	-	-	-	-	-	-
2	2	1,3,7,5,8	Good	1,4,6	Poor	2,5,6	5,6,7
3	3	4,3,4,1,5,8,7	O.K.	-	-	-	-
4	4	4,3,7,4,1,7	O.K.	-	-	2,3,4,6,5	2,7,6
5	5	1,3,7,8	O.K.	1,3,5,67	Poor	2,4,5,6,7,8	5,6,7
6	6	4,3,5,8,1	O.K.	1,6,3	Poor	2,4,8	2,8
7	7	-	-	-	-	-	-
8	8	3,2,3,6,1,7	Muddled	1,3,5,7	Poor	4,6,7	2,5,6
9	9	4,3,7,8	O.K.	1,4,6,7	Poor	4,6,7,8	2,5,7,8
10	10	4,3,7,1,7	O.K.	1,6,4,7	Poor	4,6,7,8	3,5,6,7
11	3	3,4,7,5,7,8	Good	1,4,6	Poor	2,5	3,5
12	2	-	-	-	-	4,8,7	2,6
13	10	1,3,7,8,5	O.K.	-	-	-	-
14	11	1,2,5,8	Planted	1,3,4,7	Poor	2,6,7,8	5,6,7
15	12	1,2,3,8,6	O.K.	1,4,7,6	Poor	2,6,8	5,7
16	13	-	-	-	-	-	-
17	6	4,2,3,7,5,8	Good	1,4,5,6	Poor	2,8	5,7
18	14	-	-	-	-	-	-
19	14	2,3	Very basic	1,4	Poor	4	-
20	11	1,2,3,8,5	Compost	3,6	Poor	4,5,8	5,6,7
21	4	1,3,5,7,8	O.K.	1,3,4,6,7	Poor	2,6,5	5
22	16	1,3,4,5,6,8	Good	1,8,3,6	Poor	4,8	2
23	7	-	-	-	-	-	-
24	11	-	-	-	-	-	-
25	6	-	-	-	-	-	-
26	15	-	-	-	-	-	-
27	8	-	-	-	-	-	-

Having prepared the flowerbed the participants were asked to water it. They had not been exposed to different kinds of watering apparatus and techniques. This aspect became a most obvious place for improvement and skills development. The majority of teachers were only familiar with a watering can. Some suggested using tins to water their bed, while others their

hands to distribute the water. The teachers did not realize that the size of the plant to be watered should determine the watering apparatus used. The larger the plant specimen, the stronger could be the flow of water provided.

Their answers reveal the following:

Number using watering can:	11
Number using hands:	3
Number using tin:	3

After being made aware of how little exposure the participants had had with watering (14/4), sponsorship was obtained and at the next session (2/6) each teacher was given a length of hosepipe with the correct fittings. They were shown how to attach the hosepipe and tap fittings. A great deal of time was spent on actually watering the different types of plants e.g. ground cover, tree, shrub etc. Lack of water was mentioned in the preliminary study as a major contributing factor to school gardens not being developed and the following photos show the state of this commodity in some of the schools (see Appendix F, photos 16, 17, 18, 43, 61, 68, 80 and 91).

The activity, which involved planting seeds into seed trays (14/4), was very poorly done (see Table 5.2). The teachers were given a variety of different seeds to sow into six cavity containers. The correct sequence to follow should have been:

1. Fill your container with soil
2. Don't press the soil down too hard
3. Make tiny holes in the soil with a thin stick - sow seeds to a depth of double their diameter
4. Drop your seeds into the holes
5. Carefully cover the seeds with soil
6. Water the soil using a watering can with a fine spray
7. Place container in a warm, sheltered position
8. Fertilize your container every week with a liquid fertilizer

The teachers knew superficially what had to be done but definitely not in any depth. It is possible to conclude that they had not actually carried out this exercise before. They did not stress that the trays had to be full and that the soil was not to be compacted. Nearly all used compost in the trays instead of potting soil, which is good loamy soil. The majority placed the seeds too deep in the soil. Unless they mastered this task and the following two, their school gardens would not become sustainable.

The teachers were then given beetroot, spinach, pea, carrot and Namaqualand daisy seeds to plant directly into the soil (14/4). They were shown that the larger seeds (beetroot, spinach,

pea and Namaqualand daisy should be planted directly into individual holes, twenty centimetres apart. The tiny carrot seeds should be mixed with sand in equal quantities and broadcast into shallow trenches. This would facilitate the carrot seeds being spaced further apart and so reduce competition with each other.

The correct sequence to follow for the large seed should have been:

1. Prepare the soil as before
2. Make rows 20–10 centimeters apart
3. Make a trench one centimeter deep or
4. With your finger make holes 20 centimeters apart
5. and to the depth of twice the diameter of the seed
6. Drop a seed every 20 centimeters in the trench or drop one seed into each hole
7. Gently cover the seeds with soil
8. Water the loosened soil gently so it settles
9. Label the row with the name of the seeds and the date planted

The correct sequence to follow for the small seed should have been:

1. Prepare the soil as before
2. Make rows 20–30 centimeters apart
3. Make a trench one centimeter deep
4. Mix the small seeds with sand
5. Scatter the seeds and sand in the trench
6. Gently cover the seeds with soil
7. Water the loosened soil gently so it settles
8. Label the row with the name of the seeds and the date planted

This exercise was not done very thoroughly (see Table 5.2). If the participants were to follow their exact recipe, very few of them would have been able to produce germinated seeds. Not one said that the bed needed to be prepared which may have been due to a misunderstanding and them thinking that the bed had already been prepared. In this actual planting activity their concept of measurement appeared to be very poor as most were planting their large seeds in holes, ten centimetres deep. These seeds would never germinate, as the holes were too deep. This indicates that their plant knowledge was lacking when it came to seedling growth. They did not understand that the seed stores just enough energy to germinate and grow a little bit before the green leaves develop. These green leaves then photosynthesise and produce more usable energy from the sun. If they planted the seed too deep it would not have enough stored energy to grow and reach above the soil and this would have been the case for the majority of the participants. Some participants did not cover their seeds and these would also not germinate as they would be exposed to the sun and so

die. A few participants neglected water, a necessary commodity. No teachers labelled their plants and so they would not know what was planted where.

Even though these problems were manifest at the beginning of the programme, the following photos show that they were overcome by the end of the intervention (see Appendix F, photos 104, 105, 106 and 107).

At this stage (14/4) each participant was given a tin of “Meadow Mix” seed to plant in their school grounds. The photos indicate that the participating teachers from this particular school had acquired the skills to plant seeds in situ and that the resulting plants had been looked after and were still looking good at the end of the project when the photos were taken (see Appendix F, photo 32 and 78).

In the same session the participants were asked to write down in the correct order the steps they would take to plant annual seedlings into the soil (petunias, dahlias, mesembryanthemums, onions and gazanias). This self-evaluation written exercise was extremely poorly recorded and it was decided not to complete this aspect of the task recording the activity again. In reality many participants documented the incorrect specimen. They gave instructions on how to plant seeds again instead of seedlings. This could be due to them not knowing what a “seedling” was. Those who did know gave no indication of how they would get the seedling out of the tray, or how they would hold it. There was a huge discrepancy as to the size that the hole should be that the seedling was to fit into. Very few teachers wrote down that they would press down the soil after planting and not everyone said they would water their seedlings. Also the application of fertilizer was generally ignored.

After actually being shown how to plant out a seedling correctly each participant repeated the activity and was given seedlings to plant in their school ground. Photos were taken of these seedlings at the end of the project (see Appendix F, photos 7, 9, 11, 12, 13, 33, 34, 35, 36, 38, 51, 52, 54, 57, 58, 59, 65, 67, 69, 73, 74, 76, 89, 93, 96, 102 and 109). Again these photos showed that the participants had mastered this skill after attending the workshop which again demonstrated that the learning cycle being used was proving successful in enabling botany learning to take place.

At the end of the session and after planting their seeds and seedlings into the prepared bed in the SEIDET centre’s ground, the participants were very keen to go home. None of them thought about who was going to water these plants until they met again. It was part of the learning experience for them to experience the potential consequences of this lack of responsibility or insight.

When the teachers all convened again on the 2/6 they were pleasantly surprised to see that their plants were still alive. This was thanks to the night watchman who had taken it upon himself to water the plants and put thorn branches on top of the prepared bed to keep the livestock away (see Appendix F, photos 19). This means of protecting the plants was not exhibited by the participating teachers on the 14/4 but it was later on (see Appendix F, photos 19, 47, 70, 95, 96 and 97 showing how participants also protected the plants in their school gardens). Only once the night watchman had used it did the teachers go back to their schools and emulate it and they also devised other methods such as surrounding the plants with bricks piled on top of each other. This protection skill was going to become one of the most important life skills that the teachers would have to use as most gardens did not have a fence (see Appendix F, photos 45, 75, 82 and 94). Some of the petunias in the garden had been eaten by insects (see Appendix F, photo 37) and thus needed attention. A discussion on pesticides was held (2/6) and the participants agreed that this information should be included in the booklet.

Without actually recording in writing the steps for the following activities, the participants actually planted the provided specimens while being observed (18/8 and 21/9). Then they were given a demonstration of the correct way to plant each specimen. The participants then were each given a specimen of that type to plant with their students in their school gardens after the demonstration:

- plant a groundcover e.g. verbena and a perennial e.g. dietes and agapanthus, cannas, montbrecias and irises (see Appendix F, photo 8, 22, 31, 55, 66 and 79)
- plant a shrub e.g. viburnum (see Appendix F, photo 2, 5 and 28)
- plant a tree (see Appendix F, photo 4, 10 and 24)
- plant lawn e.g. kikuyu (see Appendix F, photo 6, 30, 40, 87, 89 and 90).

The participants were asked to take note of who was involved, the students' attitude, how long it took, the problems they had and any other points of interest. Again this was not done particularly well. Nor did every participant do it.

The fact that the majority of the participating teachers were able to plant up their school gardens using the skills that they were taught during the course indicated that the intervention was successful (Appendix F). Appendix F contains photographs of actual school gardens that have been developed over the nine months and these can substantiate the claim that *actual gardening* took place.

From the above exercises the following factors initially hindered change in the teaching of botany in primary schools:

- the participants lack of the concept of measurement
- their understanding of what actually constituted a good, loamy soil

- their understanding of the concept of germination and the conditions needed for this process to take place
- the value of water

These factors (which form part of the actual syllabus in primary schools) that hindered change were overcome by actually performing relevant tasks. It was suggested that these factors be included in the booklet.

Nine months after the programme had been completed the teachers were given a questionnaire to complete on their thoughts on the state of their school garden (Appendix H).

Of the 13 participants who completed the questionnaire:

- five admitted that their school garden was in poor shape
- seven said that their garden was average
- only one said that their garden still looked good
- five teachers had added extra plants to their school garden since the project had ended which is a significant fraction (Table 5.3 – A represents average, P represents poor and G represents good).

TABLE 5.3. STATE OF SCHOOL GARDEN NINE MONTHS AFTER COMPLETION OF PROJECT

School	Teacher	State of garden P / A / G	Reason	No. plants planted
1	1	A	Drought	3 types vegetables
3	11	A	Not enough water and fencing	Some ground cover
6	6	P	No fencing, no water from November	None
5	5	A	Not enough water, rats eating plants	4 types vegetables
7	23	G	Planted vegetables but not flowers	4 types vegetables
8	8	A	Disturb rest of school in day	None
9	9	A	Poor fence, vandalized	None
10	10	P	Poor fence and branches rotted	None
10	13	P	Poor fence, vandalized	None
11	14	P	Not enough water, preparing beds	None
12	15	A	Initially no fence but now fixed	2 types of flowers
13	16	P	No fencing, no water	None
14	18	A	Getting ready to plant again now	None

5.C.3. The observations and qualitative results of question 1 obtained by completing a skills-based questionnaire related to plants and the environment

Another way of reviewing whether the participants had acquired the skills to develop their school garden qualitatively was to request them to complete a skills awareness questionnaire related to plants and the environment as a pre-test at the beginning (21/7) and as a post-test after the actual planting of their school garden (15/11). This questionnaire (Table 5.4) was formed of questions requiring open-ended responses and attempted to see whether the participants had ever thought about plants in relation to skills that could be associated with planting them. The objective of using it was to assess the participant's awareness of plants and planting skills after the intervention.

TABLE 5.4. SKILLS AWARENESS QUESTIONNAIRE

Plants:
1. What skills do you feel that you should possess after completing a course on plants?
Plants and the environment
2. What skills do you feel that you should possess after completing a course on plants and the environment?
The environment
3. What skills about plants are necessary to produce environmentally literate citizens?
4. What skills do you feel you need to have to solve environmental issues?
5. Man is the cause of many environmental problems. Can he be the cure?
If yes, how? If not, why not?

The participants of the preliminary study listed how to plant trees, how to make compost and how to draw plants (see Table 4.14) as skills that should be covered at school. Many of the teachers in the preliminary study were also part of the actual study and again they were asked the same question (Table 5.4, question 1).

At the outset of the programme in the Skills Awareness Questionnaire (21/7) the participants did not seem to consider that the issue of knowing how to actually plant and care for different plants was something that could or should be taught at school. Their responses in the pre-test were no different to the previous year which was surprising as they all knew that one of the objectives of the actual project was to plant up a garden. They still did not seem to feel that the issue of knowing how to actually plant and care for different plants was something that could or should be taught at school.

The participants were given the skills questionnaire again after the actual planting of their school garden (15/11).

TABLE 5.5. RESULTS OF SKILLS AWARENESS QUESTIONNAIRE AFTER INTERVENTION

QUESTION 1	QUESTION 2	QUESTION 3	QUESTION 4	QUESTION 6
SKILLS THAT SHOULD BE POSSESSED AFTER COMPLETING A COURSE ON PLANTS	**SKILLS THAT SHOULD BE POSSESSED AFTER COMPLETING A COURSE ON PLANTS & ENVIRONMENT**	**SKILLS NEEDED TO PRODUCE ENVIRONMENTALLY LITERATE CITIZENS**	**SKILLS NEEDED TO SOLVE ENVIRONMENTAL PROBLEMS**	**SKILLS NEEDED TO DEVELOP A SCHOOL GARDEN**
The majority of planting skills that they had accomplished during the year	Skills to be able to identify whether the environment is suitable for particular plants skills to be able to conserve water skills to be able to know how to keep the environment clean skills to be able to know how to respect the environment skills to be able to know how to plant trees skills to be able to know how to encourage others to look after their environment which includes plants skills to be able to know how plants can prevent soil erosion skills to be able to know in which season to plant certain plants skills to be able to know how to organize workshops to teach others how to care for the environment	importance of plants the love and appreciation of plants encourage the community to produce a community garden the necessary skills to run workshops in the community the skills to teach the community entrepreneurial skills	improvisation i.e. use branches of thorn trees to protect plants if there is no fence discuss the issue with the relevant stakeholders communicate with the relevant people liaison with local environmental departments initiate and co-ordinate workshops about environmental issues make posters and speak to the media teach people about the importance of plants encourage active participation develop places like clinics as gardens for the community encourage unemployed citizens to develop projects which involve the planting of plants make things happen for themselves rather than expect others to do it for them read books help solve the issue encourage people	1. planting skills 2. how to make tools 3. identify the correct soil type 4. choice of an initial suitable area 5. planning skills 6. physical skills 7. pest control skills 8. preparation of the soil 9. knowledge of plants 10. mentoring skills 11. entrepreneurial skills 12. motivational skills 13. organizational skills 14. communication skills 15. watering skills 16. plant protection skills 17. fertilizing skills 18. caring for the plants skills 19. designing skills

QUESTION 1	QUESTION 2	QUESTION 3	QUESTION 4	QUESTION 6
SKILLS THAT SHOULD BE POSSESSED AFTER COMPLETING A COURSE ON PLANTS	**SKILLS THAT SHOULD BE POSSESSED AFTER COMPLETING A COURSE ON PLANTS & ENVIRONMENT**	**SKILLS NEEDED TO PRODUCE ENVIRONMENTALLY LITERATE CITIZENS**	**SKILLS NEEDED TO SOLVE ENVIRONMENTAL PROBLEMS**	**SKILLS NEEDED TO DEVELOP A SCHOOL GARDEN**
	skills to be able to know how plants and animals, including man, interact skills to be able to know which type of soil is the best to use for different plants.		from the community to make suggestions on how to solve the issue help people to become aware of the necessary legislation instill in people the fact that they need to be responsible for their actions knowledge of computer to access information and liase with other people who can help solve environmental issues introduce campaigns aimed at teaching the communities about nature conservation combine and make a string front so that their voice is heard when solving environmental issues affecting them.	

Question 5 was not included in the table. It was a very general question and the answer given most frequently was that, yes, man was the cause of many environmental problems, but by encouraging him to love and respect the environment and become actively involved in environmental projects, he could also help cure what ails it.

Answers 1, 2, 3, 7, 8, 9, 15, 17 and 18 of question 6 are positive indications that the participants understood what needed to be learnt for their school gardens to be developed. The participants had thought about these aspects a lot and bought into the project over the

nine months. They had appeared to actually garden and so had improved in these gardening skills.

The photos in Appendix F showed evidence of changes in the school gardens during the project. While all the gardens showed improvement, some gardens had improved dramatically while in others the progress was slower. Evidence of the improvement in these gardens was a positive indication that this project was a success when it came to being able to plant up a school garden.

5.C.4. Discussion around Question 1

These results showed that generally the teachers had a good idea of how to prepare the bed, even though only ten added compost and even fewer, only three, added fertilizer. This factor is important as much of the soil in the school grounds in Siyabuswa was sandy and sterile and the participants needed to know how to rectify this problem if any future planting was to be successful. They expressed a need for extra information on how to make compost and the composition of good soil and how to understand the functioning of fertilizer and that these aspects should be included in the booklet.

The evidence that shows the improved gardens at the end of the intervention illustrates that the learning cycle used had a positive learning effect. Thus this cycle could be looked at as a factor that promotes botany learning in the face of a huge documented collection of misconceptions and prior ignorance which are factors hindering the learning of botany.

The fact that the participants could not complete the self-evaluation written exercise of the steps they would take (in the correct order) to plant annual seedlings into the soil showed that even repetition was not sufficient to empower them with the skills to record their actions. This fact was a hindrance to the learning of botany.

The emulation of the protection of the plants with thorn branches by the participants was found at a later stage than the original baseline and this punctuated discovery fits the reflexive paradigm.

The group had been exposed to skills that were new to them. Although it appeared from the earlier results that the participants had internalised gardening skills, these latest results showed that even if this was the case, the participants were not putting them into practice. Factors that hindered this change may be:

- the participants were always provided with the plant material for practicing their skills to plant in their school gardens

- now they were being asked to find their own material or propagate it from the plants already in their garden
- Siyabuswa was not a community that could boast it had beautiful, full gardens, so plant material in the area was scarce. Thus to find new plant material was difficult
- there was also not a local nursery where plants could be purchased
- it was also not yet feasible that plants could be obtained by division as they had only been in the school gardens a relatively short time.

The aesthetic nature of the garden was not sustainable. When this course is run again, more time could be devoted to the acquisition of plants with the expenditure of little money. Also it is also essential that these impoverished areas be given enough water to adequately water their gardens in a water-wise way so that the teachers and students can produce gardens that they are proud of and that will remain sustainable for a long period of time.

Thus practical experiences with the commodities enabled change to be effected.

5.D. THE METHODS, OBSERVATIONS, RESULTS AND DISCUSSION RELATED TO QUESTION 2, HYPOTHESIS 1

The second research question investigates whether there was professional growth in the participants and looked at the skills required to actually develop a school garden. It was necessary to ascertain whether the use of these skills and the results of using them enabled the participating teachers to teach in an outcomes-based manner.

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:

Hypothesis 1: The participating teachers have improved their plant knowledge. This hypothesis addresses the knowledge domain of professional development.

5.D.1. Specific methods used to help improve the participants' plant knowledge

To obtain information regarding the teachers' plant knowledge, a questionnaire, "Knowledge on Plants and the Environment" Questionnaire (Appendix D) was given both at the beginning (21/7) and at the end of the intervention (15/11) as well as a practical botanical activity "Design a Plant" which was given on the 2/6.

i. KNOWLEDGE QUESTIONS ON "PLANTS" TEST

Looking at each of the questions in the test and the reasons for including them (Appendix D), questions 1 to 6 dealt specifically with the structure of the plant, knowledge which is fundamental to all botany teaching and learning therefore needed to be assessed to see whether the teachers have an understanding of the content that they need to teach.

1. What do you understand by the word "plant?"
2. What do you understand by the term "Angiosperm?"
3. What is a flower?
4. List the different parts of the flower and give their functions.
5. What do you understand by the word "seed?"
6. What do you understand by the word "fruit?"

Question 7 tested whether the teachers understood that water was essential for plant growth and so would be able to carry this knowledge over to the practical situation in their school gardens.

7. List why you think water is important for plants.

Questions 8 and 9 determined what general knowledge the participants had regarding plants.

8. List 5 plants useful to man.
9. List 5 plants that are not useful to man.

Questions 10 and 11 were included to assess whether the teachers had any idea of methods they could use to propagate plants to ensure that their school gardens were sustainable at a later date.

10. Explain the term "vegetative reproduction"
11. List 5 methods of vegetative reproduction and give actual examples in each case.

Question 12 was included to ascertain whether the participants had noticed which plants the roving livestock did not eat.

12. List 5 plants which animals, besides man, eat.

Question 13 and 14 determined whether the teachers had given any thought to the vegetables they actually ate and which part of the plant they were eating. These questions

were also included as this section in the syllabus lended itself to very easy and interesting practical work.

13. List 5 plants that man eats.
14. Name a plant that stores food in its:
    - leaves
    - stems
    - roots
    - seeds
    - flowers
    - fruits.

Questions 15 to 18 were included to determine the participants' ability to identify the different plant groups. Plants from all these groups could be included in their school gardens.

15. Write a short paragraph on what you know about algae.
16. Write a short paragraph on what you know about fungi.
17. Write a short paragraph on what you know about ferns.
18. Write a short paragraph on what you know about cone-bearing plants.

Questions 27 to 30 were included as soil is an integral part of the planting environment.

27. What is soil?
28. Why is soil important?
29. Name the three types of soil.
30. How can you test what type of soil you have?

ii. "DESIGN A PLANT" ACTIVITY

The method used to test hypothesis 1 qualitatively was to ask the participants to "Design a Plant" (Appendix I). This "Design a Plant" (Appendix I) exercise was given to the teachers after the structure of the plant had been introduced by means of charts (2/6). After the participants had completed the "Design a Plant" activity, some time was spent discussing the structure of plants using actual different specimens e.g. petunias, dianthus and agapanthus.

This activity tested the participant's plant knowledge directly, in particular:

- the parts of a plant
- the reproductive mechanism of the plant
- the different types of plants i.e. monocotyledon or dicotyledon.

The participants were asked to design a plant that was a non-woody dicotyledon or monocotyledon that lives for only one season i.e. it is an annual. The plant must be able to reproduce and live for generation after generation.

All this information was given to help the participants design their plant. Non-woody meant that the plant was herbaceous, annual meant that it died after a year so the design had to show the parts for its full life cycle, being a dicotyledon or monocotyledon meant that it had to have flowers that produced seeds for propagation.

There were flying insects and all the other usual creatures which live in a place such as this. This was the clue to its type of pollination and so to the structure of the flower.

The participants were asked to draw the plant they had designed. Drawing was included in this activity as it is a skill required in botany. FIGURE 5.1 “WHAT BIOLOGY PUPILS SHOULD BE ABLE TO DO”, illustrates that students are expected to communicate effectively by means of diagrams. This hands-on activity was also meant to assess whether the participants could identify the structure and relate it to the function of the different parts of the plant. It also determined whether the participants understood the processes that the plant underwent in its development.

The participants were then asked to match their drawn parts to actual parts obtained from live growing plants which were made available for the purpose. This exercise was given to determine whether the participants could adapt their theoretically gained knowledge to actual plant material.

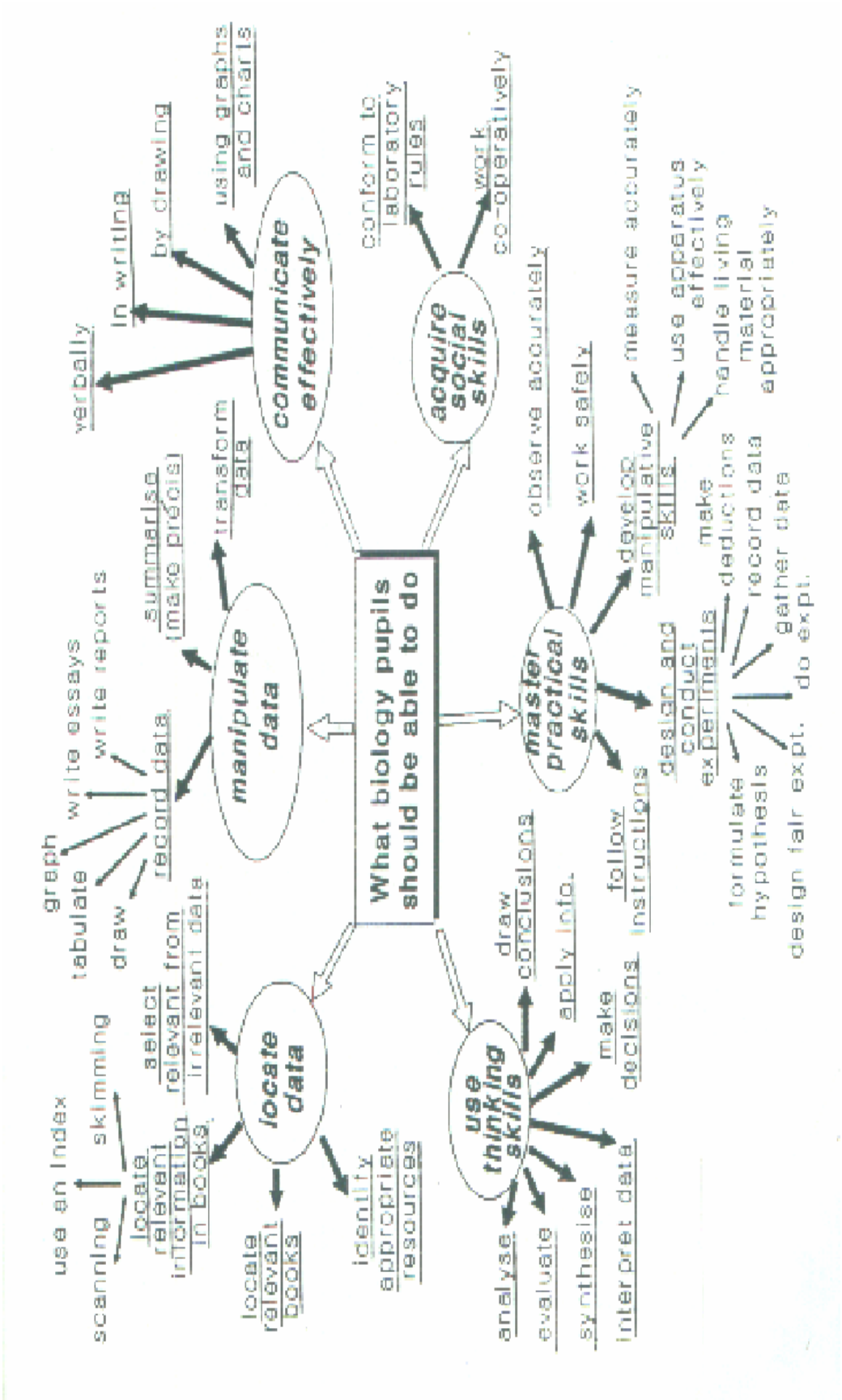

FIGURE 5.1. "WHAT BIOLOGY PUPILS SHOULD BE ABLE TO DO" (from workshop presented by M. Saunders at University of Witwatersrand – 1999)

5.D.2. The observations and quantitative results of question 2 (hypothesis 1) obtained by completing the "knowledge on plants and the environment" test

To determine whether the participating teachers had improved their plant knowledge, they were given the "Knowledge on Plants and the Environment Questionnaire" (Appendix D) to complete.

A major problem encountered with the results was that although the total number of participants who were involved in this project was twenty-seven, only fourteen completed the pre- and post-tests. A further problem was that of these fourteen, many did not give an answer to every question (Table 5.6).

TABLE 5.6. RESULTS OF WILCOXON RANK SUM TEST FOR COMPARING BOTANY KNOWLEDGE AND ENVIRONMENTAL QUESTIONS

Variable	N	Diff. In Mean	SD	P	Topic	Signifi-cance Level
Q1 (DFV1)	13	0,77	0,44	0,002	Plant	2%
Q2 (DFV2)	9	0,22	0,44	0,500	Angiosperm	Not
Q3 (DFV3)	14	0,0	0,55	1,000	Flower	Not
Q4 (DFV4)	3	0,0	0,0	-	Sepal	-
Q4 (DFV5)	5	0,0	0,0	-	Petal	-
Q4 (DFV6)	8	0,0	0,0	-	Androecium	-
Q4 (DFV7)	8	0,0	0,0	-	Gynoecium	-
Q4(DFV11)	4	1,0	2,70	1,000	Sepal function	Not
Q4(DFV12)	3	2,33	4,04	1,000	Petal function	Not
Q4(DFV13)	5	-1,6	4,15	1,000	Androecium function	Not
Q4(DFV14)	6	-1,5	3,21	0,500	Gynoecium Function	Not
Q5(DFV15)	13	0,15	0,38	0,500	Seed	Not
Q6(DFV16)	14	0,43	0,65	0,070	Fruit	10%
Q7(DFV17)	2	0,00	0,00	-	Photosynthesis	-
Q7(DFV18)	2	2,00	0,00	0,500	Nutrients in water	Not
Q7(DFV19)	2	0,00	0,00	-	Cool plant	-
Q7(DFV20)	1	0,00	-	-	Softens soil	-
Q7(DFV22)	9	0,00	0,00	-	Helps plants grow	-

Variable	N	Diff. In Mean	SD	P	Topic	Signifi-cance Level
Q7(DFV23)	3	0,00	0,00	-	Keeps plant firm	-
Q10(FV35)	13	0,31	0,48	0,125	Vegetative reproduction	Not
Q11(FV36)	7	0,00	0,00	-	Stem cuttings	-
Q11(FV37)	4	-5,50	11,0	1,00	Roots	Not
Q11(FV38)	0	-	-	-	Grafting	-
Q11(FV39)	3	0,00	0,00	-	Leaves	-
Q11(FV40)	2	0,00	0,00	-	Budding	-
Q11(FV41)	0	-	-	-	Splitting	-
Q11(FV42)	5	-2,60	2,50	0,25	Example of stems	Not
Q11(FV43)	3	2,00	1,73	0,50	Example of roots	Not
Q11(FV44)	0	-	-	-	Examples of grafting	-
Q11(FV45)	0	-	-	-	Example of leaves	-
Q11(FV46)	1	1,00	-1,00	1,00	Example of buds	Not
Q11(FV47)	0	-	-	-	Examples of splitting	-
Q12 (SV1)	14	0,86	1,46	0,06	Plant animals eat	10%
Q13 (SV2)	14	0,5	1,45	0,38	Plants man eats	Not
Q14a (FV58)	13	-0,23	0,83	0,53	Leaves food	Not
Q14b (FV59)	13	4,07	11,54	1,00	Stems food	Not
Q14c (FV60)	13	4,62	10,39	0,03	Roots food sweet potato	5%
Q14d (FV61)	12	-3,92	12,85	0,34	Seeds food	Not
Q14e (FV62)	10	2,70	9,63	0,59	Flower food	Not
Q14f (FV63)	11	-1,18	4,40	0,72	Fruit food	Not
Q15 (SV3)	14	1,00	1,11	0,02	Algae	5%
Q16 (SV4)	14	0,71	0,99	0,03	Fungi	5%
Q17 (SV5)	14	1,50	1,65	0,01	Ferns	5%
Q18 (SV6)	14	0,29	1,38	0,52	Gymnosperm	Not
Q19 (FV99)	14	-0,14	0,36	0,50	Environment	Not
Q20 (FV100)	14	0,00	0,00	-	Man part environ	-
Q20 (FV101)	14	-1,93	3,25	0,05	Why man part of	5%

Variable	N	Diff. In Mean	SD	P	Topic	Signifi-cance Level
					environment	
Q24 (FV102)	14	0,00	0,00	-	Environment affects plants	-
Q24 (FV103)	11	-1,00	1,95	0,16	How environment affects plants	Not
Q24 (FV104)	5	0,60	1,95	1,00	How environment affects plants	Not
Q25 (SV16)	14	-0,07	1,33	0,94	Plants need environment	Not
Q26 (FV111)	12	0,00	0,43	1,00	Environment conditions wrong	Not
Q27 (FV112)	12	-0,17	1,75	0,84	Soil	Not
Q28 (FV113)	14	-0,93	2,34	0,20	Soil NB	Not
Q29 (FV114)	14	0,00	0,00	-	1 type soil	-
Q29 (FV115)	14	0,00	0,00	-	2 type soil	-
Q29 (FV116)	14	0,00	0,00	-	3 type soil	-
Q30 (FV117)	11	-0,27	1,85	0,74	Test soil	Not
TOTAL TEST	14	9,43	7,04	0,0004		Yes

The statistical analysis procedure used in this test was the NPAR1WAY procedure of the SAS package SWO9001 – WD390710 – T01032 of data set G10TG13) which performs non-parametric tests for location and scale differences across a one-way classification. PROC NPAR1WAY also provides a standard analysis of variance on the raw data and statistics based on the empirical distribution function using a Wilcoxon response variable. Additionally the PROC NPAR1WAY provides tests using the raw input data as scores. When the data are classified into two samples, tests are based on simple linear rank statistics. PROC NPAR1WAY also calculates the following empirical distribution function statistics: the Kolmogorov-Smirnov statistic and the Cramer-von Mises statistic. These statistics test whether the distribution of the variable is the same across different groups.

TABLE 5.7. SIGNIFICANT RESULTS OF WILCOXON RANK SUM TEST FOR COMPARING SELECTED BOTANY KNOWLEDGE AND ENVIRONMENTAL QUESTIONS

VARIABLE	P	TOPIC	SIGNIFICANCE LEVEL
Q1	0,002	Plants	2%
Q6	0,070	Fruit	10%
Q12	0,060	Plants that animals eat	10%
Q14c	0,030	Roots – food, sweet potato	5%
Q15	0,020	Algae	5%
Q16	0,030	Fungi	5%
Q17	0,010	Ferns	5%

There was an overall difference between the total pre- and post-test "plant and environmental knowledge" test scores (irrespective of whether the participant's answers were matched in the pre- and post-test) which was significant at the 2 per cent level. This indicated that the intervention that these teachers underwent increased their plant knowledge dramatically.

When the overall test was looked at with matched question answers, the post-test total score was 881 compared to the pre-test total score of 749 for the 14 participants who answered both the pre- and post-test. This was significant at the 0,04 percent level which again indicated that the intervention resulted in a marked increase in the participants overall botany knowledge.

5.D.3. The observations and qualitative results of question 2 (hypothesis 1) obtained by completing the "designing a plant" activity

The results obtained from the "Design a Plant" activity showed that ten teachers designed a dicotyledon while seven designed a monocotyledon. The extra information given in the activity was lost on the majority of the teachers and their designed plants did not indicate that they grasped the clues.

1. Annotated drawing of a leaf of your plant.

"Annotated" was a word that many of the teachers were not familiar with. Their answers were meant to explain their labels. This only happened in five instances. Two teachers did not label their leaves at all, one drew the whole plant and one said her plant was a monocotyledon (which was correct) and then drew a dicotyledon leaf. This instance is disconcerting as it shows poor observation skills. The participants had had previous experience in labelling the

diagram of a plant, yet when asked to describe the function of each part they were unable to do it.

2. Annotated drawing of the stem of your plant.

The diagram of the stem was very badly done. Only two teachers mentioned the nodes and internodes, yet this is fundamental botanical knowledge.

3. Annotated drawing of the root system of your plant.

There is a definite lack of detail in most of the drawings. Drawing appears to be a skill that the teachers have not been taught or encouraged to use regularly. The majority of the teachers understood that monocotyledons have adventitious roots and dicotyledons have taproots but the detail did not show in their diagrams.

4. Annotated drawing of the flower of your plant showing the number of each of the parts.

The flower drawings done by the teachers who said their plants were monocotyledons were all incorrect. Only one knew that the parts had to be in multiples of three, but her diagram had no labels or detail. Five of the teachers drew the mealie plant and flower. This is disturbing, as there were no mealie plants presented to the group. The onion and agapanthus plants were the only monocotyledons evident. It has already been mentioned in Chapter 2 that the “bean” and the “mealie” are studied over and over in the different grades. This may be ascribed to:

- for these teachers the word “monocotyledon” is synonymous with “mealie” and they did not think any further
- these teachers have not been trained to observe carefully
- these teachers have not handled actual plant material

Those teachers who had dicotyledons as their plants fared better, but there were still basic problems in their knowledge about flowers. Only three indicated that they understood that dicotyledon flowers have their parts in multiples of four or five and only one of these teachers had the numbers of the parts in each whorl correct i.e. five petals, five sepals, five stamens and one gynoecium. The majority of the drawings were the usual textbook drawings even though they were given hand–lenses and actual plant material.

5. Annotated drawing of what the ovary will become after the egg has been fertilized.

This question was very badly answered. Goodwin (1991) has found in previous research that most teachers battle to understand the life cycle of the flowering plant, especially what

happens to the flower after it dies. This group of participants showed no exception. Four teachers said the ovary would swell. Only three said it would form the fruit with seeds inside.

6. Annotated drawing the seed of your plant.

This question again brought up the teachers' perception of seeds that they had studied i.e. the bean and the mealie, and these were the drawings that they presented. None of the teachers actually looked for seeds in their old flowers.

7. Definition of pollination

The majority of the teachers understood the basic concept of the transference of pollen to the stigma of the same or another flower but only four were specific about the stigma being receptive to the pollen for pollination to be able to occur.

8. How will your plant be pollinated?

This question required the teachers to re-read the question. They were told that there were flying insects and all the other usual creatures living with their plants.

Below are the different pollinating agents given:

- self-pollinated 3
- bees 1
- water 1
- wind 1
- man and animals 1

The rest of the answers were incorrect with the agents being two or more, not one i.e. wind, water, bee and bird. Pollination may have been confused with dispersal.

9. Definition of dispersal

Dispersal is the distribution of the seeds. Eleven teachers answered this question correctly.

10. How will your plant's seeds be dispersed?

- wind 3
- man 2

The rest of the teachers appeared to just list the agents of dispersal together i.e. wind, birds, insects and man. This appears to be done from their rote learning about dispersal, with little understanding. They did not comprehend that their plant would be adapted to a particular type of dispersal i.e. small light seeds for wind and maybe barbs for animal dispersal.

11. Definition of germination

This is the development of the embryo inside the seed coat and the process is complete when the radicle starts to emerge. Only one teacher stated it correctly as “the first step of the embryo growing up after fertilization”. The majority said it was the start of new life.

12. What are the best conditions for the seed germinate?

This question was well answered with most teachers listing air, warmth, moisture and good soil as being the best conditions for seed to germinate under. Some said that sunlight was necessary, again indicating that they were muddling up germination and growth.

13. Name four adaptations your plant has which will help it to live and compete successfully generation after generation

This question was very poorly answered. Fifteen teachers answered it incorrectly. This could be due to the teachers not understanding the English of the question. They were asked to name four adaptations of their plant – they listed four environmental conditions for favourable growth. The two teachers who did answer it correctly said that their plant would grow fast during favourable conditions and survive unfavourable conditions as seeds. Their plant would also have deep roots.

14. Sketch the life cycle of your plant (indicate the seasons)

The teachers were asked to draw the life cycle of their plant. One used only words. Only one teacher drew the life cycle correctly but he left out the seasons that the different stages occurred in. Two other teachers got the concept basically correct but their answers exhibited minor errors such as:

- one drew leaves independent of the plant
- one did not draw the stages in a cyclic fashion

The other thirteen had great difficulty in answering this question and basically did not show any signs of understanding the actual development of the flowering plant.

15. Choose an equivalent part from the specimens provided (if the part is available) and build up your plant. Glue the parts down on a sheet of paper in the appropriate places

Here again the teachers had to state whether their plant was a monocotyledon or dicotyledon and use the actual plant material stuck down in the appropriate places:

- two teachers produced a totally correct monocotyledonous plant, while five produced a totally correct dicotyledonous plant.
- four other teachers did not follow the instructions correctly. They did not stick the parts of the plant down in the correct places but just randomly on the sheet of paper.
- five other teachers stuck dicotyledon flower parts onto what were until then monocotyledon plants.
- one teacher did not stick down any flower parts.

5.D.4. Discussion around question 2

Looking at the some of the individual questions in “Knowledge of Plants and the Environment” test (see also Appendix D for the remaining questions):

- there was a dramatic increase, after the intervention, in the participant’s understanding of what constituted a plant. The correct answer had to include the fact that photosynthesis occurred in the organism, thus it was able to make its own food (Question 1)
- “the structure of the flower and the function of its parts” questions were very poorly understood. These results were disturbing as the structure and function of the flower are fundamental to any botany teaching and are topics that should be covered year after year in school. Sadly however, as can be determined through even a cursory examination of tertiary syllabi or by talking to botany lecturers these topics are not covered in any detail at the tertiary level as it is assumed that students are familiar with them (Question 4)
- the fact that there is a significant difference in the pre- and post-test scores for the participants understanding of a “fruit” indicates that the teachers understood the life cycle of the flowering plant more thoroughly (Question 6)
- many of the participants could not list ways they thought water was important for plants and even after nine months of being told to water their plants, many of the teachers still did not see the need to do so. This could account for many of the school gardens not being sustainable (Question 7). Another factor could be emerging here, namely that the participating teachers wanted a beautiful garden, but were not prepared or were ill equipped to maintain it
- the actual plant examples exhibiting the different types of vegetative reproductive methods was very poorly answered. Correspondingly this area needs a lot of

attention. Pedagogically it is an ideal place for hands-on experiences (Questions 10 and 11)

- the improvements in the answers to the question that asked the teachers to name specific plants that stored food in different parts of the plant were encouraging as this formed a large part of the syllabus for grade six. This improvement could have been due to the fact that the participants actually did lessons using plant parts that store food (Question 14)
- it was evident from the results that the teachers knew very little about algae, fungi, ferns and gymnosperms before the intervention. With the exception of the Gymnosperms, there was a significant increase in the participant's knowledge on algae, fungi and ferns after the intervention The scope of "plants" is so broad and these sections could have had more time spent on them or left out altogether. Possibly if an intervention of this kind is done again the time allocation should be remedied (Questions 15, 16 and 17).
- it was found that "soil" was a topic that was very well covered in the schools both knowledge-wise and practically. This was encouraging seeing as so much time of the project was spent planting material into soil (Questions 27, 28, 29 and 30)

The "Design a Plant" (Appendix I) activity shed light on the level of botanical knowledge of the participants. The results showed the factors that could hinder change in the teaching of botany. These included:

- the participants' difficulty in selectively extracting given knowledge
- their drawing skills were very poor
- they did not understand the life cycle of the flowering plant
- they could not adapt theory to practice
- they did not know the differences between monocotyledons and dicotyledons. They have learnt about these two groups for many years but they are still not able to change rote learning into understood knowledge.
- they had not been trained how to observe carefully and this very basic fundamental life skill is not something that can be achieve in a short space of time
- they did not know how to use hand-lenses initially but were competent with them by the end of the programme which proves that hands on activity in this instance was successful
- they did not read the questions carefully. When asked to make a sketch they used words
- their mastery of the English language is poor and this can hinder their understanding and ability to follow instructions.

These results were generally poor and showed a large gap in the teachers' knowledge about plants. The overall results showed that many did not understand the features which made a

plant a monocotyledon or a dicotyledon. What was evident was that the teachers were, in many instances, able to recall the parts of the plant that they had learnt by rote, but there was very little understanding of this learning. They were not able to extract selective knowledge. They showed very little evidence of having handled or observed actual plant material before this exercise. Their drawings were also very primitive and lacked scientific rigour.

It was very obvious that these teachers needed help in gaining practical botanical content knowledge which would help them improve in their professional development.

5.E. THE METHODS, OBSERVATIONS, RESULTS AND DISCUSSION RELATED TO QUESTION 2, HYPOTHESIS 2

Having looked at the skills required to actually develop a school garden it was necessary to ascertain whether the use of these skills and the results of using them enabled the participating teachers to teach in an outcomes-based manner.

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 2:

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. This hypothesis addressed the pedagogical aspect of professional development.

As mentioned before **Question 2** investigated whether being able to develop the "Gardening with Flora" booklet improved the participants' professional development, specifically with respect to botany teaching. It gave rise to **Hypothesis 2,** namely that 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. This will be reviewed by means of the following qualitative methods:

- the development of resource material
- videos of some of the participating teachers actually presenting botany lessons using plant material and process skills
- an observation matrix of the teachers analysing their peers

The reason for the viewing the booklet as a vehicle for engagement and change was because the Department of Education, in its 1998 Norms and Standards for Educators document, states that a teacher will be required to act as a designer of learning programmes and

materials. An aim of C2005 (Centre for Education Policy Development [2000] and Chisholm, L. [2000]) was that teachers needed to generate their own content and use their specific environment as the basis for their teaching. A purpose of compiling the booklet was so that the participants could act as knowledge creators and synthesisers which is one of the roles of outcomes-based education. The underlying philosophy of the "Gardening with Flora" booklet was thus the outcomes-based teaching approach.

It was decided to develop the "Gardening with Flora" booklet and determine its value in positively changing the attitudes, knowledge and skills of gardening as well its ability in improving the use of process skills in the teaching of the participating teachers. It was found that few rural schools had developed their school grounds (see Appendix F photos 14, 25, 39, 41, 44, 81 and 86). Factors that have been responsible for this lack of development include the teachers' lack of knowledge about how to plant the actual plants. In addition there was a definite lack of written resources which could have helped.

Thus the reasons for developing this resource include:

- the teachers indicated a lack of knowledge about how to plant the actual plants (see Chapter 4 Question 4.9 - Sheet 9)
- the teachers did not consider the school garden being a local environmental issue that they could relate to (see Chapter 4 Question 4.2A10 - Sheet 4.2A)
- the teachers did not see the garden as having the potential to be used as a resource for teaching so that their teaching methodology could be improved (see Chapter 4 Question 4.7 - Sheet 7)
- the development of their garden should help them to learn more about plants in a relevant way.

The compilation of the booklet "Gardening with Flora" was seen as an attempt to help improve the participants' professional growth. Much current professional development involves traditional lectures to convey science content and emphasis on technical training about teaching (National Science Education Standards, 1996). The professional preparation of teachers is often separated or disjointed. Hewson & Hewson (1988) emphasized that this separation occurred when prospective teachers learned pedagogy dissociated from subject matter. Some science education reform efforts have recently begun to bridge the gap between the pedagogical and content aspects of science teacher preparation by advocating the development of a cohesive knowledge base. Shulman (1986) developed a framework for teacher education by introducing the concept of "pedagogical content knowledge" (PCK). He described "pedagogical content knowledge" as the knowledge formed by the synthesis of three knowledge bases:

- subject matter knowledge
- pedagogical knowledge

- knowledge of context.

Thus, rather than viewing teacher education from the perspective of content or pedagogy, Shulman (1986) believed that teacher education programmes should combine these two knowledge bases within a specific context to more effectively prepare teachers for teaching. The use of "pedagogical content knowledge" as a topic for research and discussion about the nature of an appropriate knowledge base for developing future science teachers has steadily increased since its inception (National Research Council, 1996: National Standards Teaching Authority, 1999: Tobias, 1999). It was intended that the booklet "Gardening with Flora" had "pedagogical content knowledge" as its underlying focus.

5.E.1. Specific methodologies used to improve pedagogical aspects of professional growth.

i. DEVELOP THE "GARDENING WITH FLORA BOOKLET"

Hypothesis 2 investigated whether the participating teachers were using outcomes-based methods while teaching biology. One method used to assess this hypothesis was to develop the resource material, namely the "Gardening with Flora" booklet and then determine whether the approach advanced in the booklet was being implemented in the classrooms.

At the beginning of the project it was envisaged that the development of the booklet would be done primarily by the participants. As the project progressed it became evident that this would not be the case. Although the teachers had all attended a computer course their typing skills were very rudimentary and thus the typing and layouts had to be done for them. The teachers had also said initially that they could do the artwork, but again, due to time constraints, this was not possible. These shortcomings did not detract from the final outcome. The fact that the teachers developed and used the booklet was of more significance and was to some extent ascribable to them having been part of its design, hence they were committed to its heart.

The participants identified the following for inclusion in the booklet:

- what content or minds-on teaching and learning activities needed to be investigated in order to develop the school grounds? – plant knowledge
- what content needed to be taught or developed in order for the selected plants to grow well? – science foundations
- what skills or hands-on teaching and learning activities needed to be taught or developed to actually develop the school grounds?
- which plants should be included in the garden and why?

The booklet would also list where the topics could be used in the syllabus and the critical outcomes.

As the group would be basing the booklet on the biology curriculum they would need to know what was contained in the syllabus and which plants could be used to teach each topic effectively. The participating teachers as a group brainstormed the topic “plants” and produced a mind map of what should be included in the book. The participants were then given the current syllabus (Gauteng biology syllabus - Appendix B) and after plenty of discussion the group produced a revised set of botanical topics for each grade for inclusion in the booklet (see page seven and eight of the booklet – Appendix J).

The booklet was not developed in isolation, but rather within the time frame of the whole programme and fitted into the time-line of the fourteen months. It would be environmentally based and include the necessary knowledge, skills and attitudes to teach biology to grade 1 - 7. The critical outcomes (Chapter 2) were included in policy and so the participants argued that these should be itemized in the booklet and are outlined on page eight. The outcomes that needed to be achieved with their teaching would include as many of the specific and critical outcomes as was feasible. Activities, which would reflect how the learners would be engaged in working towards the achievement of the critical outcomes, would also be included.

As the year progressed and the participants handled actual plant material with their students, the participants were asked to prepare lesson plans (14/4 and 21/7) for inclusion in the booklet.

The participants were asked to draw a plan of their own home garden (between 2/6 and 21/7). They were also asked to name the plants in their own garden. The participants were also asked to find out from their students which of them had gardens at home.

Many teachers cited a lack of tools as reasons for not having a well-developed school garden and so activities outlining how to make them were included in the booklet (see Appendix F, photo 16 and booklet p 11 and 12). Poor soil was another factor for poorly developed gardens and so the teachers wanted the recipe of how to make a compost heap included in the booklet (see Appendix F, photos 48 and 50 and booklet p 16).

Trees and shrubs were also planted in some school gardens and fertilizer had to be used. The participants had indicated that they knew very little about plant nutrition and so they wanted this topic to be included in the booklet (see p 17).

To try to get the teachers to look at their school gardens holistically and understand that animals interact with plants they were taught how to build a pond and this skill was also to be included in the booklet (see Appendix F, photos 3, 29, 62, 63, 71, 98, 99 and 101).

Sexual and asexual propagation methods needed to be included in the booklet to support sustainability of the gardens. The participants were shown how to take cuttings, how to split plants and how to collect ripe seeds (see Appendix F, photos 13, 15, 23, 26 and 34 and booklet pp 39 - 42).

Some time was spent showing the teachers involved in the Siyabuswa project various alien species of plants which needed to be eradicated. They were then asked to check their school gardens for these plants and eradicate them (see Appendix F, photos 103 and 110 and booklet p 54) and this aspect was also to be included in the booklet.

ii. OBSERVE CLASSROOM LESSONS BY MEANS OF VIDEOS

Hypothesis 2 was investigated qualitatively by videoing some of the participating teachers presenting lessons (21/9). The results from the video showed generally that when materials were used they had a positive effect on the classroom interaction. The students were engaged in constructive discourse with each other. As a group they successfully organized the task at hand and generally the learning environment appeared to be a happy one with the beginnings of students volunteering ideas and explanations for results.

This activity highlighted areas where teachers were using actual plant material instead of just talking about it. The five volunteer teachers that were actually videotaped presented the following lessons:

1. The structure of a plant - teacher 8
2. The differences between monocotyledons and dicotyledons - teacher 1
3. Fruit and vegetables - teacher 6
4. Making garden tools from recycled material - teacher 2
5. Useful plants - teacher 17

PRIMARY SCIENCE PROCESS SKILLS
OBSERVING - this skill not only means looking closely at things, but- using all the senses to get information.
MEASURING - before any results can be obtained it is necessary to measure. This is a most important skill. Not only how to measure, but also how to measure accurately and the correct units to be used.
COMPARING - with this skill we are looking at two different things. Looking for difference and also where they may have the same properties.
INVESTIGATING - again a very important skill, searching for patterns, trying to see what the properties are for different sorts of things.
CLASSIFYING - this skill means that we are sorting things out or putting them into classes. Once we have put things into a class, we have some idea about their properties.
COMMUNICATING - telling other people about our experiment, not only writing but also describing it in words to another child. Making graphs or pictograms as well as many other methods.
MAKING A HYPOTHESIS - this is a higher skill but well within the grasp of older children. It means trying to give a theory or explanation and then seeing by experiment if this works or not.
PREDICTING - saying what will happen before it does. Having established a pattern it is then possible to use this pattern to predict what will happen in the future e.g. the weather.
INTERPRETING DATA - looking at the results obtained from an experiment and then trying to put these into some kind of pattern. Trying to see what might be done in future experiments.
CONTROLLING VARIABLES - being fair in an experiment and changing one thing at a time so that we know what is happening and which different things (variables) we can change.
EXPERIMENTING - the highest skill, since all the other skills are combined together, deciding on our hypothesis, designing an experiment to test this, carrying out the experiment and then recording the results.

FIGURE 5.2. PROCESS SKILLS

iii. THE UTILISATION OF THE "TEACHING OBSERVATION SCHEDULE"

The "Teaching Observation Schedule" (Appendix K) looked specifically at process skills. In anticipation of observing both the traditional and transitional models of primary science teaching, the matrix for the "Science Teaching Observation Schedule" was used. This matrix has two main sections, one focusing on teacher-centred and process-thinking patterns which is characterized by plenty of teacher statements of facts and principles and request of students to recall statements and principles (Appendix K - Form 1) and the other focusing on group-centred and process-thinking patterns which is characterized by student involvement in group work and questions involving hypothesizing and explanation (Appendix K – Form 2).

The “Science Teaching Observation Schedule” captured the use of teacher- versus enquiry-centred styles. For example, the teacher centred style was characterized by plenty of teacher statements of facts and principles and request of students to recall statements and principles. On the other hand, enquiry-centred teaching was characterized by students' involvement in group work and questions involving hypothesizing and explanation.

Categories were included which characterized a teacher-centred enquiry approach - i.e. the teacher actively soliciting the use of process skills from the students, including observation, inference, explanation etc.

The observing teachers were asked to record what activity was undertaken in the space of every two minutes. The observers were not asked to reveal their identities and so they were given an identification number at random. The lessons each lasted thirty minutes. I replayed the video at a later date and recorded my own observations of the lessons in the matrix. All the participating teachers were observed for the purpose of being analysed by means of the matrix and to determine their use of actual plant material and to give the other teachers ideas on teaching strategies for the different topics.

Form 1 quantified the task activities that the group were involved in such as making observations, raising questions, suggesting explanations, predicting, finding patterns, planning investigations, handling materials, measuring and recording. It also indicated the interactive tasks between the teacher and the students i.e. asking about topic, asking for help about procedure, answering teacher’s questions (recall), answering teacher’s questions (ideas), reporting/explaining actions and listening to the teacher. It also enabled the group dynamics such as organizing task (co-operatively), organizing task (argument), talk about topic, talk about report, non-topic talk, listening to other’s ideas, independent working and number actively working to be quantified.

Form 2 documented the observations of the teacher. The verbal activities included:

- asking questions requiring recall
- asking questions requiring students’ ideas
- asking for description of work
- asking questions for control
- answering student’s question
- answering own question
- explaining meaning of words
- commenting on students’ work or answers
- asking students to comment on each others answers
- giving information

- giving instructions and referring to worksheet (see Table 5.9)

Form 2 also looked at the non-verbal activities of the teacher such as “uses blackboard to record students’ ideas”, “uses blackboard for other purposes”, “organizes/distributes equipment”, “demonstrated activity”, “helps with use of specific equipment”, “listens to students” and “observes students/not interacting” (see Table 5.9).

Peer teachers completed a “Science Teaching Observation Schedule” (Appendix K) while observing these lessons.

5.E.2. The observations and qualitative results of question 2, hypothesis 2 obtained by developing the “gardening with flora” booklet

The participants’ professional development, specifically with respect to botany teaching, was measured to see if it had improved with the development of a school garden and participation in the production of a booklet on how and what to plant in a school garden.

Only three participants handed in the drawing of their home garden. The participants approved of including this activity in the booklet so that teachers using it would hone in on it and so improve in their skills and knowledge. One of the teachers had an extensive list of names and her good knowledge of plants was becoming evident. It was discovered that she actually ran a small business selling plants she had potted up and also those that she arranged in vases. Plants that she had growing in her garden included elephant’s ears, Spathyphyllum, wondering dew, rubber tree, roses, avocados, clivia, privet, hen and chick, chrysanthemums, phoenix palms, carnations, osteospermum, bauhinia, lettuce, gazania, ferns, beetroot, petunia, agapanthus, ageratum, crassula, conifers, guava, litchi, grapes, spinach, pelargonium and arum lilies. These plants were a good starting point for examples to be included in the booklet as easy ones to plant. The fact that the other participants did not hand in this activity, led to the conclusion that they did not know the names and thus it was these plants which needed to be included in the booklet. The participants were also asked to find out from their students which of them had gardens at home. Although only six teachers returned this questionnaire, it showed out of one hundred and ninety-two students only thirty-seven, (19 per cent) did not have a garden at home. Possibly the concept of “a garden” was not defined clearly enough.

The photos in Appendix F showed evidence of changes in the school gardens during the project. The participants had utilized the outcomes-based activities which were to be included in the booklet. Evidence of the improvement in these gardens was a positive indication that hypothesis 2 was supported and that the development of the booklet became a teaching and learning aid that when used, enabled a school garden to be planted up successfully.

Nine months after the course had been completed, the participants were asked to complete a questionnaire reflecting on their present usage of booklet "Gardening with Flora" (Figure 5.3) that they had helped compile. Only 12 members of the original group of 27 were present to complete this exercise.

Answer the following questions as truthfully as possible:

1A. Have you read the book "Gardening with Flora" from cover to cover? Y N

1B. If your answer to 1A was "NO", have you read about 50 per cent of the book? Y N

2. How many activities from the book have you done with your class this year?
   Results:
   A = 0
   B = 1-5
   C = 6-10
   D = >10

3. Did you share any of your activities with you colleagues? Y N

4. Did you go to the Siyabuswa hardware for anything related to your teaching of plants? Y N

5. Did you try to raise funds to develop your school grounds? Y N

6. Did you take your class outside into the school grounds for a lesson this year? Y N

7. Have you talked to your principal about this project? Y N

8. Have any of your colleagues showed an interest in going on a similar gardening course? Y N

9. Would you like to see this course being re-given? Y N

10. If yes, in what format?

FIGURE 5.3. REFLECTIONS ON USAGE OF BOOKLET "GARDENING WITH FLORA"

This questionnaire was used to investigate the participants' usage of the "Gardening with Flora" booklet.

TABLE 5.8. RESULTS ON THE USAGE OF THE BOOKLET "GARDENING WITH FLORA"

Teacher	Q1A	Q1B	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1	N	N	B	N	N	N	Y	N	Y	Y
5	N	N	B	N	N	Y	Y	Y	Y	Y
6	N	N		Y	N	N	Y	Y	Y	Y
8	N	Y	B	N	N	N	Y	N	N	Y
9	N	Y	B	N	N	N	Y	N	Y	Y
10	N	Y	B	Y	Y	Y	Y	Y	Y	Y
11	N	Y	B	Y	N	N	Y	Y	Y	Y
14		Y	C	Y	N	N	Y	Y	Y	Y
15	N	Y	B	Y	N	Y	Y	Y	Y	Y
16	N		A	N	N	N	Y	Y	Y	Y
18	N	Y	B	Y	N	N	Y	N	Y	Y
23	N	Y	B	Y	N	N	Y	N	Y	Y
% Y	**0**	**66,7**		**58,3**	**8,3**	**25,0**	**100,0**	**58,3**	**91,7**	**100,0**

The results obtained were as follows:

- 67 per cent said that they had read at least 50 per cent of the booklet.
- The majority of the group had used between one and five activities from the booklet in their teaching.
- Due to the participants sharing their activities with their colleagues (58 per cent) many students were receiving outcomes-based lessons
- Some of the participants (25 per cent) had tried to raise funds for their school grounds
- All the participants said that they had taken their class into the garden for at least one practical lesson.
- All but one of the participants said that their colleagues had expressed interest in attending a similar gardening course.

5.E.3. The observations and qualitative results of question 2, hypothesis 2 obtained by videoing the participants conducting lessons

The video recordings that were made faithfully reflected the interactions in the classroom. The results recorded under "Z" in Tables 5.9 were those taken directly from the viewing the video at a later stage. The discrepancies uncovered between the analysis derived from the video and those recorded by participants present at the lesson are disturbing but can be explained by the observing technique being new to the participants, their poor interpretation of the written words, their inability to concentrate for the whole lesson and them being distracted by

their surroundings. In some instances the observing teachers forgot that they were meant to be observing the behaviour of the students and tended to record the teacher's actions.

The recordings show that the teachers were no longer only involved in demonstrations or text book learning. Their students were actually involved a great deal of the time in handling the actual plant material. They also showed that the students still spent a lot of time listening to the teacher and answering low level questions involving recall. Most of the students handled group work well and interacted in a positive way with each other.

5.E.4. The observations and quantitative results of question 3, hypothesis 2 using the "science observation matrix"

TABLE 5.9. RESULTS OF "SCIENCE OBSERVATION MATRIX"

	TEACHER 8					TEACHER 2					TEACHER 6					TEACHER 1					TEACHER 17					
	H	**I**	**J**	**Z**	**Ave**	**P**	**Q**	**Y**	**Z**	**Ave**		**ZG**	**ZH**	**Z**	**Ave**	**ZT**	**ZU**	**ZV**	**Z**	**Ave**			**ZAJ**	**ZAK**	**Z**	**Ave**
Asks questions requiring recall	2	2	5	2	2,8	1	2	2	0	1,3		8	13	0	7,0	3	3	3	0	2,3			4	3	2	3,0
Asks questions requiring ideas	0	6	4	0	2,5	4	5	4	0	3,3		9	13	9	7,3	4	2	2	4	3,0			9	3	4	5,3
Asks for description of work	3	4	4	1	3,0	1	0	5	0	1,5		6	11	0	5,7	1	1	2	0	1,0			4	3	0	2,3
Asks questions for control	1	4	6	0	2,8	2	6	2	0	2,5		5	9	0	4,7	2	10	1	0	3,3			2	3	0	1,7
Answers pupil's question	1	3	3	0	1,8	2	0	0	0	0,5		8	3	0	5,2	0	0	2	0	0,5			0	1	0	0,3
Answers own question	1	0	3	0	1,0	2	4	5	0	2,8		4	12	2	6,0	0	0	0	1	0,3			0	1	0	0,3
Explains meaning of words	0	2	3	1	1,5	2	5	0	3	2,5		6	13	6	8,3	4	2	2	1	2,3			3	1	0	1,3
	K	**L**	**O**	**Z**		**AA**	**AB**	**AD**	**Z**			**ZI**	**ZJ**	**Z**		**ZW**	**ZX**	**ZY**	**Z**			**ZAL**	**ZAM**	**ZAN**	**Z**	
Comments on pupils' work	1	0	1	1	0,8	0	1	1	1	0,8		4	0	1	1,7	0	1	1	3	1,3		4	4	0	0	2,0
Pupils comment on each other	5	5	0	0	2,5	0	0	0	0	0,0		9	4	1	5,2	2	1	1	0	1,0		2	0	0	0	0,5
Gives information	5	7	0	2	3,5	5	11	1	7	6,0		4	4	10	6,0	0	1	1	0	0,5		3	2	5	6	4,0
Gives instructions	2	3	1	5	2,8	11	3	1	1	4,0		6	10	2	6,0	3	8	9	2	5,5		3	5	3	1	3,0
Refers to worksheet	0	0	0	0	0,0	0	0	1	0	0,3		0	0	0	0,0	0	0	0	0	0,0		0	0	4	0	1,0
Other (write in)	2	3	0	0	1,3	1	1	0	0	0,5		2	0	0	0,7	0	1	2	0	0,8		0	0	0	0	0,0
		M	**N**	**Z**			**AC**	**AE**	**Z**		**ZI**	**ZJ**	**ZL**	**Z**		**ZW**	**ZZ**	**ZAA**	**Z**					**ZAN**	**Z**	
Uses b/b record pupils' ideas		0	0	0	0,0		2	5	2	3,0	5	1	1	4	2,8	0	0	0	0	0,0				2	1	1,5
Uses b/b for other purposes		1	0	2	1,0		1	0	0	0,3	0	3	0	0	0,8	0	0	0	0	0,0				0	0	0,0
Organize/distribute equipment		2	2	2	2,0		2	4	3	3,0	7	3	2	6	4,5	7	0	0	1	2,0				8	1	4,5
Demonstrated activity		4	2	1	2,3		9	5	2	5,3	3	3	3	2	2,8	0	2	1	0	0,8				3	3	3,0
Helps with use of equipment		7	4	1	4,0		8	2	0	3,3	3	4	3	0	2,5	4	7	8	0	4,8				0	0	0,0
Listens to pupils		1	2	0	1,0		7	0	1	2,7	0	3	3	6	3,0	0	5	5	1	2,8				0	0	0,0
Observes pupils not interact		3	3	3	3,0		7	0	1	2,7	0	1	1	1	0,8	0	6	8	6	5,0				0	3	1,5
Other (write in)		3	0	0	1,0		0	0	0	0,0	0	2	0	0	0,5	0	0	0	0	0,0				0	0	0,0
	A	**B**	**C**	**Z**	**Ave**	**T**	**U**	**V**	**Z**	**Ave**		**ZA**	**ZB**	**Z**	**Ave**	**ZM**	**ZN**	**ZO**	**Z**	**Ave**	**ZAB**	**ZAC**	**ZAD**	**ZAE**	**Z**	**Ave**
Making observations	4	6	5	1	4,0	9	10	8	9	9,0		5	9	9	7,7	4	2	3	0	2,3	1	6	7	7	5	5,2
Raising questions	3	1	0	0	1,0	2	1	0	0	0,8		6	2	0	2,7	1	0	2	0	0,8	6	0	0	6	0	2,4
Suggesting explanations	1	2	4	0	1,8	6	12	6	0	6,0		3	6	0	3,0	15	3	2	0	5,0	1	7	5	4	0	3,4

	TEACHER 8					TEACHER 2					TEACHER 6					TEACHER 1					TEACHER 17					
Predicting	0	1	0	0	0,3	3	0	6	0	2,3		9	7	1	5,7	9	0	1	0	2,5	0	6	0	6	0	2,4
Finding patterns	7	2	6	0	3,8	5	8	7	0	5,0		3	9	0	4,0	10	3	3	0	4,0	1	6	9	7	0	4,6
Planning investigations	1	1	8	0	2,5	4	11	2	0	4,3		0	8	0	2,7	8	8	0	5	5,3	0	5	9	4	0	3,6
Handling materials	8	4	12	8	6,0	6	10	6	5	6,8		6	11	6	7,7	11	11	10	6	9,5	1	6	7	9	7	6,0
Measuring	1	0	0	0	0,3	1	0	1	0	0,5		2	0	0	0,7	10	0	2	5	4,3	2	0	0	5	1	1,6
Recording	2	0	0	0	0,5	5	6	5	0	4,0		0	0	0	0,0	0	0	1	0	0,3	0	0	0	0	0	0,0
Other	8	4	1	0	3,3	5	0	5	0	2,5		0	1	0	0,3	0	8	8	0	4,0	0	0	0	0	0	0,0
	D	**E**	**F**	**Z**	**Ave**	**R**	**X**	**W**	**Z**	**Ave**	**ZC**	**ZD**	**ZE**	**Z**	**Ave**	**ZP**	**ZQ**	**ZR**	**Z**	**Ave**		**ZAF**	**ZAG**	**ZAH**	**Z**	**Ave**
Asking about topic	0	0	4	0	1	6	1	1	0	9	4	8	2	0	3,5	1	3	3	0	1,8		10	0	3	0	3,3
Asking for help about method	1	0	8	0	2,3	0	0	0	0	0	1	7	3	0	2,8	2	1	3	0	1,5		0	0	1	0	0,3
Answering teacher (recall)	1	0	4	3	2,0	6	1	1	2	0	4	5	3	8	5,0	4	1	3	3	2,8		8	2	4	9	5,8
Answering teacher (ideas)	2	4	3	0	2,3	2	2	0	0	1	2	5	4	0	2,8	1	3	5	3	3,0		3	2	3	0	2,0
Reporting/explaining actions	4	5	10	0	4,8	15	6	10	0	0	1	9	3	0	3,3	3	5	10	2	5,0		10	1	4	0	3,8
Listening to teacher	0	2	9	4	2,8	13	4	0	9	0	0	2	1	9	3,0	0	1	3	4	2,0		7	2	2	5	4,0
Other (write in)	5	5	0	0	2,5	0	3	7	0	6	3	1	0	0	1,0	11	11	0	0	5,5		0	1	7	0	2,0
			G	**Z**				**S**	**Z**				**ZF**	**Z**				**ZP**	**Z**					**ZAI**	**Z**	
Organizing task together			15	7	11			11	2	6,5			12	1	6,5			8	6	7,0				10	4	7,0
Organizing task (argument)			10	0	5,0			1	0	0,5			10	0	5,0			4	0	2,0				9	0	4,5
Talk about topic			8	3	5,5			5	2	3,5			12	3	7,5			7	6	6,5				7	0	3,5
Talk about report			1	2	1,5			5	0	2,5			5	0	2,5			2	0	1,0				4	0	2,0
Non-topic talk			9	0	4,5			3	0	1,5			2	0	1,0			11	0	5,5				1	0	0,5
Listening to other's ideas			10	3	6,5			10	0	5,0			4	4	4,0			15	6	10,5				9	2	5,5
Independent working			11	0	5,5			8	0	4,0			5	0	2,5			13	6	9,5				6	0	3,0
Number actively working			14	4	9,0			6	0	3,0			5	2	3,5			14	6	10,0				6	4	5,0
Other (write in)			1	0	0,5			0	0	0,0			3	0	1,5			1	0	0,5				0	0	0,0

Of concern were the discrepancies found between my observation and those of the peer teachers. Table 5.10 highlights some of these discrepancies:

- in something as simple as whether the blackboard was used to record student's ideas there was a difference
- I recorded higher levels of listening than the peer group indicating perhaps that teachers are not aware that their students are listening to their every word
- an indication of the amount of "group work" was over-estimated by the peer group. The arrangement of furniture in the classroom into groups is something that the teachers have become very accustomed to due to the high number of students per class. This leads to the conclusion that the teachers assume that group work is taking place due to the layout of the class. Teachers appear to assume that if the class is arranged with learners scattered around tables this equals group work.

TABLE 5.10. DISCREPANCIES BETWEEN AVERAGE PEER OBSERVATIONS AND SEPARATE RESEARCHER OBSERVATIONS (Z)

Teacher	8	8	2	2	6	6	1	1	17	17
	Ave	Z	Ave	Z	Ave	Z	Ave	Z	Ave	Z
Handle material	6	8	6.8	5	7.7	6	9.5	6	6.0	7
Listen to teacher	2.8	4	0	11	3	9	2	4	4	5
Low level recall	2	3	0	2	5	8	2.8	3	5.8	9
Group work	11	7	6.5	2	6.5	1	7	6	7	4

The results obtained from these observations could not be looked at as conclusive evidence of any of the activities as there was so much variation. They could however be used as guidelines for highlighting different aspects of teaching methodology, stressing both the teacher and student activities that take place in a classroom.

5.E.5. Discussion around question 2, hypothesis 2

Looking at the usage of the booklet:

- The attempt to read the booklet indicated a desire to use a more outcomes-based teaching approach
- The attempt to use the booklet indicated an attempt to improve teaching strategies
- The cascade effect was being implemented with colleagues being tutored by the participants and those tutored were using the outcomes-based methods to teach their students

- By trying to raise funds, which was indicative of the participants taking ownership of the garden, they did have the money to develop their gardens
- The most rewarding result of all was that every participant had taken their class out into the garden at least once.

The above provides evidence of a change towards acceptance of outcomes-based teaching. This supports Hypothesis 2. However the results were obtained 9 months after the programme had been completed and the number of participants that had read and used activities from the booklet was relatively low. This indicates a need for further reinforcement of the change.

Thus if teachers were able to improve in their professional capacity in terms of knowledge, skills and attitudes towards planting up their school gardens, then it implied that their standard of teaching would automatically improve.

When volunteers were requested to conduct their lessons and be videoed, many more than five teachers were willing to present, which was an encouraging indication that they were gaining confidence within themselves.

A positive feature of the "science Observation Matrix" results was that the students were involved in answering their teacher's questions but unfortunately most of the questions were of the lower order type, requiring only recall. As English was not the home language of these teachers or students, and the teaching was done in English a lot of time was spent explaining the meaning of words. In general, the rule of thumb appeared to be that the mother tongue was used when the teacher believed there to be a possibility of her idea, instructions etc. in English, not being understood by the class. The use of the mother tongue may also be an indication of when the teacher herself felt insecure about her ability to communicate. Certainly the fact that mother tongue explanations were given quickly, fluently and at rather greater length than English ones would seem to bear out such an interpretation.

Most of the teachers often repeated a statement that they had made, especially if a student had just been asked to answer their recall question. So the sequence would go - Statement-Question-Recall-Repeat-Statement. Thus there was massive repetition of information. Although there was information built into all the lessons the teachers transformed the lessons by the repetition of information and the frequent requests for recall. It was quite clear that the materials themselves could not completely control what the teachers did in the classroom. The teachers transformed what they had been given by their own interpretation or the task itself, by their personal style, as well as by their perception of the needs of their students. This observation should serve as a cautionary tale for those who believe in materials-driven innovations. In specific terms the majority of teachers neither rewarded accurate recall, nor

did they correct students' answers explicitly. Students were expected to infer the validity of an answer by the questioning process that followed. It seemed that the teachers found it very important that the students understood what she was saying, rather than that *she* should understand what they were saying.

There was one behaviour prominently lacking in all the observations and that was students asking questions. Students neither asked questions for clarification nor for information. Yet asking questions is something which is characteristically associated with primary school children. Teachers should listen to the original contributions that students characteristically make and while they may appear to be off the subject, they offer a clue to the student's state of mind (alternative conceptions) and often give rise to very fruitful learning experiences. While the student's limited English competence was possibly an important reason why they did not make contributions of this nature, it may also indicate that they have accepted a non-questioning attitude towards their education. The teachers themselves are a product of the same type of education, the results of which may only start manifesting itself in adult life and this could account for why they tend to ask very few questions of their students and those questions that they do ask are at a low level involving only recall.

In reviewing this observation task, all the teachers took a relatively long time to actually get their lessons going. The students were passive and unchallenged for a good five minutes in most cases and when one considered that the duration of the lesson was usually thirty minutes, a lot of valuable time was wasted.

Taylor and Vinjevold (1999) stressed the importance of not underestimating what was happening in the actual classroom. They described the characteristics of South African classrooms as follows:

- lessons were dominated by teacher talk on low-level questions
- lessons were generally characterized by a lack of structure, the absence of activities which promoted higher order skills such as investigation, understanding relationships and curiosity
- real world examples were often used, but at a very superficial level
- little group work or other interaction occurred between students
- little reading and writing was done by students – when it was it was of a very rudimentary nature

All these aspects were evident in the observed classrooms except that in the case of group work, teachers and students did attempt this task albeit with some caveats regarding confidence and purpose of group work. Although the topics of the given lessons were different, as were the presenters of the lessons, what was of extreme importance and interest was that in all instances the teachers encouraged their students to actually observe and

handle the plant material. It is hoped that this would become a familiar way of teaching for the participants although a lot more practice in this hands-on technique was needed if the teachers were to show more confidence, but these presentations showed the beginning of professional growth on the part of the teachers.

There was a large variation in the recording of the observed teaching activities and so time was spent discussing process skills (Figure 5.2). In Chapter 2 some different learning methodologies for environmental education were looked at and all of them stressed process skills. If the “Gardening with Flora” project was repeated, a lot more time should be spent clarifying these skills as it appeared that the majority of biology teachers found great difficulty with them especially predicting, investigating and formulating hypotheses. Teachers should be encouraged to facilitate the use of process skills as far as possible in their classrooms. Evidence has shown that a student could spontaneously exercise his process skills in a situation which was conducive to doing so. However, it is not known yet whether higher order process skills would develop if the lower order skills that could be exercised at this level were not nurtured. For this to happen, teachers would have to be trained in a different style of classroom interaction.

Qualitatively it can be stated that 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 - has been substantiated. However these teachers still tended to use the teaching methods within the state-question (generally low level questions) repeat format they had traditionally used.

5.F. THE METHODS, OBSERVATIONS, RESULTS AND DISCUSSION RELATED TO QUESTION 3

The final point of this research was to determine whether environmental knowledge was necessary for outcomes-based learning of botany. The baseline findings showed that the participants had inadequate knowledge of even the most rudimentary aspects of botany and the relationship between botany and the environment hence they could not use the environment to teach botany. They were bored and because outcomes-based education uses relevance as a tool, the environment is an opportunity to make botany relevant and interesting. If this became the case, the environment could then be used as a resource for materials for teaching. To determine whether environmental knowledge was necessary for outcomes-based learning of botany it was necessary to determine the participants’ environmental knowledge before the intervention and then again after the intervention.

5.F.1. Specific method used to evaluate the change of attitude by means of questionnaires (question 3)

This question addressed the affective domain.

In the preliminary programme the participants were given a questionnaire (Appendix A – Figure 4.11 - Sheet 11) in which they were specifically asked what attitudes they wanted their students to have regarding plants and to link a particular plant as a resource for enabling those attitudes to be imparted. On the 21/7 the group was given the “Attitudes to Plants and the Environment” questionnaire. This test was not given as a post-test but rather the participating teachers were asked to evaluate the course and hand in their evaluation on the 18/11. A further analysis of attitudinal change was done by means of questionnaires completed by the participants’ Head (Appendix L), some peer teachers (Appendix M) and some students (Appendix N) on the 15/11.

5.F.2. The observations and qualitative results appropriate to question 3

The following is a composite list of attitudes and the resources that the teachers decided should be covered at school (obtained from the preliminary study):

TABLE 5.11. PLANT ATTITUDE AND THE RELEVANT PLANT SPECIMENS

ATTITUDE	SPECIMEN
Love	? (2), flowers (5), grass, trees (2), vegetables (1), fruit (1), all plants, beans
Acceptance	Flowers (2), grass, trees (2), fruit
Positive attitudes	? (3), flowers, grass, trees (2), vegetables, fruit, cabbages
Negative attitudes	poisonous weeds
Uses of plants	Furniture, food, beautify our homes
Appreciation	? (2), flowers, trees, fruit
Healthy attitude	vegetables, fruit
Happiness	?
Love the plants for their uses	Food, shade, decoration
Observe the growing plant	?
Appreciate the effort growing them	Trees
Care for them	trees, shrubs, all plants
Enjoy working in the garden	Flowers
Joy in watching plants grow	Flowers
Respect their surroundings	Flowers
Be responsible	Trees
Love of nature	different kinds of plants
Relevance to their lives	?
Instil an interest in plants	?
A willingness to learn more	?
The value of plants	? (4)

This questionnaire was very poorly answered. Most of the participants translated the majority of questions into knowledge questions rather than handle them in the affective domain. The following test was given in the main study to determine the participant's attitudes towards plants:

TABLE 5.12. THE ATTITUDE QUESTIONNAIRE USED AS THE INSTRUMENT TO ASSESS ATTITUDES TO PLANTS QUALITATIVELY

ATTITUDE QUESTIONNAIRE	
Name:	
Grade being taught this year:	
Plants:	
Do you like plants?	If not, why not? If yes, why?
Do you enjoy learning about plants?	If not, why not? If yes, why?
Did you find your study of plants at school boring?	If not, why not? If yes, why?
Do you feel that there is a need to study plants?	If not, why not? If yes, why?
Plants and the environment:	
Has your school and tertiary learning about plants resulted in you looking at plants on their own or as part of the environment?	
Since leaving school or your tertiary institution, have you done any further learning about plants? Yes / No (circle the correct one)	
List the further learning experiences about plants you have done. State for each experience whether you looked at plants in isolation (on their own) or as an integral part of the environment?	
Do you see plants as forming an important part of the environment? If yes, why? If not, why not?	
Do you think plants can tell us things about the environment? If yes, list what can they tell us? If not, why not?	
The environment:	
Do you think it is important to look after your local environment? If yes, why? If not, why not?	
Do you think you can make a difference to the state of the global environment? If yes, how? If not, why not?	
Do you think that it is important for you to be environmentally literate? If yes, why?	
If not, why not?	
What attitudes about plants do you feel are necessary to produce environmentally literate citizens?	
How can these attitudes be produced?	
What attitudes about the environment do you feel are necessary to produce environmentally literate citizens?	

The results of the post-test are included here to give a sense of the participant's attitude toward plants and the environment. When asked whether they liked plants all the participants

said that they did and all agreed that they enjoyed learning about plants. All stated that there was a need to study plants and the reasons given included that they:

- added beauty to the environment
- could be used medicinally
- were useful to man and animals
- formed part of the environment
- the knowledge of them could help to create jobs.

Every participant saw plants as forming an important part of the environment because they:

- beautify the environment
- co-exist with animals
- form part of the ecosystem
- prevent soil erosion
- provide food for animals
- serve as wind-breakers
- give shelter to animals.

All said that plants could tell us something about the environment. These aspects included the:

- seasons
- type of soil
- presence of water in the soil
- type of animals that could be found in that environment
- type of people living in that environment.

The participants agreed that it was essential to look after the environment and if everyone started with their “own backyard”’ this would make the world a much better place.

They all stated that it was important to be environmentally literate because then they:

- would know how to care for the environment
- would understand the importance of plants and learn to love and respect them
- would have the skills to rectify environmental problems
- could educate the community about the dangers of pollution.

They mentioned that the following attitudes about plants needed to be evident in environmentally literate citizens:

- love and respect plants
- care for plants
- have an interest in plants

- enjoy plants.

These attitudes could be fostered by:

- teaching people about plants
- by working together in workshops
- actually planting plants
- teach students by using actual plants and not only theory
- producing booklets on how to care for plants and distributing them to the community
- encouraging the community to plant different plants at their homes.

These test results illustrate a general positive attitude towards plants and the environment.

The questionnaires filled in by the heads showed that generally they felt that the project had been a success (Table 5.13). The Head from School 10 went so far as to say that the attendance of some of his teachers at the “Gardening with Flora” workshops had transformed these teachers in a way never thought possible. It had motivated them to such an extent that they were able to enthuse to the other teachers, thus it had really been of help to the school and this indicated that the intervention had been successful in bringing about positive change. Comments included the fact that the students were enjoying the project and they were caring for the gardens on their own without being instructed to do so (School 10). The Head from School 12 concluded that the students loved their school garden very much. They worked very hard in it and showed signs of disappointment when things were stolen or damaged or when there was a shortage of water so that they could not water properly.

The parents whose children were involved with the project gave the following feedback:

- their children had started improving their own home garden
- the school ground had improved significantly
- their children were being kept busy
- their children now knew what needed to be done in the garden and did not need to be told what to do
- their children were happy and motivated
- some parents had thanked the Head for the school-grown vegetables that their children had taken home.

These factors indicated that the students had undergone a change in attitude towards plants and were prepared to work hard in their school garden.

TABLE 5.13. COMBINED RESULTS FROM HEADS OF PARTICIPATING SCHOOLS

School	Teacher	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Comment
1	1	Y	Y	Y	Y	Y	Y	N	Y	N	Y	
2	2	Y	N	Y	N	N	Y	N	Y	Y	Y	=T12
2	12	Y	N	Y	N	N	Y	N	Y	Y	Y	=T2
3	3	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	=T11
3	11	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	=T3
4	4	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	
5	5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
6	6	Y	N	Y	Y	Y	Y	N	Y	Y	Y	=T17
6	17	Y	N	Y	Y	Y	Y	N	Y	Y	Y	=T6
7	7	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	
8	8	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	
9	9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
10	10	-	-	-	-	-	-	-	-	-	-	=T13
10	13	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	=T10
11	14	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	
12	15	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	
13	16	N	N	Y	N	N	Y	N	N	Y	Y	
14	18	Y	Y	Y	Y	N	Y	Y	N	Y	N	
		94 % Y	65 % Y	100 % Y	82 % Y	76 % Y	100 % Y	47 % Y	76 % Y	88 % Y	88 % Y	

Table 5.14 was compiled to look at the individual scores of the different colleagues with regard to their interaction with the participating teachers.

TABLE 5.14. RESULTS FROM COLLEAGUES OF PARTICIPATING SCHOOLS

School	Teacher	Peer	Q 1	Q 3	Q 4	Q 6	Q 7	Q 8	Q 9	Q 11	Q 12	Q 13	Q 14
1	1	1	N	Y	Y	Y	Y	P	N	Y	N	N	Y
1	1	2	Y	Y	Y	Y	N	P	Y	Y	N	N	Y
1	1	3	Y	N	Y	Y	Y	P	Y	Y	N	N	Y
1	**1**	**% Y**	**67**	**67**	**100**	**100**	**67**	**100**	**67**	**100**	**0**	**0**	**100**
2	2	4	Y	Y	Y	N	N	P	Y	Y	N	N	Y
2	2	5	Y	N	Y	Y	Y	P	Y	Y	N	N	N
2	2	6	Y	N	Y	Y	Y	P	Y	Y	N	N	Y
2	2	7	N	Y	Y	Y	Y	-	Y	Y	N	N	N
2	**2**	**% Y**	**75**	**50**	**100**	**75**	**75**	**75**	**100**	**100**	**0**	**0**	**50**
2	12	8	Y	Y	Y	Y	Y	P	Y	Y	N	N	Y
2	12	9	Y	Y	Y	Y	Y	P	Y	Y	N	-	Y
2	12	10	Y	Y	Y	N	N	P	Y	N	N	N	Y
2	**12**	**% Y**	**100**	**100**	**100**	**67**	**67**	**100**	**100**	**67**	**0**	**0**	**100**
3	3	11	Y	Y	N	N	Y	P	-	Y	N	Y	Y
3	3	12	Y	N	N	Y	Y	P	N	Y	N	Y	Y
3	3	13	Y	N	N	Y	Y	P	N	Y	N	Y	Y
3	**3**	**% Y**	**100**	**33**	**0**	**67**	**100**	**100**	**0**	**100**	**0**	**100**	**100**
3	11	14	Y	N	Y	Y	Y	P	Y	Y	N	Y	N
3	11	15	Y	N	N	Y	Y	P	Y	Y	N	Y	Y
3	11	16	Y	Y	N	Y	Y	P	Y	Y	Y	N	Y
3	**11**	**% Y**	**100**	**33**	**33**	**100**	**100**	**100**	**100**	**100**	**33**	**67**	**67**
4	4	17	Y	Y	Y	N	N	-	Y	Y	N	N	N
4	4	18	Y	-	Y	Y	Y	P	Y	Y	Y	Y	Y
4	4	19	Y	Y	Y	Y	Y	P	N	Y	Y	N	Y
4	**4**	**% Y**	**100**	**67**	**100**	**67**	**67**	**67**	**67**	**100**	**67**	**33**	**67**
5	5	20	Y	N	Y	Y	Y	P	Y	Y	N	N	Y
5	5	21	Y	Y	Y	Y	Y	P	Y	Y	N	N	Y
5	**5**	**% Y**	**100**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**0**	**0**	**100**
6	6	22	Y	N	Y	Y	Y	P	Y	Y	Y	Y	Y

School	Teacher	Peer	Q 1	Q 3	Q 4	Q 6	Q 7	Q 8	Q 9	Q 11	Q 12	Q 13	Q 14
6	6	23	Y	N	Y	Y	Y	P	Y	Y	Y	Y	Y
6	6	24	Y	Y	Y	Y	Y	P	Y	Y	N	Y	Y
6	6	25	Y	N	Y	Y	Y	P	Y	Y	N	Y	Y
6	**6**	**% Y**	**100**	**25**	**100**	**100**	**100**	**100**	**100**	**100**	**50**	**100**	**100**
6	17	26	Y	N	Y	-	-	-	Y	Y	-	-	-
6	17	27	Y	Y	N	Y	Y	P	Y	Y	N	Y	Y
6	17	28	Y	-	Y	N	N	-	N	Y	N	Y	Y
6	17	29	Y	Y	Y	-	Y	P	Y	N	N	Y	Y
6	**17**	**% Y**	**100**	**50**	**75**	**25**	**50**	**50**	**75**	**75**	**0**	**75**	**75**
7	7	30	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
7	**7**	**% Y**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
8	8	31	Y	Y	Y	Y	Y	P	Y	Y	N	N	Y
8	8	32	Y	Y	Y	-	Y	P	Y	Y	Y	Y	Y
8	8	33	Y	Y	Y	Y	Y	P	Y	Y	Y	N	Y
8	**8**	**% Y**	**100**	**100**	**100**	**67**	**100**	**100**	**100**	**100**	**67**	**33**	**100**
9	9	34	Y	Y	Y	Y	Y	P	Y	N	N	Y	N
9	9	35	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
9	9	36	Y	-	Y	Y	Y	P	Y	Y	Y	Y	Y
9	**9**	**% Y**	**100**	**67**	**100**	**100**	**100**	**100**	**100**	**67**	**67**	**100**	**67**
10	10	37	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
10	10	38	Y	N	Y	Y	Y	P	Y	Y	Y	Y	Y
10	10	39	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y
10	**10**	**% Y**	**100**	**67**	**100**	**100**	**100**	**67**	**100**	**100**	**100**	**100**	**100**
10	13	40	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
10	13	41	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y
10	13	42	Y	Y	Y	Y	Y	P	Y	Y	Y	N	Y
10	13	43	Y	Y	Y	Y	Y	P	Y	Y	Y	N	Y
10	**13**	**% Y**	**100**	**100**	**100**	**100**	**100**	**75**	**100**	**100**	**100**	**50**	**100**
11	14	44	Y	-	Y	Y	Y	P	Y	Y	N	Y	Y
11	14	45	Y	Y	Y	Y	Y	P	Y	N	Y	Y	Y
11	14	46	Y	N	Y	Y	Y	P	Y	Y	Y	Y	Y

School	Teacher	Peer	Q 1	Q 3	Q 4	Q 6	Q 7	Q 8	Q 9	Q 11	Q 12	Q 13	Q 14
11	**14**	**% Y**	**100**	**33**	**100**	**100**	**100**	**100**	**100**	**67**	**67**	**100**	**100**
12	15	47	Y	Y	Y	N	N	P	Y	N	N	N	N
12	15	48	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
12	15	49	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	Y
12	15	50	Y	Y	Y	Y	Y	P	Y	Y	N	-	Y
12	**15**	**% Y**	**100**	**100**	**100**	**75**	**75**	**100**	**100**	**75**	**50**	**50**	**75**
13	16	51	N	Y	N	Y	-	P	Y	Y	N	N	Y
13	16	52	N	Y	N	Y	N	-	N	Y	-	N	Y
13	16	53	N	N	N	Y	N	-	Y	Y	-	N	Y
13	**16**	**% Y**	**0**	**67**	**0**	**100**	**0**	**33**	**67**	**100**	**0**	**0**	**100**
14	18	54	Y	Y	Y	N	N	P	Y	Y	Y	Y	Y
14	18	55	Y	Y	Y	N	-	P	Y	N	Y	N	N
14	18	56	Y	N	Y	N	-	P	Y	N	Y	N	N
14	**18**	**% Y**	**100**	**67**	**100**	**0**	**0**	**100**	**100**	**33**	**67**	**33**	**33**

This table was then modified to produce Table 5.15, where even though the teachers being critiqued were not the same for all the questionnaires (Appendix N), nor were the teachers doing the critiquing the same, it would be of interest to see if there was a trend for the whole group.

TABLE 5.15. COMBINED RESULTS FROM COLLEAGUES OF PARTICIPATING SCHOOLS

School	Teacher		Q 1	Q 3	Q 4	Q 6	Q 7	Q 8	Q 9	Q 11	Q 12	Q 13	Q 14
1	**1**	**% Y**	67	67	100	100	67	100	67	100	0	0	100
2	**2**	**% Y**	75	50	100	75	75	75	100	100	0	0	50
2	**12**	**% Y**	100	100	100	67	67	100	100	67	0	0	100
3	**3**	**% Y**	100	33	0	67	100	100	0	100	0	100	100
3	**11**	**% Y**	100	33	33	100	100	100	100	100	33	67	67
4	**4**	**% Y**	100	67	100	67	67	67	67	100	67	33	67
5	**5**	**% Y**	100	50	100	100	100	100	100	100	0	0	100
6	**6**	**% Y**	100	25	100	100	100	100	100	100	50	100	100
6	**17**	**% Y**	100	50	75	25	50	50	75	75	0	75	75
7	**7**	**% Y**	100	100	100	100	100	100	100	100	100	100	100

School	Teacher		Q 1	Q 3	Q 4	Q 6	Q 7	Q 8	Q 9	Q 11	Q 12	Q 13	Q 14
8	**8**	**% Y**	100	100	100	67	100	100	100	100	67	33	100
9	**9**	**% Y**	100	67	100	100	100	100	100	67	67	100	67
10	**10**	**% Y**	100	67	100	100	100	67	100	100	100	100	100
10	**13**	**% Y**	100	100	100	100	100	75	100	100	100	50	100
11	**14**	**% Y**	100	33	100	100	100	100	100	67	67	100	100
12	**15**	**% Y**	100	100	100	75	75	100	100	75	50	50	75
13	**16**	**% Y**	0	67	0	100	0	33	67	100	0	0	100
14	**18**	**% Y**	100	67	100	0	0	100	100	33	67	33	33
	Ave.	**%Y**	91	65	84	80	78	87	88	88	43	52	85

It was encouraging that 91 per cent of the participating teachers gave feedback to their colleagues about what they had learnt on the course. This reinforced a principle of the "Cascade model" and enabled the correct information to be distributed more quickly than if each teacher had to attend the course before implementing newly acquired knowledge. It also indicated a willingness to share knowledge and skills with peers, which showed professional maturity.

84 per cent of the participating teachers' peers said that they were involved in developing their garden in the year that the project was being tried. Some of the reasons included:

- the teacher who attended the course encouraged them to
- they now had plant material to plant
- to make the school garden attractive
- to have plants available for teaching
- to get to know the different types of plants
- to improve learners' skills
- to help the learners to start developing their garden at home.

The gardening tasks that the participating peer teachers' had been involved in included:

- planting vegetables seedlings
- planting flower seedlings
- making a rockery
- planting trees
- making a fish pond
- planting lawn
- sowing seeds
- putting a fence around the school
- removing weeds

- preventing soil erosion
- cutting thorn branches to put over plants to protect them from roaming livestock
- fertilizing the plants
- making a compost heap.

80 per cent of the colleagues that responded said that they had changed their teaching to outcomes-based teaching while their peers had been involved in the project. This again affirms hypothesis 2. This could be due to other programmes that they were attending but question 7 asks them specifically if this was due to them being involved in the development of the garden and 78 per cent answered in the affirmative.

88 per cent of the participant's colleagues said that their learner's attitude was positive towards plants and this was encouraging when compared to the work done by Yager & Tamir (1993) who found that learners preferred to learn about animals rather than plants. One peer teacher commented that she "did nothing except water the plants if a science teacher or her students were not around". She did however comment that "those students who were taught by the teachers who attended the workshops had a positive attitude. Even if their teachers were absent, they could be found busy watering and cultivating in their school garden and while doing that they were happy". Another teacher said that the students "had developed a love for the subject whereas before they had disliked it when it was only the theory. Even when the period was over, they felt like going on – they were never satisfied".

It was encouraging to see that 85 per cent of the group wrote that their school garden could be used to produce things that could be sold to raise funds for the school. Vegetables featured dominantly. Some teachers suggested that they could grow roses and flowers and sell them as well.

This questionnaire showed that the participant's active involvement in the "Gardening with Flora" project rubbed off on the other staff in the schools. In the majority of incidents the influence was positive and attitudes were changed for the better. It also appeared that the teachers attending the workshops were keen to share their knowledge.

From the results of the questionnaire filled out by the participating teachers' students (Appendix N), Table 5.16 was compiled.

TABLE 5.16. RESULTS FROM SELECTED INDIVIDUAL STUDENTS OF PARTICIPATING TEACHERS

School	Teacher	Learner	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Grade
1	1	1	Y	Y	Y	Y	Y	N	flower	7
1	1	2	Y	Y	Y	Y	Y	N	flower	7
1	1	3	Y	Y	Y	Y	Y	N	flower	7
1	1	4	Y	Y	Y	Y	Y	N	carrot	7
1	1	5	Y	Y	Y	Y	Y	N	flower	7
1	1	%Y	100	100	100	100	100	0		
2	2	6	Y	Y	Y	Y	Y	N	flower	6
2	2	7	Y	N	Y	Y	Y	Y	flower	6
2	2	8	Y	Y	Y	Y	Y	Y	fruit	6
2	2	9	Y	Y	Y	Y	Y	Y	vegetables	6
2	2	%Y	100	75	100	100	100	75		
2	12	10	Y	Y	Y	Y	Y	N	fruit	6
2	12	11	Y	N	Y	Y	Y	N	fruit	6
2	12	12	Y	Y	Y	Y	Y	Y	fruit	6
2	12	13	Y	Y	Y	Y	Y	Y	fruit	6
2	12	14	Y	Y	Y	Y	Y	Y	vegetables	6
2	12	15	Y	N	Y	Y	Y	N	flower	6
2	12	16	Y	Y	Y	Y	N	N	flower	6
2	12	%Y	100	71	100	100	86	43		
3	3	17	Y	Y	Y	Y	Y	N	trees	5
3	3	18	Y	Y	Y	Y	Y	Y	flower	5
3	3	19	Y	Y	Y	Y	Y	N	flower	5
3	3	20	Y	N	Y	Y	N	N	trees	5
3	3	%Y	100	75	100	100	75	25		
3	11	21	Y	Y	Y	Y	Y	Y	bulbs	8
3	11	22	-	-	-	Y	Y	Y	strawberry	8
3	11	23	Y	Y	Y	Y	Y	Y	strawberry	8
3	11	24	Y	Y	Y	Y	Y	Y	carrot	8
3	11	25	Y	Y	Y	Y	Y	Y	flower	8
3	11	%Y	80	80	80	100	100	100		
4	4	26	Y	Y	Y	Y	Y	Y	flower	8

School	Teacher	Learner	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Grade
4	4	27	Y	Y	Y	-	Y	Y	flower	8
4	4	28	Y	Y	Y	Y	Y	Y	flower	8
4	4	29	Y	Y	Y	Y	Y	Y	flower	8
4	4	30	Y	Y	Y	Y	Y	Y	flower	8
4	4	%Y	100	100	100	80	100	100		
5	5	31	Y	Y	Y	Y	Y	Y	flower	4
5	5	32	Y	Y	Y	Y	Y	Y	flower	4
5	5	33	Y	Y	Y	Y	Y	Y	onion	4
5	5	34	Y	Y	Y	Y	Y	Y	flower	4
5	5	35	Y	Y	Y	Y	Y	Y	grass	4
5	5	36	Y	Y	Y	Y	Y	Y	cabbage	4
5	5	%Y	100	100	100	100	100	100		
6	6	37	Y	N	Y	Y	Y	Y	onion	4
6	6	38	Y	N	Y	Y	Y	N	carrot	4
6	6	39	N	Y	-	Y	N	Y	watering	4
6	6	40	Y	Y	Y	Y	Y	Y	carrot	4
6	6	41	Y	Y	Y	Y	Y	Y	flower	4
6	6	%Y	80	60	80	100	80	80		
6	17	42	Y	Y	Y	Y	Y	Y	pond	6
6	17	43	Y	Y	Y	Y	Y	Y	pond	6
6	17	44	Y	N	N	N	N	Y	vegetables	6
6	17	45	Y	Y	Y	Y	Y	Y	pond	6
6	17	46	Y	Y	Y	Y	Y	Y	pond	6
6	17	47	Y	Y	Y	Y	Y	N	flower	6
6	17	%Y	100	83	83	83	83	83		
7	7	48	Y	Y	Y	Y	Y	-	vegetables	4
7	7	49	Y	Y	N	N	Y	N	vegetables	4
7	7	50	Y	Y	Y	Y	Y	N	mealie	4
7	7	51	Y	Y	Y	Y	Y	Y	flower	4
7	7	%Y	100	100	75	75	100	25		
8	8	52	Y	Y	Y	Y	Y	Y	flower	5
8	8	53	Y	Y	Y	Y	Y	Y	pond	5
8	8	54	Y	Y	Y	Y	Y	Y	vegetables	5
8	8	55	Y	Y	Y	Y	Y	Y	pond	5
8	8	56	Y	Y	Y	Y	Y	Y	pond	5

School	Teacher	Learner	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Grade
8	8	%Y	100	100	100	100	100	100		
9	9	57	Y	Y	Y	Y	Y	Y	onion	5
9	9	58	Y	Y	Y	Y	Y	N	onion	5
9	9	59	Y	Y	Y	Y	Y	Y	bean seed	5
9	9	%Y	100	100	100	100	100	67		
10	10	60	Y	Y	Y	Y	Y	Y	flower	5
10	10	61	Y	Y	Y	Y	Y	Y	tree	5
10	10	62	Y	Y	Y	Y	Y	Y	tree	5
10	10	63	Y	Y	Y	Y	Y	Y	aquarium	5
10	10	64	Y	Y	Y	Y	Y	Y	-	5
10	10	%Y	100	100	100	100	100	100		
10	13	65	Y	Y	Y	Y	Y	Y	flower	4
10	13	66	Y	Y	Y	Y	Y	Y	flower	4
10	13	67	Y	Y	Y	Y	Y	Y	flower	4
10	13	68	Y	Y	Y	Y	Y	Y	flower	4
10	13	69	Y	Y	Y	Y	Y	Y	flower	4
10	13	%Y	100	100	100	100	100	100		
11	14	70	Y	Y	Y	Y	Y	Y	flower	4
11	14	71	Y	Y	Y	Y	Y	Y	beetroot	4
11	14	72	Y	Y	Y	Y	Y	Y	tree	4
11	14	73	Y	Y	Y	Y	Y	Y	pond	4
11	14	%Y	100	100	100	100	100	100		
12	15	74	Y	Y	Y	Y	Y	Y	beetroot	6
12	15	75	Y	Y	Y	Y	Y	Y	tree	6
12	15	76	Y	Y	Y	Y	Y	Y	apple	6
12	15	77	Y	Y	Y	Y	Y	Y	beetroot	6
12	15	78	Y	Y	Y	Y	Y	Y	carrot	6
12	15	79	Y	Y	Y	Y	Y	Y	tree	6
12	15	%Y	100	100	100	100	100	100		
13	16	80	Y	Y	Y	Y	N	N	pumpkin	8
13	16	81	Y	Y	Y	Y	N	N	pumpkin	8
13	16	82	Y	Y	Y	Y	N	N	carrot	8
13	16	83	Y	Y	Y	Y	Y	Y	tree	8
13	16	84	Y	Y	Y	Y	Y	Y	tree	8

School	Teacher	Learner	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Grade
13	16	%Y	100	100	100	100	40	40		
14	18	85	Y	Y	Y	Y	Y	Y	tomato	4
14	18	86	Y	N	Y	Y	Y	Y	cabbage	4
14	18	87	Y	Y	Y	Y	Y	Y	carrot	4
14	18	88	Y	N	Y	N	Y	Y	beetroot	4
14	18	89	Y	N	Y	Y	Y	Y	onion	4
14	18	%Y	100	40	100	80	100	100		

This table highlighted individual scores and again even though the teachers being critiqued were not the same for all the questionnaires, nor were the students doing the critiquing the same, it would be of interest to see if there was a trend for the whole sample. Table 5.17 was then drawn up.

TABLE 5.17. COMBINED RESULTS FROM SELECTED INDIVIDUAL STUDENTS OF PARTICIPATING TEACHERS

School	Teacher	Learner	Q1	Q2	Q3	Q4	Q5	Q6
1	1	%Y	100	100	100	100	100	0
2	2	%Y	100	75	100	100	100	75
2	12	%Y	100	71	100	100	86	43
3	3	%Y	100	75	100	100	75	25
3	11	%Y	80	80	80	100	100	100
4	4	%Y	100	100	100	80	100	100
5	5	%Y	100	100	100	100	100	100
6	6	%Y	80	60	80	100	80	80
6	17	%Y	100	83	83	83	83	83
7	7	%Y	100	100	75	75	100	25
8	8	%Y	100	100	100	100	100	100
9	9	%Y	100	100	100	100	100	67
10	10	%Y	100	100	100	100	100	100
10	13	%Y	100	100	100	100	100	100
11	14	%Y	100	100	100	100	100	100
12	15	%Y	100	100	100	100	100	100
13	16	%Y	100	100	100	100	40	40
14	18	%Y	100	40	100	80	100	100
	Average	**%Y**	**98**	**88**	**97**	**95**	**92**	**74**

It appeared that:

- only one student out of the 89 said that they did not like plants
- 88 per cent of the students said they had gardens at home
- 97 per cent of the teachers had taken their students into the garden to teach them about plants.

The list that the students were asked to make regarding what they were taught in the garden comprised of the following:

- how to plant flowers
- how to make a fish pond
- how to plant seeds
- how to water the different plants in a water-wise way
- how to make and apply compost
- how to weed
- how to erect a fence
- how to plant a tree

- how to plant vegetables
- how to make garden tools
- how to plant a ground cover
- how pollination took place
- how to plant a lawn
- the functions of plants
- how to plant bulbs
- how to protect the plants
- how to identify good loamy soil
- the large variety of plants
- differentiate between fruits and vegetables.

95 per cent of the students said they enjoyed working in their school garden. Those who said that they did not enjoy it gave the following reasons:

- hard work
- got tired
- it is too hot
- they could get hurt.

92 per cent of the group said that they had told their parents about the project which is very encouraging as it indicated that the students had internalised what they had learnt and were able to share it with others. 74 per cent of the parents said that they approved of their children working in the garden. These parents appreciated that their children were learning life skills in a hands-on practical way.

5.F.3. Discussion around question 3

Table 5.11. (PLANT ATTITUDE AND THE RELEVANT PLANT SPECIMENS) was very poorly answered. This could have been a result of language barriers and the fact that these types of questions are foreign to teachers.

The general feeling among the participants was that although initially their students were slow to show enthusiasm, at the end of the session they were sorry it was over. Photo 100 showing thank-you cards made by some of the pupils demonstrates how appreciative they were when they were involved in planting up their school gardens. This is indicative of a positive attitude to plants which was gained by being involved with the actual plant material.

Once their gardening activities were started in the individual school gardens:

- most students showed great enthusiasm and were sorry when the lessons ended

- many teachers indicated that their students watered their plants without being reminded to do so
- some students indicated that they would try to bring extra plants from home to help beautify their school grounds.

These again were all positive attitudinal changes among the students.

During the course of the year teacher 4 got married. It appeared that she had really bought into the project. Appendix P illustrates her wedding invitation. As can be seen, the illustration depicts gardening tools and accessories as well as an outline of a fully mature tree. The wording says “Nature’s Will Fulfilled”. All these icons illustrate a positive attitude towards plants and the environment and even though teacher 4 is only one from the group, her message is very loud and clear! From general discussions held with the participating teachers at the end of the project, none appeared to have a negative attitude towards plants. They all expressed an appreciation of the value of planting up their school garden and the merits in using actual plant material from these gardens.

All these positive attitudinal changes were very encouraging as the baseline findings indicated that the majority of students found the learning of botany boring and now after the intervention they were loathe to leave the garden and go back into the classroom!

The last question in this research is in the environmental literacy domain.

5.G. THE METHODS, OBSERVATIONS, RESULTS AND DISCUSSION RELATED TO QUESTION 4, HYPOTHESIS 3.

The evaluation of change of environmental perceptions and engagement was done using Chacko’s Questionnaire.

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.

5.G.1. Specific quantitative method used to determine the environmental literacy levels of the participants

Chacko's questionnaire was used as the measuring instrument to obtain information regarding teachers' environmental literacy. This research attempts to measure the participant's professional growth by, among other things, their increase in environmental literacy. The definition of environmental literacy used in this research is "the ability to observe and interpret the relative healthiness of environmental systems and to take the appropriate action to maintain the state of these systems."

Environmental literacy involves awareness of the total environment, knowledge of environmental problems, attitudes which lead to responsible environmental behaviour and participation in solving or preventing environmental problems.

5.G.2. Specific qualitative method of environmental engagement by means of developing a school garden

To investigate hypothesis 3 qualitatively the participant's ability to perceive the lack of a developed school garden as an environmental issue and then what skills they had at their disposal to appeal for help to develop their school garden were established.

Awareness and solving of environmental issues is a skill indicative of environmental literacy. Time was spent in the session (14/4) looking at issues in general. The approach to issue analysis was studied and the following was stressed:

- identify the problem
- analyse who the role players/stakeholders are and their positions, beliefs, values
- investigate the issue by gathering factual information from local environment and from sources in society. Also consider the values of stakeholders e.g. social, economical, political, legal, and environmental and then analyse the information.
- make decisions by looking at alternatives, assessing costs, risks and values and then choose the best solution
- take action (see page nine in the booklet).

All the participants came to the realization that their lack of a well-developed school garden was an environmental issue that they needed to solve. For homework they were asked to start planning how to develop their school garden by actually getting permission and buy-in from their head, colleagues and students.

Another skill that the group was expected to master was the writing of appeal and thank you letters to sponsors as there was very little resource material to work with in the schools. The

participants would have to ask for donations remembering that the definition of environmental literacy is “the ability to observe and interpret the relative healthiness of environmental systems and to take the appropriate action to maintain the state of these systems.” When finished these letters were sent to the different companies to ask for goods and then later sent to thank them for the sponsored equipment. The teachers realised that people were very willing to give, if they were just asked. An advertisement in “The Hardware Retailer” journal stating that one of the hardware stores was prepared to help Siyabuswa residents improve their properties was brought to the participants’ attention. It was suggested that they approach this hardware store and see if it could help with fencing or tools or any other equipment needed.

They were asked to map out their garden and take photos if possible. Those involved in the preliminary study had already completed Figure 4.4 - Sheet 4, which was to map out their school grounds showing the buildings and the planted up areas. (Activity 1 – ”Draw a map of your school grounds”).

They were also asked to list the requirements that were needed to develop their school gardens and to cost out these requirements. Each participant was asked to check on his or her school’s water availability.

Therefore, before designing an effective environmental education programme to foster environmental literacy, it is necessary to assess the level of environmental literacy of teachers who are going to implement it. This was done using Chacko’s Environmental Literacy questionnaire (Appendix C). For each teacher an overall score was achieved (Table 5.18).

5.G.3. The observations and quantitative results appropriate to question 4, hypothesis 3

TABLE 5.18. INDIVIDUAL ENVIRONMENTAL LITERACY SCORES FOR OVERALL PRE-TEST (14/4) AND POST-TEST (15/11)

Sample No	Total Score Pre-test	Average Pre-test %	Total Score Post-test	Average Post-test %
2	258	47.78	261	48.33
3	227	42.04	223	41.30
4	257	47.59	249	46.11
5	245	45.37	229	42.41
6	226	41.85	190	35.19
7	277	51.30	283	52.41
8	202	37.41	187	34.63
9	208	38.52	227	42.04
10	246	45.56	228	42.22
11	238	44.07	253	46.85
12	264	48.89	248	45.93
13	261	48.33	237	43.89
14	253	46.85	245	45.37
15	258	47.78	264	48.89
17	196	36.30	210	38.89
Total	**241.06**	**44.64%**	**235.63**	**43.64%**

From the above results it can be noted that the average score for the pre-test was 44.64 per cent while 43.64 per cent for the post-test. This difference in the total score of 7.36 is not significant at the 95 per cent level.

If the individual scores are compared only six participants improved in environmental literacy after the intervention (individuals 2, 7, 9, 11, 15 and 17).

Chacko did not do an overall analysis of his sample with regard to environmental literacy, but rather analysed each of the four categories, namely awareness, knowledge, attitude and participation individually. Table 5.19 summarizes a similarly categorised analysis.

TABLE 5.19. INDIVIDUAL ENVIRONMENTAL LITERACY SCORES FOR PRE-TEST AND POST-TEST ACCORDING TO CATEGORIES

Individual	Awareness		Knowledge		Attitude		Participation	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
	%	%	%	%	%	%	%	%
2	47.22	42.59	48.53	52.21	38.19	40.97	56.58	55.92
3	45.37	41.67	46.32	51.47	38.89	34.03	38.82	38.82
4	47.22	49.07	49.26	50.74	45.14	43.75	48.68	42.11
5	45.37	47.22	47.79	50.00	43.06	38.19	45.39	36.18
6	41.67	34.26	40.44	35.29	39.58	31.94	45.39	38.82
7	50.93	54.63	51.47	52.21	53.47	51.39	49.34	51.97
8	42.59	37.96	36.76	34.56	36.81	32.15	34.87	34.87
9	37.96	45.37	44.12	52.21	34.72	32.64	37.50	39.47
10	45.37	47.22	52.21	44.85	39.58	38.19	45.39	40.13
11	42.59	50.93	47.06	52.21	44.44	48.61	42.11	37.50
12	49.07	45.37	48.53	49.26	49.31	43.75	48.68	45.39
13	50.93	40.74	50.00	46.32	43.75	44.44	49.34	43.42
14	50.00	44.44	45.59	44.85	43.75	42.36	48.68	49.34
15	45.37	51.85	46.32	49.26	51.39	46.53	47.37	48.68
17	30.56	40.74	38.24	38.97	34.03	42.36	40.79	34.21
TOTAL %	44.81	44.94	46.18	46.96	42.41	40.75	45.26	42.46

Summary of results:

AWARENESS

- if the individual scores are compared only seven participants improved in environmental **awareness** after the intervention (individual 4, 5, 7, 9, 10, 11, and 15)
- the overall increase for the group in environmental awareness went from 44,81 per cent to 44,94 per cent which is not significant

KNOWLEDGE

- if the individual scores are compared ten participants improved in environmental **knowledge** after the intervention (individual 2, 3, 4, 5, 7, 9, 11, 12, 15 and 17)
- the overall increase for the group in environmental knowledge went from 46,18 per cent to 46,96 per cent which is also not significant

ATTITUDE

- if the individual scores are compared only four participants improved in environmental **attitude** after the intervention (individual 2, 11, 13 and 17)
- there was an overall decrease for the group in environmental attitude from 42,41 per cent to 40,75 per cent which is also not significant

PARTICIPATION

- if the individual scores are compared only four participants improved in environmental **participation** after the intervention (individual 7, 9, 14 and 15) while individual 3 and 8 stayed the same
- there was an overall decrease for the group in environmental participation from 45,26 per cent to 42,46 per cent which is also not significant

Following Chacko's example the influence of:

- gender
- age
- professional qualification
- years of teaching experience
- training in environmental education
- membership of environmental organization on awareness, knowledge, attitude and participation were investigated by one-way analysis of variance.

This procedure performs non-parametric tests for location and scale differences across a one-way classification. This procedure also provides a standard analysis of variance on the raw data and statistics based on the empirical distribution function using a Wilcoxon response variable. It also provides tests using the raw input data as scores. When the data are classified into two samples, tests are based on simple linear rank statistics.

Using the Wilcoxon Rank Test the following results that showed a significant difference were:

- the attitude towards the environment of those participants who were older than 39 years of age was worse than their younger counterparts with regard to environmental literacy at the 10 per cent level of significance
- the attitude towards the environment of those participants who had received four years or more educational training was worse than their less qualified peers with regard to environmental literacy at the 5 per cent level of significance
- the attitude towards the environment of those participants who had been teaching for less than 11 years was worse than their more experienced peers with regard to environmental literacy at the 5 per cent level of significance
- the participation aspect of those teachers who had received four years or more educational training was worse than their less qualified peers with regard to environmental literacy at the 10 per cent level of significance
- there was an overall decline (10 per cent level of significance) with respect to environmental literacy in the case of those participating teachers who had received four or more years of teacher training.

The workshops that the teachers attended concentrated specifically on plants and planting skills, so that growth in environmental literacy would have been a positive bye-product, had it occurred.

Referring to Table C.1.2 (Appendix C.1) which details the ten concepts that an environmental literate person should be aware of, each one of these concepts with respect to the different aspects and variables used above was investigated. The results from the pre- and post-test indicated the following:

AWARENESS

- the female teachers scored higher in environmental **awareness** compared to their male counterparts with respect to "interrelations in an ecosystem" at the 5 per cent level of significance ($p = 0.0129$) as well as with respect to "the ability to make choices" at the 10% level of significance ($p = 0.0825$) and with respect to "decision making on environmental issues" at the 10 per cent level of significance ($p = 0.0808$)
- those teachers who were older than 40 years of age scored higher in environmental **awareness** than their younger counterparts with respect to "the biosphere" at the 10 per cent level of significance ($p = 0.0655$)
- those teachers who had 11 years or less teaching experience received higher scores in environmental **awareness** than their more experienced counterparts with respect to "the ability to make choices" at the 10 per cent level of significance ($p = 0.0988$)
- those teachers who had received no training in environmental education scored higher with respect to environmental **awareness** compared to those who had received similar training with respect to "resources" at the 10 per cent level of significance ($p = 0.0612$)
- those teachers who did not belong to an environmental education organization scored higher with respect to environmental **awareness** compared to those who did with respect to "resources" at the 10 per cent level of significance ($p = 0.0612$).

KNOWLEDGE

- the male teachers scored lower in environmental **knowledge** compared to their female counterparts with respect to "the biosphere" at the 5 per cent level of significance ($p = 0.0235$)
- those teachers who were older than 40 years of age scored lower in environmental **knowledge** than their younger counterparts with respect to "environmental changes" at the 10 per cent level of significance ($p = 0.0887$)
- those teachers who had a qualification of three years or less scored higher in environmental **knowledge** than their more qualified counterparts with respect to "environmental changes" at the 5 per cent level of significance ($p = 0.0475$)

- those teachers who had more that 11 years teaching experience scored higher in environmental **knowledge** than their less experienced counterparts with respect to "interrelations in an ecosystem" at the 10 per cent level of significance (p = 0.0819)
- those teachers who had less that 11 years teaching experience scored higher in environmental **knowledge** than their more experienced counterparts with respect to "basic human needs" at the 10 per cent level of significance (p = 0.0961)
- those teachers who had a qualification of three years or less scored higher in environmental **knowledge** than their more qualified counterparts with respect to "environmental changes" at the 5 per cent level of significance (p = 0.0475)
- those teachers who had received training in environmental education scored higher with respect to environmental **knowledge** compared to those who had not received similar training with respect to "interrelations in an ecosystem" at the 10 per cent level of significance (p = 0.0569)
- those teachers who did belong to an environmental education organization scored higher with respect to environmental **knowledge** compared to those who did not belong with respect to "interrelations in an ecosystem " at the 10 per cent level of significance (p = 0.0569).

ATTITUDE

- those teachers who had received training in environmental education scored higher with respect to environmental **attitude** compared to those who had not received similar training with respect to "maintaining environmental quality" at the 10 per cent level of significance (p = 0.0545)
- those teachers who had received no training in environmental education scored higher with respect to environmental **attitude** compared to those who had received similar training with respect to "environmental ethics" at the 5 per cent level of significance (p = 0.0235)
- those teachers who did belong to an environmental education organization scored higher with respect to environmental **attitude** compared to those who did not belong with respect to "maintenance of environmental quality " at the 10 per cent level of significance (p = 0.0545).

PARTICIPATION

- those teachers who were older than 40 years of age scored lower in environmental **participation** than their younger counterparts with respect to "environmental changes" at the 10 per cent level of significance (p = 0.0887)
- those teachers who had a qualification of four years or more scored lower in environmental **participation** than their more qualified counterparts with respect to "decision making on environmental issues" at the 10 per cent level of significance (p = 0.0714)

- those teachers who did not belong to an environmental education organization scored higher with respect to environmental **participation** compared to those who did not belong with respect to "environmental ethics" at the 5 per cent level of significance (p = 0.0235).

5.G.4. The qualitative observations and results of question 4, hypothesis 3 obtained by means of developing a school garden

Through discussion it became obvious that all the teachers saw the necessity in developing their school garden so that they could use its contents in their teaching. They did however admit that they did not know how to start developing it, nor did they know which plants to use.

All but one of the participants said that their heads were in favour of them attending the Gardening workshops for the year and that they would encourage the development of the school grounds and their use in teaching. The dissident head (Makopanong Primary School – School 6) said that it was a waste of time. Her teachers had participated in the preliminary study. She stated that it was more beneficial for the students to be busy in the classroom than to do gardening in the school grounds. This school was of particular interest as the course progressed to see whether the participating teachers (6 and 17) were able to positively influence the attitude of the head. At the end of the course all the Heads of the participating schools said that the project had been a success (Table 5.13) thus it can be concluded that Teachers 6 and 17 were able to positively influence their Head's attitude.

Many teachers said that the lack of adequate fencing was a huge problem and that any plants they were going to plant, would be eaten either by sheep, goats or roaming cows. Lack of money to buy equipment was also listed as an inhibiting factor, as was the lack of sufficient water and theft of the plants by the community. On the positive side the students were excited and colleagues were eager to help.

The sponsor letters were relatively well done when facilitated and the participants saw that material was forthcoming. Unfortunately none of the group took up the challenge regarding the Hardware's offer even though they had been advised that they could appeal for funding. None of the participants appeared to feel that they needed funding to start developing their school grounds although some of them had said initially that they had not developed their gardens due to lack of money for resources! The question asked was why not? Was the group too lazy? Did they not buy into the project? Were they too scared to seek assistance? When they were asked, their answers had no substance – i.e. they could not say why they had not followed up this route!

None of the participants asked for any requirements such as tools to develop their garden. This could be due to the fact that none of them had been involved in developing a garden up to this stage and so did not know what tools would be required. Costing was required from the participants. As no tools etc. were seen to be necessary, the participants gave no costing.

Only one school (Phutikwena) requested the installation of a tap, as up to this stage they did not have any water laid on in the garden. When installed this new facility was only capable of giving water one hour per day, but for the school it was a vast improvement.

5.G.5. Discussion around question 4, hypothesis 3

In this study the results indicated that there did not seem to be any pattern to environmental literacy regarding the variables, gender, age category, educational qualifications, years of teaching experience, exposure to environmental education programmes and membership of environmental education organizations. It could also be noted from the above that there were many factors that contribute to the participant's level of environmental literacy.

The overall results of this questionnaire showed that the teachers in the Siyabuswa group were below average as far as environmental literacy was concerned when compared to Chacko's large sample which was drawn from similar circumstances. These results refuted hypothesis 3 and the participating teachers have not, according to Chacko's environmental literacy questionnaire, become more environmentally literate due to their active involvement in developing the "Gardening with Flora" booklet and their own school garden. A reason could have been due to time constraints. A shortage of time in the programme resulted in environmental literacy with respect to the environment as a whole not being emphasised, but only the small aspect relating to plants. If the Siyabuswa teachers could be helped in this area of expertise they would perhaps grow further professionally.

From the above it also appeared that the teachers were overly zealous to start their garden and did not look properly at the problems that needed to be overcome before they could start. This shows evidence of an inadequate progress in environmental literacy. On the other hand some other factors showed that the participants had improved in environmental literacy. Revisiting the definition of environmental literacy as used in this research i.e. "the ability to observe and interpret the relative healthiness of environmental systems and to take the appropriate action to maintain the state of these systems", the participants admitted that they realized that their school gardens needed to be developed. Thus they saw the lack of their school garden as an environmental issue. With assistance within the intervention they embarked on the path of trying to establish these gardens. Once they had started to develop their school garden they did attempt to "take the appropriate action to maintain the state of it" which is indicative of a level of environmental literacy.

The development of their school gardens was an issue that they were supposed to be able to solve on their own once they had attended the sessions. As this was probably their first attempt at issue resolution and they were not given another chance during the duration of the project to see whether they could emulate this skill it could not be said categorically that the participants had improved their environmental literacy with respect to this aspect. Thus hypothesis 3 could not be categorically refuted or accepted if looked at quantitatively and qualitatively.

An interesting fact that emerged was that although the participants had agreed that the lack of a school garden be looked at as an environmental issue and these skills be included in the booklet, their active engagement in the programme did not alter their environmental literacy while it did improve their ability to teach using outcomes-based methods.

5.H. DISCUSSION AND CONSOLIDATION

Referring back to the context of the study where the group had initially tended to teach by the traditional “chalk and talk” method, the video taken at the end of project showed that some participants had altered their teaching methodology towards outcomes-based. They were now utilizing actual plant material instead of only the textbook. Because they were starting to learn more about plants they had the confidence to use them in their lessons. They were even worrying about their school garden whereas before they had not even been involved in developing it. A lot of what was included in the botany syllabus and was previously not touched on in lessons was now being addressed, such as the concept of measurement (plants were planted at the correct spacing), the value of water for plants (many plants were still alive at the end of nine months), germination (seeds that they had germinated were fully grown plants at the end of the project), awareness of plants in the environment (the participants were actually naming plants that they had been exposed to) and planting skills (the development of the school gardens was evidence of this).

Some aspects of botany teaching and learning did not change even with this nine month long intervention such as the participants’ difficulty in selectively extracting given knowledge, their inability to change rote learning into understood knowledge, their difficulty to adapt theory to practice (some could not classify actual plants as monocotyledons or dicotyledons yet they could list the differences), their ability to observe accurately (see the results recorded from the Observation Matrix – Table 5.9), their inability to draw up lesson plans (this task was abandoned towards the middle of the programme as the participants never produced these plans citing it as being too difficult) and process skills were not well understood. With regards to the participants understanding and involvement in the environment very little was achieved and they were still not aware of the total environment, nor did they have much more

knowledge of environmental problems and their environmental literacy was still very poor. These factors reinforce the realization that environmental issues were not dealt with in enough detail in this project.

The greatest stumbling block to change in the teaching and learning of botany was language and this did not change during the nine months. The participants and students mastery of English was so poor in some instances that it hindered their understanding and ability to follow instructions.

The participants still used low level questioning involving recall and a lot of time was spent listening to the teachers who were repeating themselves to obtain clarity. Students were not able to ask questions for clarification or information.

On the other hand a major factor that facilitated change in the teaching and learning of botany due to this project was a change to a positive attitude towards plants, outcomes-based teaching and the development of the school garden. This change was supported by the learning cycle implemented throughout which gave the participants the confidence to actually improve their teaching, and develop their school gardens. The participants were also all keen to develop the booklet and even though it was not fully utilized by this group of participants, they expected that future groups would find it extremely valuable.

CHAPTER 6

RESEARCH CONCLUSIONS AND RECOMMENDATIONS

6.A. REFLECTION ON THE PURPOSE OF THE STUDY

The intention of this research was to determine which factors facilitated and hindered change in the teaching of botany in primary schools. The starting point was that “active engagement promotes change”. Throughout this project active engagement was carried out to determine whether knowledge, skills and attitudes towards the environment could be changed by (i) the active participation of teachers in the production of a booklet on what and how to plant in a school garden and (ii) the actual development of a school garden. The initial findings of the main study were compared to the final findings to determine whether the active interventions resulted in change, be it positive or negative.

Specifically, the investigation determined whether the production of a booklet with a high level of participation by teachers on how and what to plant in a school garden, together with the actual planning, planting and tending of a garden at a community centre 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
- the lack of a cultivated school garden.

An issue underpinning this research was the teachers’ capacity to create their own materials. This research investigated whether the intervention in the main study brought about a change in the participants ability to produce learning programmes. It sought to determine whether the intervention in the main study brought about a change in the teachers’ plant knowledge. It 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. It tried to determine whether the intervention was able to bring about a change in the teachers’ method of presenting plant material to their students and 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. It also attempted to determine whether there was an increase in the use of the resources for teaching and whether the teachers were facilitative after the intervention of the main study and were now more competent and skilled to teach about plants in a hands-on way.

Thus this research actually 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.

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 as applicable to a reduced number of years.

It examined teacher beliefs, skills and knowledge about plants during the implementation of a professional development programme. Professional development was viewed as a process in which teachers regularly increased their academic knowledge and pedagogical understanding in the context of the changed environment of the school. The professional development encompassed formal and informal learning experiences in order to provide the connections between school science and real-life science. Contact consisted of nine three weekly meetings following a preliminary workshop. The programme was discussed and agreed to by the participating teachers.

6.B. ASSESSMENT OF THE PROGRAMME

The programme used very complex contexts e.g. “Design-a-Plant”, design activities for a booklet, create, develop and maintain a garden and then use the products of the garden in teaching. This research provided an opportunity to question the usefulness of highly contextualized learning/teaching approaches, the outcome of which could be very generally applicable.

The programme was built around methods of active engagement (see Chapter 3 – Time-line) which were designed to help teachers learn pedagogical techniques that prepared them to:

- direct student inquiries
- assess student science understandings
- promote scientific conceptualisation.

It was intended that this programme actively engage teachers in learning and that teacher learning was analogous to student learning. It was to encourage teachers to teach science as:

- articulating questions
- pursuing answers to the questions
- interpreting information gathered
- proposing applications

- viewing the new learning as a part of the larger perception of science teaching.

By the end of the programme fewer objectives than had been hoped for had been achieved. This could have been due to the following factors that hindered positive change in the participants:

- their capacity to create their own materials was very limited and they were not able to produce learning programmes (see Chapter 5.E)
- their lack of plant knowledge which included their initial botany knowledge with regard to the structure and function of parts of a plant as well as vegetative reproduction was so poor that only handling the actual plant material did not improve their knowledge (see Chapter 5.D). They did not understand the life cycle of the flowering plant nor know the differences between monocotyledons and dicotyledons (see activity "Design a Plant"). They have learnt about these two groups for many years but they are still not able to change rote learning into understood knowledge.
- their paucity of environmental literacy (see Chapter 5.G)
- the aesthetic nature of the garden was not sustainable due to the participants feeling that the resources for planting up their own garden, and then using these in their teaching were not readily available. They were not actually aware of plants in the environment but rather only as information and drawings in a textbook and so presented plant material to their students as such, rather than hands-on i.e. competency and skill to teach about plants in a hands-on way was limited. (see Chapter 5.C)
- their lack of ability to develop their own school garden included them having very little concept of measurement (see Chapter 5.C and QUESTION 4.4 - SHEET 4 – poor drawing of their maps of their school grounds showing the buildings and the planted up areas) as well as when they sowed seeds some of them made holes 10cm deep so the seeds would never germinate, as the holes were too deep (see activity "preparing a bed for planting, sowing seeds into trays and sowing seeds in situ - Appendix G). They had never thought about planting skills as very few had actually been involved with actual plant material or developing a garden.

Expectations had been too high. It was anticipated that the knowledge and skills possessed by the teachers were better than they actually were and thus there was a large gap between what was intended and what was actually feasible.

Since the project and the research were completed, Rogan et al. (2003) have hypothesized a theory of implementation of curriculum change based on three major constructs, namely:

- profile of implementation
- capacity to support innovation
- support from outside agencies.

PROFILE OF IMPLEMENTATION

Teachers who presented content in a well organized, correct and sequenced manner, based on well-designed lesson plans were typical of "Classroom Interaction" at the lowest level, namely Level 1. These teachers provided adequate notes, used textbooks effectively and engaged students with questions. The students stayed attentive, engaged and responded to and initiated questions. For the science practical work the teachers used classroom demonstrations to help develop concepts, as well as specimens found in the local environment to illustrate lessons.

According to the results of the Classroom Teaching Observation Matrix (Appendix K) of "Gardening with Flora" project *the participating teachers were at a stage far below level 1* (see Chapter 5.E.1.ii). Also throughout the nine months the participating teachers were requested to produce lesson plans but they *found this task very difficult* and could not produce them so they did not hand them in (see Table 5.2). This aspect should perhaps have been concentrated on more and included in the booklet.

CAPACITY TO SUPPORT INNOVATION

The programme was also supposed to prepare teachers to use new instructional materials in their teaching. Assessing the programme in terms of its professional development standard should have showed the following characteristics:

- clear goals of botany learning, teaching and teacher development being set – *this did happen* (see Appendix D) but the achievement of these goals were not always met to the same degree. Some tasks involved gardening skills that were very specific and included plant knowledge having to be mastered in order to be able to perform the skill i.e. planting a seedling successfully required the participant to know the different parts of the seedling and its environmental requirements. The photos in Appendix F showed evidence of changes in the school gardens during the project. While all the gardens showed improvement, some gardens had improved dramatically while in others the progress was slower indicating the different levels of internalisation of botany learning, teaching and teacher development by the participants.
- programme components that were integrated and coordinated so that understanding and skills could be built over time. These should have been reinforced continuously and practiced in a variety of situations. Again *gardening skills were practiced over and over with different plants and in different locations* (the community centre and the participant's own school garden). These could be reinforced even more with the implementation of each succeeding "Gardening with Flora" programme.

- options that recognized the developmental nature of teacher professional growth and individual and group interests, as well as the need of teachers who had varying degrees of experience, professional expertise and proficiency. With three-week intervals between contact sessions, the participating teachers should have had time to practice their newly acquired skills. *There was a range of competencies in achieving these skills based on the teachers' motivation and dedication and their reminders to their students to care for their plants in the garden.*
- the people involved in the programme i.e. the participating teachers, teacher educators, Heads of schools and colleagues collaborating well and with clear respect for the unique perspectives and expertise of each. The *Heads of the schools could have shown more interest in the project* (see Table 5.13). The cascading effect of this programme had impressive results with respect to peer involvement. *Many non-participating teachers wanted to get involved* and with help from participating teachers actually got their classes to emulate what was happening in participating classes. The participant's active involvement in the "Gardening with Flora" project rubbed off on the other staff in the schools. In the majority of incidents the influence was positive and attitudes were changed for the better. It also appeared that the teachers attending the workshops were keen to share their knowledge (see Chapter 5.F). Future programmes could perhaps enlist more help from scientists, administrators, policy makers and business people to get more buy-in and credibility.
- continuous programme assessment being carried out. This should have captured the perspective of all those involved, used a variety of formal and informal strategies, focused on the process and effects of the programme and fed directly into programme improvement and evaluation which would be evident when the next course was run. Although this was an evolving project the suggestions for improvement on activities that had already taken place, would have to wait until a future programme was offered.

Further assessment of the programme was based on the factors Rogan et al. (2003) proposed influenced the capacity to implement an innovation. These included:

- **physical resources** - *the schools involved in this project were very under resourced.* Phutikwena School did not even have a tap in their grounds at the beginning of the programme. *The schools possessed neither tools nor plants* that the teachers could use while the programme was unfolding (see Chapter 5.G.2.2).
- **teacher factors** – these relate to the teachers' own background i.e. *none of them had gardens with quantities of plants* which they could use in their teaching or share with their students (see Chapter 5.E.2.1); their actual training i.e. *they tended to teach as they were taught* (see Chapter 4.A) which was not enquiry based, nor did it involve active engagement; *their level of confidence was very low* and they were not keen to

try new ideas; *they were not very committed to teaching* – to many of them it was just a job and they were not very motivated.

- **learner factors** – many of the learners came from homes where there was *no one to support and help them in their studies* (their parents worked in Pretoria and their grandparents were raising them and for many their *language of instruction was not their home language* as was evident from the videos (see Chapter 1.D and Chapter 5.E).

SUPPORT FROM OUTSIDE AGENCIES

The "Gardening with Flora" project is a new innovation and no outside agency in the form of the Department of Education was used to assist in its initial implementation. After completing the programme for the first time it must be concluded that for this programme to be successful in the future there needs to be buy-in by the Department of Education and *the use of "Subject Advisors" as "Support Teachers"* (see Chapter 6.E) *is recommended*. These advisors would be there to help participating teachers with content knowledge, drawing up of lessons plans and hands-on teaching strategies. To achieve the best results this *programme would need to be condensed to cover less content* (remove the environmental education aspects and cover only the botany content) and be *implemented over and over again*, rather than just once. The approach actually taken was supportive of environmental knowledge, but most strongly focused on its strongest contextual theme – the botany itself. The botany knowledge, skills and attitudes improved markedly, but this success did not extend to the environmental knowledge.

From the above one must agree with De Feiter et al. (1995) who said that looking at the complexity of the intended changes, and considering the actual classroom practices, it is not surprising that *in many instances the innovation gap was too big to overcome*.

6.C. REFLECTIONS ON SOME OF THE ASSUMPTIONS MADE AT THE COMMENCEMENT OF THE PROJECT

With all the actual ground work, hands-on practical work and analysis of the results completed, the time was right to reflect on what was expected at the commencement of the project and what actually did occur. Looking at the initial assumptions the following aspects emerged:

- the group was composed of teachers who had received very limited educational training. This was very evident specifically when it came to botanical knowledge and skills. *Very few teachers were able to draw the parts of their plant even with the specimen in front of them* (see Chapter 5.2.2). *Thus both their drawing and*

observation skills were underdeveloped. This could be due to their own training having been by means of "chalk and talk" rather than hands-on.

- these teachers were a product of an educational system that did not emphasize self-exploration and a critical outlook. The training these teachers received was one of total acceptance of the lecturer's methods and point of view. When preparing the lessons for the video they did not include questions that they would ask their students in their lesson plans. *They still held to the principle that they should give as much knowledge as possible* (see Chapter 5.2.2). This approach discourages enquiry and exploration. Future emphasis should be on breaking this cycle so that the teachers could start asking questions and then the students would feel comfortable doing the same, as was evident in the "Threshold Project" for learning primary science, where the approach to science was viewing it as a problem-solving activity and the teacher challenged the students with a comprehensive array of questions.
- *the attendance at the botany workshops once a month for 9 months gave the participants the skills to develop their school garden but the relevant plant material was not yet readily available for them to use in their teaching.* Although the gardens had improved substantially the plant material had not multiplied in many instances to the extent that it could be used hands-on by each student, but it could be used for demonstration purposes (see Chapter 5.C.3).
- the level of knowledge of these teachers was thought to be similar to that of most under-privileged teachers in the rest of the country and so findings from this project could be used as the basis for further work in this field with regard to under-privileged teachers. Since completing the project many organizations have wanted to utilize the "Gardening with Flora" booklet to uplift areas and participants with regards to school gardens. These facilitators have indicated that their groups possess a similar level of plant knowledge as the Siyabuswa group.
- the majority of *rural schools in South Africa were very impoverished, under-equipped and lacking in most resources* and so any further research with rural teachers should take cognisance of this fact. *At the outset of the project it was not appreciated just how impoverished the schools actually were.* One could not assume that these teachers would be able to bring any plant material to the sessions. Although some teachers were able to encourage students to bring some plant material from home, the majority knew that this was not possible as there was already very little in the home gardens. This is something that has since been stressed with other facilitators who want to pursue a similar development project. *All the products that the participating teachers needed for the duration of the course had been brought to them* and so this lack of resources was not evident but when the teachers were left to maintain and replenish plants in their school gardens this was not well done, possibly due to the fact that the teachers could not get additional plant material and that these gardens were not totally self-sustaining at this stage for this reason.

- few rural schools have developed their school grounds. Again it is mentioned that with the completion of this project many organizations have asked for assistance in developing their school gardens and have asked for copies of the booklet to use as resource material.
- school gardens were not developed due to the teachers' lack of knowledge about how to plant the actual plants. *It was not realized at the outset of the project how few skills the participating teachers actually possessed about plants.* It was assumed that they would know a little bit. After watching them attempt to plant the plants they were given in each session, it was realized that if there was no intervention, the plants would die. The participants all planted the seeds too deep (Table 5.2), did not understand the need to water frequently (after the first session they all just went home and did not worry about how their newly planted plants were going to be watered) or did not worry about a fence being present to prevent sheep and goats from eating them.
- gardening could also encourage entrepreneurial skills. *This was too ambitious an outcome at this stage.* Once this project has been running for a few years and the students and teachers have been propagating plants to be returned to their garden, only then will the participants be in a position to produce excess plants that they could sell. *Even though this is the case the idea should be reinforced at all times.*
- if teachers improved in their professional capacity in terms of knowledge, skills and attitudes towards plants and the environment, then it implied that their standard of teaching would automatically improve. This aspect looked specifically at question 2 which investigated whether the participating teachers had become better biology teachers. One method used to assess this hypothesis was by developing the resource material namely the "Gardening with Flora" booklet. *At the beginning of the project it was expected that this task would be able to be done primarily by the participants. As the project progressed it became evident that this would not be able to be the case.* The teachers had all attended a computer course and so it was assumed that they would be able to type up the pages of the booklet but *their typing skills were very rudimentary* thus due to the limited amount of time made available for this project I was compelled to do all the typing for the booklet. The teachers had also said initially that they could do the artwork, but again due to time constraints, this was not possible. *One had to come to terms with the fact that the participating teachers were not actually coming to the project with the skills that had been expected and so their involvement in the actual development of the booklet had to be scaled down.* It was felt that this would not detract from the final outcome. The fact that the participants had used the booklet was of more significance and was to some extent ascribable to them having been part of its design, hence they were committed to its heart – an aspect that should not be forgotten. The booklet was outcomes-based and its use encouraged teachers to use this approach. In botany teaching this is

considered to be the preferred method of teaching as it produces students that are not afraid of actually interacting with plant material in a hands-on way.

- the participants' involvement in the project would enable them to transfer the expertise they gained to other areas of learning and teaching. This assumption was not tested, as time was not available. It is suggested that this project run for a few years and become part of a bigger project where interdisciplinary teaching and learning is encouraged and where different topics can be pursued. Only then can it be seen whether the skills learnt and used in this gardening project were being implemented in other projects.

6.D. REFLECTIONS ON SOME OF THE ISSUES RAISED IN THE LITERATURE REVIEW

At the Tbilisi Conference in 1977 an important objective of environmental education was formulated, namely to develop environmentally literate citizens who had the awareness, knowledge, values, attitudes, commitment, skills and responsible environmental behaviour to improve and maintain the quality of the environment. Environmental education was to be seen as a process that promoted a greater understanding of environmental problems in order to stimulate action that would lead to the sound management of the available natural resources. *This project started out by looking at the lack of a school garden as an environmental issue* (see Chapter 4.B)*. The participating teachers had never looked at their school garden in this light. In fact a few of them admitted that they had not even contemplated their school garden at all.* The scope of this project proved to be too large. It could be separated into two aspects, one being environmental education and the other being the development of a school garden. Due to time constraints environmental literacy with respect the whole environment was not concentrated on but only the small aspect relating to plants. Thus *the lack of improvement in environmental literacy could have been due to this aspect not being actively pursued during the course of the project.*

Samuel's study (1993) was a very similar to the "Gardening with Flora" project, the main difference being the educational level of the participants. Hers was a case study of a secondary school in the process of developing and implementing an environmental education programme while the "Gardening with Flora" project enlisted practising teachers. Teachers in Samuel's case study discovered that environmental education was best implemented by integrating it where it fitted in the curriculum rather than devoting a special unit to it. Environmental education has not received status as a stand-alone subject in the South African school curriculum and I feel this may be (as also concluded by Samuel) a reason that there appears to be a general apathy among teachers to teach environmental education.

In the case of action research, the on-going process of curriculum reform constitutes its own evaluation tool i.e. the process constitutes the outcome. If continuous assessment is driven by the participants, then the evaluation becomes self-reflective, self-critical and empowering (Lotz & Janse van Rensberg, 1995). Evaluation should as it were lead development and be integrated with it. Then the conceptual distinction between development and evaluation is destroyed and the two merge as research (Stenhouse, 1975). This project was to be an example of "participatory action research". As mentioned in the literature review a number of authors have noted that *participatory research is deceptively difficult to conduct* (see Chapter 2.M). Lotz (1996), in her research on the "We Care" environmental educational resources for primary schools demonstrated how, despite her attempts to involve teachers in a participatory process on material development ended up conducting an expert-driven workshop in which little or no lasting teacher development or classroom reform resulted. This project fell into the same category. W*hen it came to actually developing the resource material, the facilitator was the main driving force, and not the participants.*

Although the participating teachers did show signs of improvement in their botanical knowledge, skills and attitudes, there is little evidence that these would be long lasting, rather the slowing down in the attention given to the respective school gardens once the project had been concluded indicates the contrary. *The assumption could not be made that change combined with infrequent workshops would result in lasting change.* Perhaps next time this project was run, this long lasting change could occur if the following conditions were met:

- the facilitator met with the relevant stakeholders to get complete buy into the project. This could assist participants in having a broader platform from which to ask for help and advise during the three weeks in between the actual workshops.
- the participating teachers were asked only to actually use the booklet, not develop it. This would enable them to concentrate on taking the booklet into the garden and use it to develop their lesson plans.
- the garden itself was focussed on
- the facilitator did not provide all the resource material but helped the teachers to find it locally
- initially actual lesson plans were developed giving step-by-step instructions as how the lessons should progress. This would reduce the number of new activities that the participants were expected to carry out and allow them to concentrate on hands-on teaching using materials from the garden. Over time a record and collection of curriculum activities that could be carried out in the garden could be compiled.
- a small specific area in the garden was set aside for the project and not the whole garden. This would make the project less ambitious (more achievable) and more focussed. It is easier to maintain a smaller area than the whole garden.
- the project was not completed after one year but continued for a few years (Neathery et al. 1997).

Changes such as those mentioned above would result in the teachers having more time to actually come to grips with the project and its intended objectives. This familiarity with the project may result in practitioner development and since teachers will always be the true focus of any real change in educational practice and thinking then long lasting improvement could be visualized.

6.E. RECOMMENDATIONS ON THE IMPLEMENTATION OF FUTURE SIMILAR PROGRAMMES AS IN-SERVICE PROGRAMMES

According to Mathison (1988) the use of multiple data sources, triangulation of data from the multiple sources and searches for counter examples to the assertions provides a level of trustworthiness to the analysis. This research used Mathison's recommendations and as a result of the multiple data source analysis, the following four main issues emerged which needed to be stressed:

- support structures
- botany curriculum materials
- botany content
- teachers' beliefs.

Issue 1: Key support structures are critical to reform success

Throughout the initial implementation of this project, it became increasingly clear that support structures would be critical to its success. *It must be recommend that support structures be built into future projects*. Some of these could be composite constructs for parental support, resource availability, administrative support and collegiality. Potential problems could be experienced with time to plan, working with other teachers and participating in professional development experiences and all these need to be addressed. *For future projects of this nature to be successful the use of "Support Teachers" needs to be investigated.* These "Support Teachers" could actually be the present Subject Advisors. They could be assigned to work with a group of teachers from one or more schools. They could carry out the following tasks during the course of the programme:

- visit their cohort of teachers on a biweekly basis
- discuss needs-based issues with the classroom teachers
- provide assistance for obtaining and scheduling curriculum materials
- provide strategies for teaching botany (such as questioning and investigation, integration and co-operative learning)
- provide botany content background information
- assist with classroom and regional botany performance-based assessments
- team teach with classroom teachers in order to model strategies

- peer coach the classroom teacher.

Thus the “Support Teachers” could:

- provide peer support
- help teachers get started using the botany curriculum materials
- promote enthusiasm, interest and comfort in teaching botany
- help teachers find resources and materials
- provide public relations for the programme.

The “Support Teachers” could receive training regarding their leadership roles in the project which could give them “credits” towards a further qualification. This training could focus on the following topics:

- peer coaching
- interpersonal skills
- continuous assessment
- unit standards
- content knowledge
- use of resources
- grant writing.

The “Support Teachers” also need to conduct purposeful interactions among stakeholders as well as peer mentoring. The primary stakeholders in a project like this includes classroom teachers, heads of schools, students and administrators and *it is essential that all of these stakeholders are involved in the planning and delivery of the programme.*

Issue 2: The quality of science curriculum materials impacts on reform processes

Prior to the project, the prospective participating teachers need to be given the “Gardening with Flora” booklet. For the successful use of the materials the following needs to happen:

- teachers should have positive experiences with the curriculum materials prior to using them in their classrooms. The participating classroom teachers need to attend training sessions focused on teaching them the botany content of the booklet by having them participate in the activities of the booklet. Just *having practical experience with the activities will provide enthusiasm to use the material, as the hands-on approach to teaching botany is new to many of the teachers.*
- interdisciplinary connections need to be made for the busy elementary teachers who are preoccupied with teaching other subjects that are often perceived as more important than science. There appears to be a fear that teaching gardening will take away from teaching the basics of reading and mathematics. In an effort to alleviate

these fears, the booklet has interdisciplinary connections, which although not stressed in this actual course, should be stressed in future courses.

- the quality of the botany curriculum materials used needs to be of a high standard as the use of the resource material impacts on the professional development of the teachers and its classroom implementation. *The quality of the booklet was found to be high in terms of helping students learn botany concepts and involving students in botany enquiry. When teachers were observed using activities from the booklet, the quality of the teaching and learning was good. Students were engaged in tasks, excited about learning and actively involved in developing an understanding of botany concepts.*

Issue 3: Elementary teachers need well-designed professional development in botany content in order to effectively use quality science curriculum materials

Prior to participating in professional development activities, the classroom teachers indicated that they did not feel well enough prepared to teach botany. In order to address this content inadequacy in the future, professional development sessions for these classroom teachers need to be designed so that they learn botany content as they participate in the activities of the booklet they are to use. *The general feeling from the group was that future courses should be run on the same basis as the initial project.* If used, the "Support Teachers" need to possess the necessary content knowledge so that they can help the teachers learn the botany content relevant to the grade they are teaching in conjunction with the booklet "Gardening with Flora".

Issue 4: Teachers' beliefs may be influenced by restructuring efforts

This project was designed to help enhance teachers' beliefs that their environmental context can be supportive in their botany teaching (context belief) and that they have the ability to teach botany effectively (self-efficacy). The results from this programme lend support to Bandura's (1997) theory that experiences impact one's belief systems. Research in this area has revealed that positive professional development experiences are needed to impact teachers' beliefs. Teachers' beliefs are addressed in professional development and it is becoming increasingly clear that those teachers' beliefs and attitudes are important in effective reform efforts. A recent report by Walberg & Lai (1999) indicates that the most effective type of professional development programme is one that involves changing teachers' attitudes and beliefs. This concept needs to be emphasized in all future programmes that want to emulate this present study.

Based on this project's results and previous studies by Ramey-Gassert et al. (1996), it was hypothesized that teachers' beliefs may be related to certain key background variables.

These variables include years of teaching experience, number of graduate level science education courses, grade level assignment, how often science is taught and the variety of science teaching strategies teachers use in their classrooms. Ramey-Gassert found that science teaching self-efficacy was positively related to the number of graduate courses the teacher had taken, how many minutes per week they teach science, the variety of science teaching strategies used and the number of science teaching methods courses taken. The present group did not produce these same results. *It was however disturbing to discover a negative correlation between science teaching self-efficacy and years of teaching experience both by Ramey-Gassert (1996) and this research.*

Botany learning is a constructive process that requires active participation on the part of both the learner and the teacher. *The in-service participants need to see that actually doing the outdoor activities provides them with the incentive and confidence to use them in their classes*. They also need to experience the ripple effect, started by involvement in the project, extending outward from the classroom into the rest of the school and local community. They should find the resource material very applicable and plan to share the workshop ideas with other teachers at their schools. They will recognize the positive effects of teachers' collaboration on in-service presentations.

The evaluation of this project thus identified support structures, opportunities to experience success, quality materials and a strong botany content focus as some of the several emerging factors necessary for systemic reform. Professional development facilitators should contextualize these factors for their particular situation when planning systemic change and repeating this programme with other teachers in in-service programmes.

6.F. RECOMMENDATIONS ON THE IMPLEMENTATION OF FUTURE SIMILAR PROGRAMMES AS PRE-SERVICE PROGRAMMES

This professional development programme focused on environmental science content and afforded elementary teachers from rural schools with workshops in formal and informal settings. This programme could form a module in pre-service teacher training. It will then introduce prospective teachers to a focused resource, the booklet, and provide opportunities to develop enquiry-based instruction and familiarize the pre-service teacher-participants with the teaching/learning cycle recommended by Bybee (1993). The field experiences can provide these teachers with opportunities to perceive the interconnections between school science and real-life science. These student teachers will realize that engaging in concrete activities with the phenomenon promotes enthusiasm and they will also see the importance of the concrete activities that they experience in the project. The manipulation of the materials will provide an impetus for following through with the activities in their future classrooms. Engaging in hands-on, practical field experiences will encourage these teachers to think like

scientists and improve their environmental science knowledge as well as instruction**.** The practical field experience will give them valuable knowledge to use in developing their botany curriculum and lesson plans. *The participants will be able to take many innovative ideas and interdisciplinary activities to their future classrooms.*

Most importantly, the hands-on, participatory design of the programme will provide pre-service teachers with opportunities to develop the confidence needed to apply the new concepts learned in their future classroom settings.

6.G. CONCLUSION

As a teacher educator, my experience over the past twenty years has shown that preparing botany teachers to deliver active participation instruction has not been easy or particularly effective. This problem is one of teacher education's most challenging tasks as it represents a significant departure from a textbook based curriculum. It formed the basis for research question 2, hypothesis 2 and due to the positive results of this research it is hoped that all teachers, both prospective and practicing, will experience this "Gardening with Flora" programme (with modifications suggested through its initial implementation). This will then result in all students' immediate environment being a productive place of beauty and one which they have helped to create. This objective was encapsulated in question 1. Both the teachers and students need to see the gardening skills they learn as being life-long skills that will enable them to have beautiful gardens of their own that they enjoy nurturing. This research investigated whether there would be a positive attitude change towards plants – research question 3 - and it was borne out by the fact that the participants enjoyed and appreciated plants at the end of the programme. If the necessary knowledge, skills and attitudes can be imparted to the teachers and they can impart these to their students, who hopefully will share them with their parents, the whole community will be encouraged to uplift their own gardens. This was the aim of question 4 hypothesis 3 with regard to the participants. If an outcome of this project and future implementations of adapted projects of this nature is ultimately an increase in the production of food and floral products actually grown in the participants' gardens, which they are able to propagate and then sell, the development project will have gone a long way to uplifting the community.

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APPENDICES

APPENDIX A - ACTUAL PRELIMINARY STUDY WORKSHEETS

QUESTION 4.1 - SHEET 1

COMPLETE QUESTION 4.1 - SHEET 1
BRAINSTORM THE ENVIRONMENTAL ISSUES IN YOUR AREA. WHAT ARE THE ROOT CAUSES OF THESE ISSUES?

LIST YOUR EXAMPLES IN TWO COLUMNS:

RESOURCE ISSUES	WASTE ISSUES

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Are you, yourselves environmentally literate and environmentally active?

Definition of Environmental Literacy: the ability to observe and interpret the relative healthiness of environmental systems and to take the appropriate action to maintain the state of these systems.

QUESTION 4.2A - SHEET 2A

COMPLETE QUESTION 4.2A - SHEET 2A
Have you ever had any experience in solving a local community environmental problem?
If yes state the problem and explain in detail how you went about tackling it.

If no explain how you would solve the following issue: You live in an area where you do not have access to basic water services. How would you go about making sure that each person has access to 25 litres per day?

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QUESTION 4.2B - SHEET 2B

COMPLETE FIGURE 4.2B – SHEET 2B
You live in an area where not everyone has access to basic water services. How would you go about making sure that each person has access to 25 litres per day?

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How is your school encouraging environmental education?

QUESTION 4.3 - SHEET 3

COMPLETE QUESTION 4.3 - SHEET 3
How is your school encouraging environmental education? List all the ways you can think of

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Many educators have promoted the idea that citizens need to play an active part in decision-making processes about social issues. Today more than ever it appears that the issues that citizens are asked to consider, fall into the category of science related social issues. It appears however that students are not being trained to deal with Science-Technology-Society issues and that existing science courses are not giving the students the knowledge and experience they need to become active citizens.

Science education should produce informed citizens prepared to deal responsibly with science related societal issues. Science must instill in students a sense of responsibility, an appreciation of the potential of science to solve or alleviate societal problems and a sense of custodianship to protect and preserve that natural world with which science concerns itself.

Because environmental issues can be considered within the realm of Science-Technology-Society issues, the goal areas that need to be covered include:

- science foundations
- issue awareness
- issue investigation
- issue resolution

This technique can be looked at as one of several instructional “means” for biology.

Let us look at an issue very close to home, namely your **SCHOOL GARDEN.**

QUESTION 4.4 - SHEET 4

COMPLETE QUESTION 4.4 - SHEET 4
DRAW A MAP OF YOUR SCHOOL GROUNDS SHOWING THE BUILDINGS AND THE PLANTED UP AREAS

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Teachers have identified that pupils find the teaching of plants, as presented in the current biology curriculum, difficult, boring and irrelevant. Biology is seen today by many pupils as the memorization of many unrelated facts, which have very little or no bearing on their lives. The emphasis in biology should not be on memorizing facts but on the understanding, interpretation and application of biological information.

Unfortunately many teachers teach as they were taught. These educators are generally a product of a science education system, which did not emphasize self-exploration and a critical outlook, both of which are essential in providing ways and means of solving everyday problems. It is noted that teachers usually resort to teaching about plants by lecturing and demonstration while pupils take down notes. This tends to generate a negative attitude towards plants. Teachers need to have the necessary knowledge of plants, the skills to handle them and a positive attitude towards them, to teach about plants with enthusiasm. With this in mind it is necessary to formulate a biology curriculum that is enlightening, interesting and relevant.

Biology is the study of living organisms and the relationship between them with the abiotic environment. Biology teachers mainly teach IN or ABOUT the environment. The environment is the world around us and includes both the living and non-living. It also includes the social and personal aspects. Thus 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. Topics in biology can be extended to include teaching FOR the environment. Although the knowledge base (teach ABOUT the environment) will always remain important for biology teachers, they should find ways to teach FOR the environment. By teaching FOR the environment, biology teaching can be made more relevant to everyday life.

With all the above in mind let us develop a "package for teachers that will utilize plants to impart to them, the knowledge, skills and attitudes necessary to identify and tackle, as environmentally literate citizens, a local problem, namely the school garden."

Using the diagram on problem solving, the following needs to be identified:

- What is the problem? – issue awareness - lack of well developed school grounds
- What do we need to know to solve the problem? - issue investigation – how do we go about developing the school grounds?
- Knowing how to go about developing the school grounds, how do we actually develop the school grounds? - issue resolution – which plants should be included in the garden and why? - who is going to do what?
- What do we need to know about the plants for them to grow well? – science foundations

QUESTION 4.5 - SHEET 5

COMPLETE QUESTION 4.5 - SHEET 5
PROBLEM: HOW CAN SCHOOL GARDENS BE IMPROVED?
List the garden/nature areas that you think should be included in your ideal school garden.

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QUESTION 4.6 - SHEET 6

COMPLETE QUESTION 4.6 - SHEET 6
Taking the SEIDET garden as the sample, brainstorm how you would improve it.

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PROBLEM: CAN PLANTS IN THE SCHOOL GARDEN BE USED IN THE LEARNING SITUATION?

QUESTION 4.7 - SHEET 7

COMPLETE QUESTION 4.7 - SHEET 7

Are your school grounds being used as a learning resource? If so, state for which topic in the syllabus they are being used. If not, state why not.

RESOURCES USED	TOPIC IN SYLLABUS

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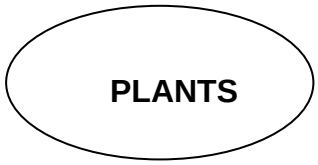
QUESTION 4.8 - SHEET 8

COMPLETE QUESTION 4.8 - SHEET 8

Brainstorm what you think pupils in your particular learning phase should know about plants remembering that learning should be relevant.

Write down the grade/s that you are teaching at the moment. GRADE: _____

Brainstorm what you think pupils in your particular learning phase should know about plants remembering that this learning should be relevant to them.



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Having completed Question 4.8 - Sheet 8, what KNOWLEDGE do you want your pupils to have regarding plants? Try to make a list linking a particular plant as a resource for enabling that knowledge to be imparted?

QUESTION 4.9 - SHEET 9

COMPLETE QUESTION 4.9 - SHEET 9

What KNOWLEDGE do you want your pupils to have regarding plants? Make a list linking a particular plant as a resource for enabling that knowledge to be imparted?

KNOWLEDGE	PLANT

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QUESTION 4.10 - SHEET 10

COMPLETE QUESTION 4.10 - SHEET 10

Having completed Question 4.9 - Sheet 9, what SKILLS do you want your pupils to have regarding plants? Make a list linking a particular plant as a resource for enabling those skills to be imparted?

SKILL	PLANT

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QUESTION 4.11 - SHEET 11

COMPLETE QUESTION 4.11 - SHEET 11

Having completed Question 4.10 - Sheet 10, what ATTITUDES do you want your pupils to have regarding plants? Try to make a list linking a particular plant as a resource for enabling those attitudes to be imparted?

ATTITUDE	PLANT

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APPENDIX B - GAUTENG BIOLOGY SYLLABUS SHEETS FOR EACH GRADE 1 – 7

GRADE 1 – 3

General information p1 & 2 Grades Syllabus

PLANTS

Beauty of God's creation - sense of wonder

Instil an interest and love of plants in pupils:
Be guided towards discovering interesting facts by his own efforts pursuing the steps of: critical observation, recording, discussion, drawing of conclusions, exploring, classifying, comparing, reasoning, predicting, acquire good working habits, problem solving, recording, speech, reading, writing, drawing, critical thought, classifying their world

Express themselves through the medium of their own:
Drawings, dramatization, singing, games, making of models

Learn to care for plants (respect them):
Sustaining natural resources (grade 2)
Seasons – the effects on plants (grade 2)
Awareness of the wonderful things created by man
Continuous observations e.g. day / night, weather (grade 3)

Evaluation:
Listening
Speaking
Doing – creative activities using plants:
- Painting
- Drawing
- Cutting
- Stenciling
- Printing
- Modeling

School grounds:
Need to know the composition e.g. draw playing fields, garden etc. (grade 3)

Need to know care of the grounds (appreciate plants – do not damage) (all)
Need to know safety

GRADE 4

PLANTS

Beauty of God's creation - sense of wonder

Instill an interest and love of plants in pupils:
Be guided towards discovering interesting facts by his own efforts pursuing the steps of: critical observation, recording, discussion, drawing of conclusions, exploring, classifying, comparing, reasoning, predicting, acquire good working habits, problem solving, recording, speech, reading, writing, drawing, critical thought, classifying their world

Express themselves through the medium of their own:
Drawings, dramatization, singing, games, making of models

Learn to care for plants (respect them):
Stimulate an eagerness to learn about natural phenomena
Introduce scientific technology
Accurate observations
Basic concepts
Factual knowledge
Effect of moving air on plants
Importance of water for plants
Plants and humankind:
useful plants – habitat, use, general appearance, fruit, seed dispersal
unwanted plants – habitat, use, general appearance, fruit, seed dispersal

GRADE 5

PLANTS

Beauty of God's creation - sense of wonder

Instill an interest and love of plants in pupils:
Be guided towards discovering interesting facts by his own efforts pursuing the steps of: critical observation, recording, discussion, drawing of conclusions, exploring, classifying,

comparing, reasoning, predicting, acquire good working habits, problem solving, recording, speech, reading, writing, drawing, critical thought, classifying their world

Express themselves through the medium of their own:
Drawings, dramatization, singing, games, making of models

Learn to care for plants (respect them):
Stimulate an eagerness to learn about natural phenomena
Introduce scientific technology
Accurate observations
Basic concepts
Factual knowledge
Germination of seeds (importance of air, water and warmth)
Monocotyledon: structure, growth, reproduction
Dicotyledon: structure, growth, reproduction
Vegetative reproduction – cuttings
Importance of soil

GRADE 6

PLANTS – subject matter should be related to everyday lives and experiences of the pupils

PLANTS

Beauty of God's creation - sense of wonder

Instill an interest and love of plants in pupils:
Be guided towards discovering interesting facts by his own efforts pursuing the steps of: critical observation, recording, discussion, drawing of conclusions, exploring, classifying, comparing, reasoning, predicting, acquire good working habits, problem solving, recording, speech, reading, writing, drawing, critical thought, classifying their world

Express themselves through the medium of their own:
Drawings, dramatization, singing, games, making of models

Learn to care for plants (respect them):
Stimulate an eagerness to learn about natural phenomena
Introduce scientific technology
Accurate observations
Basic concepts

Factual knowledge
Plants as a primary food source for:
animals
humankind

Food storage in:
leaves
stems
roots
seeds
flowers
fruits

Importance of conservation
Dangers of pollution to plants

GRADE 7

PLANTS – subject matter should be related to everyday lives and experiences of the pupils

PLANTS

Beauty of God's creation - sense of wonder

Instill an interest and love of plants in pupils:
Be guided towards discovering interesting facts by his own efforts pursuing the steps of: critical observation, recording, discussion, drawing of conclusions, exploring, classifying, comparing, reasoning, predicting, acquire good working habits, problem solving, recording, speech, reading, writing, drawing, critical thought, classifying their world

Express themselves through the medium of their own:
Drawings, dramatization, singing, games, making of models

Learn to care for plants (respect them):
Objectivity
Acquire knowledge of natural world
Know how to use apparatus
Know how to use vocabulary
Analyze data

Observe carefully

Solve problems by scientific method – reasoning and scientific procedures

Be aware of science

Role and implications of natural science for people's way of life

Study of algae – pond

Study of fungus – bread mould, mushrooms

Study of moss

Study of ferns

Study of cone-bearing plant

Study of flowering plants:

- monocotyledon (external)
- dicotyledon (external)

Sorting – using keys (life and living)

Specific conservation programme

Arbor Day

Conservation of natural resources (Earth and Beyond)

Use of soil for pH and plants growing in & peat

Use of plants in acids and bases – lemon juice, vinegar

Use of plants in dyes (beetroot)

Use of plants to talk about radiation

Use of plants to discuss energy – coal, fossil fuel

Use of plants to grasp measurement – magnifying glass

Equilibrium between plants, animals and man

APPENDIX C - ENVIRONMENTAL LITERACY QUESTIONNAIRE

APPENDIX C - QUESTIONNAIRE TO TEACHERS

INFORMATION TO TEACHERS

Please read the following carefully before you answer the questionnaire.

1. Your honest opinion is of great importance.
2. Please write your name on the answer sheet.
3. Please attempt all the items in this questionnaire.
4. Please do not write anything on the questionnaire.
5. For each item indicate your response by means of a single stroke with a HB pencil on the appropriate number on the answer sheet, for example:

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

6. Please make sure that the answer number on the answer sheet corresponds to the question number on the questionnaire.

SECTION A - BACKGROUND INFORMATION

Indicate your response (1, 2, 3, etc) to each item (1-12). For example:

Question number on the questionnaire 3. Location of your school.

Urban = 1
Rural = 2
Semi-urban = 3

If your answer is “Semi-urban” mark on your answer sheet as follows:

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

1.Gender:

Male = 1
Female = 2

2. In which age category do you fit?

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

3. Location of your school.

Urban	= 1
Rural	= 2
Semi-urban	= 3

4. Location of your home.

Urban	= 1
Rural	= 2
Semi-urban	= 3

5. Please indicate your highest academic qualifications

Standard 10	= 1
B.A.	= 2
B.Sc.	= 3
B.Com.	= 4
Other	= 5

6. In which learning area is your highest qualification?

Language, Literacy and Communication	= 1
Human & Social Sciences	= 2
Mathematics, Mathematical literacy & Mathematical sciences	= 3
Natural Sciences	= 4
Arts & Culture	= 5
Economics & Management Sciences	= 6
Life Orientation	= 7
Technology	= 8

7. Please indicate your professional qualifications

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

8. Teaching experience in years

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

9. In which Phase are you teaching?

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

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

Language, Literacy and Communication	= 1
Human & Social Sciences	= 2
Mathematics, Mathematical literacy & Mathematical sciences	= 3
Natural Sciences	= 4
Arts & Culture	= 5
Economics & Management Sciences	= 6
Life Orientation	= 7
Technology	= 8

11. Have you received any training in environmental education?

Yes = 1
No = 2

12. Do you belong to any environmental education organization?

Yes = 1
No = 2

SECTION B1

Consider each statement below and indicate to what extent you agree or disagree with each one. Use the following scale for your responses.

Strongly Agree =1
Agree =2
Disagree =3
Strongly Disagree =4

Indicate your response to items 13-120 on your answer sheet.

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

28. If a drought exists in a certain area and plants die off, predators such as lions in the area will also be in danger of extinction.
29. In an ecosystem there are producers, carnivores, herbivores, omnivores, and decomposers.
30. Ecosystems consist of people and other animals, plants and other life forms, and non-living factors interacting and interdependent in a wide variety of ways.
31. Loss of the particular place where it lives has contributed to many species of wildlife to become endangered.
32. Tree planting days will increase public awareness of the necessity of trees.
33. I think that there is too much fuss about pesticides entering the food chain.
34. I would be interested to know what kind of little creatures live in ponds.
35. I enjoy talking about the TV programmes I watched about nature.
36. I am willing to participate in recycling paper at my school.
37. When shopping, I avoid buying products made from animal furs or skin.
38. At present, most of the energy used in South Africa comes from the burning of coal and wood.
39. Energy from the sun is passed on to animals through food chains and food webs.
40. Trees in plantations cause lower water flows into rivers.
41. Only very little of the sun's energy is reaching tertiary consumers such as human beings in an ecosystem.
42. Carbon dioxide produced by burning coal causes a warmer climate.
43. Earthworms play an important role in a food chain.
44. We should save plants and animals from extinction.
45. When natural fires occur within national park boundaries it is better to have a "let it burn" policy.
46. Individual actions such as collecting cans for recycling have no effect on the environment.
47. I shall support a campaign to kill all snakes because snakebites can be fatal.
48. I am willing to be involved in a tree planting campaign.
49. I will strive to study problems in nature.
50. The energy from sunlight absorbed by plants may be utilised by animals which eat plants.
51. High concentrations of sewage in an area result in a serious depletion of dissolved oxygen in the water.
52. There is continuous environmental pollution from industry.
53. Limiting the size of the family is important to avoid overpopulation.
54. All of the following factors will contribute to the pollution of the atmosphere: veld fires, braai fires, smoke from factories, smoke from cars.
55. Abundant resources and a low death rate stimulate rapid growth in a population of organisms.
56. It is important to repair leaking taps.
57. When humans interfere with nature, it produces disastrous consequences.

58. Factory waste may be disposed in rivers because it has little effect on biological life in the rivers.
59. I encourage others to limit the size of families to avoid overpopulation.
60. I would be willing to write letters asking people to help reduce pollution.
61. I encourage people to start using electricity for cooking so that smoke pollution from home will be reduced.
62. I feel responsible to teach about environmental changes brought about by urbanisation in the normal classroom situation.
63. All animals, including human beings have basic needs.
64. Some resources once used are unavailable to future generations.
65. Coal is an inexhaustible natural resource.
66. Harmful gases in the atmosphere can be reduced if people do not use aerosols.
67. If the hole in the ozone layer gets worse more ultra-violet sunrays will reach the earth.
68. If the number of people in the world rises further at such a fast rate we will no longer be able to maintain a healthy environment.
69. Waste materials cannot be used in a positive manner by organisms in meeting their basic needs.
70. Scarcity of factors essential for the survival of organisms limits population growth.
71. Community education can counteract the effect of misuse of natural resources.
72. In order to provide food for human beings, forests must be cleared so that grains can be grown.
73. I would be willing to use public transport in order to reduce air pollution.
74. Every time I go shopping, I am willing to take a bag so that there is no need to get a plastic one from the shop.
75. When shopping, I avoid buying products known to be harmful to the environment.
76. The more people there are, the fewer resources are available per person.
77. The overuse of resources often results in environmental problems such as the destruction of the particular place where living organisms are found.
78. Conservation is the wise use of the environment to achieve sustainable environmental quality.
79. Depletion of the ozone layer causes heating of the earth.
80. Certain animal and plant species can be saved from extinction by the proclamation of nature reserves.
81. Energy, its production, use and conservation is essential in the maintenance of a sustainable society.
82. Illegal hunting is harmful to the environment.
83. It is important to make compost with biodegradable home wastes.
84. I am not interested in learning about the reasons behind the disappearance of forests.
85. It is important for all of us to reduce the consumption of material goods.
86. I always switch lights off when I don't need the light anymore.

87. I often buy products made with recycled materials.
88. I normally leave the water running when I brush my teeth.
89. Whenever possible, I take a shower instead of a bath in order to conserve water.
90. I make compost with biodegradable wastes.
91. Environmentally responsible behaviour includes personal action that benefits the environment.
92. Misuse of natural resources will not affect human beings.
93. The quantity of water on earth is constant and may be used over and over.
94. Environmental quality is the net sum of the consequences of individual and group actions.
95. Individual lifestyles such as mode of transport affect the environment directly or indirectly.
96. Many factories contribute to the formation of acid rain.
97. Green revolution is a programme focussing on the propagation of fast growing plant species to grow more food.
98. Only science teachers should know how the environment works.
99. I get upset when I see other people littering.
100. I try to behave in an environmentally responsible manner.
101. It is necessary for us to know about the environmental problems of people in other countries.
102. I will vote for or against a political candidate because of the views of the political candidate on environmental issues.
103. I encourage my students to use both sides of a paper.
104. I encourage my students to pick up litter at school.
105. Consumers need to be able to evaluate benefits as well as drawbacks for the environment when purchasing goods.
106. Recycling paper will result in fewer trees being cut down for commercial purposes.
107. Increased consumption of natural resources results in increased environmental pollution.
108. Advertising tends to ignore the drawbacks of a product to the overall health of the environment.
109. Use of unleaded petrol will reduce air pollution.
110. A reduction in the consumption of material goods will reduce the amount of wastes.
111. I do not think it is my responsibility to teach environmental issues in the normal classroom situation.
112. If I make an attempt to regulate my actions with respect to air pollution, I am sure this will have an effect on air quality.
113. When I see smoke from chimneys, I think of air pollution.
114. Even if I stop buying environmentally harmful products, it would make little difference because others are still buying these products.
115. I support the modification of the environment to provide comfort and leisure.
116. I am making personal sacrifices for the sake of slowing down pollution even though the immediate results may not be significant.

117. I am an active member in an environmentalist group.
118. I have changed some of my behaviours during the past few years to protect the environment.
119. I am infusing the study of environmental aspects into my teaching.
120. When pesticides are used to kill insects, no other animals are affected.

SECTION B2

Consider each statement below and indicate to what extent you agree or disagree with each one. Use the following scale for your responses.

Strongly Agree	=1
Agree	=2
Disagree	=3
Strongly Disagree	=4

1. Economic development often produces more environmental problems than benefits.
2. Social values and customs influence personal conservation behaviour.
3. The use of technology for disease prevention has resulted in rapid increases in the human population.
4. Ozone gas protects life on Earth from damaging effects of ultraviolet radiation.
5. The green house effect is an increase in carbon dioxide.
6. People have the right to change nature whenever they want to.
7. The benefits of modern consumer products are more important than the pollution that results from their production and use.
8. It is solely the government's responsibility to solve environmental problems.
9. A goal of my teaching is to increase the level of environmental responsibility in students.
10. I would like to discuss the influence of political decision making on the environment with my students.
11. I discuss relationships between economic development and a healthy environment with other people.
12. Human society has not developed sustainable feedback mechanism for the use and reuse of basic materials.
13. The management of natural resources to meet the needs of future generations demands long-term planning.
14. Humans tend to select short-term economic gains, which often result in long-term environmental loses.
15. In a food chain, energy is supplied by green plants.
16. Individual citizens should be stimulated to become well informed about the environment.
17. It is important to protect all useful animals.

18. The better we understand the earth, the better we can manage our resources.
19. Humans have a responsibility to develop respect for the rights of others.
20. Educators must help students' develop concern for the environment.
21. Because humans are more intelligent than other living beings, they have the greatest right to live.
22. We must set aside more land to support endangered plants.
23. I will try to persuade others to take part in environmentally responsible behaviour.
24. Because of my teaching my learners have a concern for the environment.
25. It is my conviction that I should point out to others not to smoke.
26. I discuss with my family ways to protect the environment for future generations.
27. I believe my teaching contributes to the development of environmentally literate citizens.

Thank you very much for your co-operation.

APPENDIX C.1 – VALIDITY AND RELIABILITY OF CHACKO'S ENVIRONMENTAL LITERACY QUESTIONNAIRE

It often happens that a questionnaire consists of different subsections, measuring different constructs. Chacko's questionnaire is an example of such a situation since it measures awareness, knowledge, attitude and participation with regard to the environment. In total the questionnaire measures environmental literacy. Although the test consists of different constructs, they are related to one another and to the total construct of the test because they all deal with behaviour in an environmental context. One would therefore expect to find significant positive correlations among the constructs (subsections) and between each construct (subsection) and the construct measured by the questionnaire in total (environmental literacy). If such correlations exist, one can regard the questionnaire to be construct valid. Therefore, in order to determine construct validity, Chacko calculated the correlation coefficients between the four different constructs and between each construct and the total of the test. These correlation coefficients appear in Table C.1.1.

TABLE C.1.1. INTERCORRELATIONS BETWEEN ENVIRONMENTAL LITERACY AND THE VARIABLES IN CHACKO'S (2001) "ENVIRONMENTAL LITERACY" QUESTIONNAIRE

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

[see Chacko (2001) Table 15 page 200]

*Statistically significant at .01 level.

EL = Environmental Literacy

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

In Chacko's (2001) "Environmental literacy" questionnaire the reliability was established by calculating the alpha coefficient for each aspect of environmental literacy as well as for the questionnaire as a whole. The final reliability coefficients for each section are given in Table C.1.2.

TABLE C.1.2. RELIABILITY OF CHACKO'S (2001) "ENVIRONMENTAL LITERACY QUESTIONNAIRE

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

[see Chacko (2001) Table 14 page 196]

As shown in Table C.1.2 the reliability coefficient for the questionnaire as a whole is 0,945. As this value is close to 1,0 (higher than 0,8), this questionnaire can be considered as a reliable instrument to measure environmental literacy of teachers.

A major concern with Chacko's questionnaire was its length which could result in a low accurate response rate mainly because of too many questions and the responding teachers losing concentration.

DESIGN OF CHACKO'S ENVIRONMENTAL LITERACY QUESTIONNAIRE

FORMAT OF THE QUESTIONNAIRE

As a point of departure, ten central concepts, each representative of particular sub-concepts related to environmental literacy, were selected for Chacko's environmental literacy test (Table C.1.3). The ten concepts related to environmental literacy were formulated from the definition of environmental literacy, the levels of environmental literacy, the characteristics of an environmentally literate person and an environmentally literate society from the concepts outlined by Munson (1994), Roth (1992) and Loubser (1992). The following were chosen:

TABLE C.1.3. THE CONCEPTS RELATED TO ENVIRONMENTAL LITERACY

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

In the questionnaire presented to the teachers selected for this study, all the items for a concept were arranged in order. The arrangement of the items is shown in Table C.1.4. For each concept there are items to test awareness, knowledge, attitude and participation in the prevention and solving of environmental problems.

TABLE C.1.4. ITEMS IN SECTION "B" OF THE ENVIRONMENTAL LITERACY QUESTIONNAIRE

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

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

SCORING THE QUESTIONNAIRE

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

Strongly agree = 1
Agree = 2
Disagree = 3
Strongly disagree = 4

The desired response to 19 items from Section B1 (20, 21, 26, 33, 45, 46, 47, 58, 65, 72, 84, 88, 92, 93, 98, 111, 114, 115, 120) and four (4) items from Section B2 (6, 7, 8 and 21) were negative and the other (112) items were positive. This information was used during scoring

and analysis of the questionnaire. The scores for the negative items were reversed so that high scores represented a positive response.

APPENDIX D – KNOWLEDGE ON "PLANTS AND THE ENVIRONMENT" TEST

NAME:

PHASE TAUGHT:

KNOWLEDGE QUESTIONS ON "PLANTS" TEST

1. What do you understand by the word "plant?"
2. What do you understand by the term "Angiosperm?"
3. What is a flower?
4. List the different parts of the flower and give their functions.
5. What do you understand by the word "seed?"
6. What do you understand by the word "fruit?"
7. List why you think water is important for plants.
8. List 5 plants useful to man.
9. List 5 plants that are not useful to man.
10. Explain the term "vegetative reproduction"
11. List 5 methods of vegetative reproduction and give actual examples in each case.
12. List 5 plants which animals, besides man, eat.
13. List 5 plants that man eats.
14. Name a plant that stores food in its:
    - leaves
    - stems
    - roots
    - seeds
    - flowers
    - fruits.
15. Write a short paragraph on what you know about algae.
16. Write a short paragraph on what you know about fungi.
17. Write a short paragraph on what you know about ferns.
18. Write a short paragraph on what you know about cone-bearing plants.

KNOWLEDGE QUESTIONS ABOUT "PLANTS AND THE ENVIRONMENT"

19. What do you understand about the term "environment"?
20. Do you consider man to be part of the environment? Give reasons for your answer.
21. Can plants live independent of the environment?
    If yes, how? If not, why not?

22. Can plants affect the environment positively?
    If yes, list the many ways? If not, why not?
23. Can plants affect the environmentally negatively?
    If yes, list the many ways? If not, why not?
24. Does the environment affect plants?
    If yes, how? If not, why not?
25. What do plants need from the environment?
26. List what could happen to plants if the environmental conditions were not correct?
    Give reasons for your answers.
27. What is soil?
28. Why is soil important?
29. Name the three types of soil.
30. How can you test what type of soil you have?
31. What do you understand by conservation?
32. Name any conservation programmes that you know of.
33. Do you think it is important to conserve things?
    If yes, why? If not, why not?
34. What do you understand by the term “pollution”?
35. What types of pollution can affect plants?
36. How can these types of pollution affect plants?

APPENDIX E - TWELVE PRINCIPLES OF CLASS CONTROL (PLUS ONE) by Al Janulaw

California Classroom Science - March 1999

i. Be the Alpha.
ii. Project confidence.
iii. Require perfection.
iv. Remember, you are not their friend.
v. Never give an inch.
vi. Grow eyes on the back of your head.
vii. Don't do anything for them that they can do for themselves.
viii. Use natural consequences and minimal punishment.
ix. Keep them busy.
x. Be consistent.
xi. Avoid confrontations.
xii. Be aware of your stomach.
xii+i. Let your curriculum be the discipline.

§ § § § § § § § § § § §

i. Be the Alpha.

In classrooms, as in wolf packs, one member is the Alpha (dominant) and all the others are of beta status or lower. Chickens have their pecking order in which the bottom chicken may be pecked to death. If the teacher is not the dominant personality, someone else will be; the most assertive student will fill the void.

In the beginning of the year you must establish yourself as the dominant force in your class. Kids may fool you by being on their "best behavior" for the initial day or two. Until they learn if you are dangerous or not. If you have no teacher strategies up your sleeve, they will soon find out and begin stretching the limits. If they discover you are helpless to control them, their resentment will be unbridled. A weak leader makes young people insecure. Kids have no tolerance for perceived weakness, whether it is detected in a peer or in a teacher. The

following principles, when applied with kindness and firmness, will establish you as the leader of your class and open doors to successful teaching and learning.

ii. Project confidence.

This may be hard to do when you are not feeling confident, but you must do it. Know that you have the tools to teach as well as to nudge a misaligned kid into place. Walk like John Wayne, or Clint Eastwood, if you prefer. "Make my day." Wear a confident smile as you face thirty kernels of popcorn that could go off at any time. You know that popcorn is edible. No problem. It takes some practice and success at being an Alpha before fully accomplishing this, but it is a goal toward which to work.

iii. Require perfection.

Emphasize that everything that happens in the classroom must be done exactly a particular way. The books must be on the shelf in perfect order, perfectly aligned. Students must sit with excellent posture. The papers, pencils and all other materials must be arranged perfectly and inspected by the teacher before moving on or leaving the room. The military uses this technique to control people. All socks must be rolled in a particular way in the footlocker and inspected. The method of rolling and placing the socks is arbitrary. The exact positioning of the socks doesn't matter because the goal is control of people as much as care of equipment. This method works. Later in the year, after students have bought into perfection, it is much easier to preserve both the material and emotional order in the classroom and to relax a bit.

iv. Remember, you are not their friend.

Your doctor is not your friend. Neither is your lawyer or plumber. You may be a friendly, kind teacher, but your relationship with students is professional. Keep it that way. There is nothing in this admonition that prevents discussing problems with and feeling empathy for students. In fact, everyone needs a big brother or sister or some other role model that cares about her or him. In the end, students will appreciate your strength and professionalism more than your desire to be their pal.

v. Never give an inch.

Established standards are not negotiable, nor are they bendable. Students must know you would rather die than compromise your principles. And the class is required to share your standards because you are the Alpha. Long after your standards have become the norm for the class, you may make slight adjustments for individuals who courteously approach you in

private with a strong case for mercy; "I'm so sorry to hear about the tornado that took your home last night. In this case I will allow you to turn in your project a day late with no penalty"

vi. Grow eyes on the back of your head.

Or, at least let the kids think you have them. Here's a move that will establish you as omniscient: Find a little boy, somewhere in your peripheral vision or behind you, who has an inappropriate object in his hands. Quietly walk over to him and hold out your hand. Say, "You may pick it up today after school." No discussion or explanation. If he says, "You can't do that," reply, "You may pick it up tomorrow after school." Upping the ante is something kids understand. Chances are, the little perpetrator will quickly cease his protest to avoid digging the hole deeper. After he hands you the object, put it away and return it to him, as promised. Never keep a child's things. This is a cruel act that will initiate a festering resentment for which you will pay. Perhaps he will take one of your things or ruin something, as retribution. From this simple power move, kids will gain the belief that you know what is going on and will act when necessary.

vii. Don't do anything for them that they can do for themselves.

Yes, you are hired to provide top-quality learning opportunities for students, but no, you are not hired to be their servant. What can students do?
They can keep their daily work in order, record it, collect work, tidy the room, make sure materials and equipment are in place, figure out how and when to do assignments from clear directions, ask for makeup work after an absence, and pay attention. With the exception of kindergarten teachers, we should not be teaching kids how to be students. Our role is to provide learning opportunities and to, on occasion, gently remind them of their responsibilities. Put kids in charge of tasks they can handle and expect them to perform. They will appreciate your faith in them and rise to the occasion.

viii. Use natural consequences and minimal punishment.

A student who misuses equipment doesn't get to use it for a while. A student who draws an ugly picture of the teacher on his paper copies it over (without the picture). Someone who throws doe doesn't get to do sculpting that day. A student who spits on the ground fetches a paper towel and wipes it up. The gum-chewer gets to scrape gum off the undersides of desks. Make the punishment fit the crime. Once in a while the teacher has to impose punishment on a class. For example, if the class fails to give its attention to the teacher within a reasonable amount of time, the teacher writes the number of seconds of wasted time on the board. That number of seconds is spent with the class sitting with hands folded after the bell rings. Sitting

for seventeen seconds works as motivation as well as seventeen minutes. The class will respond more quickly next time.

ix. Keep them busy.

No, we do not want to load kids up with irrelevant busy work, but we must recognize their need to be constantly doing something. If you do not provide something to do, they will think of things on their own. And you will be sorry. Here are some sub-principles that may help:

- Always" over-plan" your lessons. If, for example, you want students to read a passage and write the important information, be prepared to have them swap papers and critique each other's work or have several share their discoveries orally or mind-map the information or draw an illustration of how the information affects their lives. Note that the critique, the sharing, the mind-map and the illustration are mainly dispensable and only need to be used when there is "extra" time.

- Keep them learning. Watch their pencils. Or, during a lab, monitor their actions and conversations closely. When two-thirds of the pencils have stopped moving or when extraneous conversations begin to erupt, inform the class that it has "one more minute and then we need to move on." At the end of about a minute, hurry them on to the next assignment.

- Note: This is a frustrating situation because it is a kind act to allow kids who work slowly and carefully to have all the time they need. Unfortunately, most youngsters will not wait and the class situation will deteriorate rapidly as they finish their work. If you find that some conscientious students are suffering from the need to move rapidly, offer genuine opportunities for them to work at lunch or after school or to take the materials home.

- Have several little tricks up your sleeve. When your lesson ends ten minutes before the end of the period have them get out a piece of paper and write what they learned today, with illustrations. Some teachers use daily journals for this purpose. Or, if you are feeling clever, pose a challenging question using the principles in the lesson such as, "Should an airplane take off with the wind blowing toward its front or its tail? Use illustrations and explain your thinking."

x. Be consistent.

The world isn't always fair, but the leader of a class of youngsters must provide a stable environment and consistent expectations. The way students enter and function in a classroom

has to be the same every day. For some kids, school is the most stable situation in their lives. Provide the secure place for them. They will appreciate it and return the favor.

xi. Avoid confrontations.

It is tempting, when most of the class is following directions, to fine-tune the situation by mentioning an individual's name. "Phillip, why are you standing when I told everybody to sit down?" If Phillip is feeling feisty right then, he might respond, "I have a bad case of hemorrhoids," thus eliminating any chance of the class finding the rest of your directions of mud, interest. A much safer statement on the part of the teacher would be, "It's nice to see that almost everyone is sitting." No names, no dumb question, little chance of confrontation. This example of non-confrontation is called "addressing the ceiling," as looking up to avoid eye contact with potential teacher-tusslers can often perform it. Another strategy for non-confrontation is known as "describing the problem." For example, if there is a piece of litter on the floor and you would like to have it picked up, say, "There is a piece of litter on the floor" When students first hear this sort of declaration they will have no idea what your point is. Initially, a little explanation is always necessary; "What I mean is that we will go to lunch when the door is tidy." Strict enforcement of everyone sitting while the rest of the school rushes to lunch will make your subsequent "descriptions of the problem" much more meaningful.

xii. Be aware of your stomach.

It's that place just under your ribs that grows a knot when something is wrong in the classroom. The teacher, or Alpha, must be comfortable at all times. If the knot appears, this means you need to act. There are three ways to deal with a lesson that doesn't feel right.

- Ride out the lesson. If the lesson appears to be going sour near the end of the period you may decide to let it finish and plan overnight how to prevent reoccurrence of the discomfort.

- Make in-progress adjustments to the class or to individuals. "Please remain in your seats at all rimes unless you are actually going somewhere." Or, "Jerrod, I don't like it when you poke other kids with your pencil."

- Abandon the lesson and replace it with another. "OK. Time is up for this activity. Everybody return to your assigned seats and write three things you learned about nuclear reactors from the lesson and draw a detailed picture of one. Feel free to copy the illustration in the text." Please notice that the teacher didn't announce that the lesson was a flop, but just that it was time to move on.

One more note about protecting your stomach:
Do not allow poor behavior to become chronic. You may also get an uncomfortable feeling from the actions of a student or the conduct of the class. Don't ignore the knot. Apply Principle xii. immediately.

A thirteenth characteristic was added which the researcher believes should underpin all learning i.e.

xiii. Let your curriculum be the discipline.

If the curriculum is relevant and engages the pupils in activities that involve them in decision-making about and active participation in, the learning process then the need for discipline falls away because they enjoy the learning process.

Nearly all of the words of wisdom above are about working with students who have been trained by their culture, at school and at home, to expect an adversarial relationship between children and adults as well as among students. The most important long term goal for any teacher, one that will virtually eliminate the need for the first twelve principles, is to create an engaging curriculum with accompanying activities that involves the students in decision-making about, and active participation in, the learning process. Question everything you do. If students do not see the relevance of the curriculum, maybe it is not relevant. Let the kids teach you. Learn what motivates them by watching and listening. Then plan content-rich units that are in a style that works. Students who are given curricular opportunities that they consider interesting or, in their words, "fun" will provide the energy of twenty or thirty people pulling in the same direction. A powerful force indeed! This being the case the need for "class control" will disappear.

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APPENDIX F – PHOTOS

Photo 1: Entrance to Siyabuswa

Skills acquired at the start of the project at the Siyabuswa SEIDET Centre

Photo 2: Hebe (shrub) planted and protected by Acacia thorn branches

Photo 3: Constructing a pond using sponsored plastic

Photo 4: Planting and protecting a tree

Photographs showing plant growth after two months at the Siyabuswa SEIDET Centre

Photo 5: Hebe unaffected by roving domestic livestock

Photo 6: Planted seeds of kikuyu grass showing good growth

Photo 7: Plants protected by thorn branches

Photographs showing plant growth after four months at the Siyabuswa SEIDET Centre

Photo 8: Agapanthus (perennial – monocotyledon – indigenous) in full flower

Photo 9: Carrots ready for harvest with petunia in full bloom

Photo 10: Tree showing plenty of new growth

Photo 11: Spinach leaves ready for picking although some of them, including the onion leaves, have been eaten by rabbits.

Photographs showing plant growth after four months at the Siyabuswa SEIDET Centre

Photo 12: Mesembryanthemum finished its life cycle (annual) and Namaqualand daisies now in full flower

Photo 13: Teachers collecting Namaqualand daisy seeds for the following year's propagation

School 1

Photo 14: Barren areas in school ground

Photo 15: Barren areas demarcated into beds and soil turned over for planting vegetables

School 1

Photo 16: Students showing their watering cans made from recycled materials

Photo 17: Trench dug for pipe for water supply to garden

Photo 18: The schools first tap

School 2

Photo 19: Bricks used to protect plants from roving livestock

Photo 20: Brick fragments used to stop water runoff which causes soil erosion

Photo 21: Sponsored annuals planted in front of classrooms

Photo 22: Verbena (ground cover) displaying poor growth due to poor soil conditions

School 2

Photo 23: Teachers collecting Dodonea (indigenous shrub) seeds for propagation any time

Photo 24: Tree planted in school grounds before the program started – note the lack of depression for good soaking watering

School 3

Photo 25: School grounds with large barren places

Photo 26: Barren areas being cultivated for vegetable gardens

School 3

Photo 27: Patches of poorly nourished grass

Photo 28: Newly planted shrubs protected by thorn branches

Photo 29: Newly constructed pond

School 3

Photo 30: Grass patches looking much healthier after students have learnt how to water and fertilize

Photo 31: Pink verbena planted early on in programme and spreading rapidly

School 3

Photo 32: Participating teachers showing “Meadow Mix”

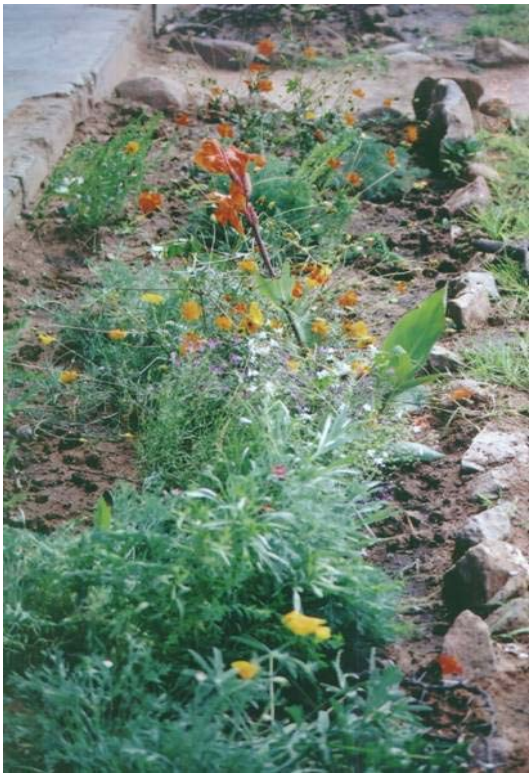

Photo 33: Full flowerbed

School 3

Photo 34: Participants collecting zinnia seeds for planting the next season

Photo 35: Petunias and geraniums planted around aloe

School 3

Photo 36: Daisy bush starting to flower and ready to take cuttings

Photo 37: Cabbage being eaten by pests

School 3

Photo 38: Flowerbed filled with annual colour planted in the middle of the project and well looked after and maintained

School 4

Photo 39: Participating teachers surrounded by bare ground

Photo 40: The home garden of a participating teacher showing well-kept lawn areas

School 5

Photo 41: Very little new growth at beginning of project.

Photo 42: Trees well positioned for shade.

School 5

Photo 43: The biggest problem cited for not developing a school garden is a lack of water but this photo shows huge water wastage due to poorly maintained pipes.

School 6

Photo 44: Barren ground before.

Photo 45: Broken fence enabling livestock to roam freely in school grounds.

School 6

Photo 46: Flower beds full of weeds at start of project.

Photo 47: Flowerbeds now planted up with annuals and protected with thorn branches.

School 6

Photo 48: Start of compost heap.

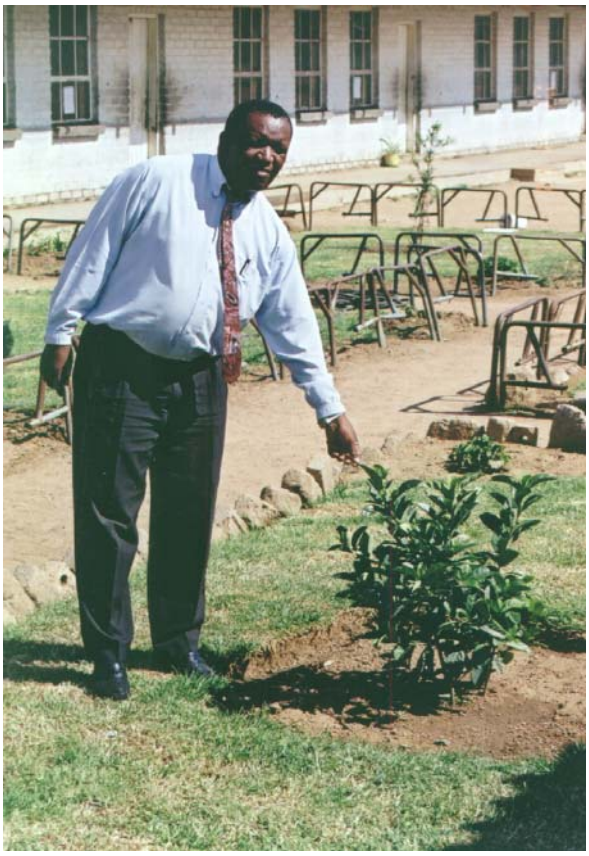

Photo 49: Viburnum shrub showing much vegetative growth.

Photo 50: Kitchen refuse brought in by students to add to compost heap.

School 6

Photo 51: Pansy in full flower at end of project.

Photo 52: Chrysanthemum paludosum in full flower at end of project.

School 6

Photo 53: Fern showing new fronds.

Photo 54: Phlox in full bloom.

Photo 55: Iris, a monocotyledon, with many new leaves.

School 7

Photo 56: Newly planted tomato seedlings.

Photo 57: Fully grown tomato plants at end of project.

School 7

Photo 58: Newly planted cabbage seedlings.

Photo 59: Cabbages ready to be harvested and then sold to the local community to raise funds for the school.

School 7

Photo 60: Students removing weeds from mealie field.

Photo 61: A water-wise idea to save water that would otherwise be wasted.

School 7

Photo 62: The pond lined with plastic.

Photo 63: A pond lined with clay collected from the local stream.

School 7

Photo 64: The pond showing water plants growing well.

Photo 65: A flowerbed of petunias in full flower at the end of the project.

School 7

Photo 66: Daylily flowering at end of project.

Photo 67: Daylily and chrysanthemum flowering at end of project

School 8

Photo 68: New hosepipe acquired with funds raised by students.

Photo 69: Marigold and dietes towards middle of project.

Photo 70: Thorn branches protecting plants from roving livestock.

School 8

School 8

Photo 71: Pond dried up due to lack of water.

Photo 72: Viburnum shrub protected by old fencing.

Photo 73: Chrysanthemum paludosum and alyssum white in full flower

School 8

Photo 74: Petunia lavender in full flower at end of project.

Photo 75: Roving cattle which cause havoc in school gardens eating all in their path.

School 9

Photo 76: A well lawned school garden with newly planted annuals close to classrooms.

Photo 77: A Frangipani tree which reproduces very easily by stem cutting.

School 9

Photo 78: “Meadow mix” interspersed with petunias and Namaqualand daisies.

Photo 79: Agapanthus growing well with a lettuce gone to seed.

School 10

Photo 80: Pipe lacking tap attachment which was stolen by a community member.

Photo 81: Initially a bare school ground with no fencing.

School 10

Photo 82: Fence erected with thorn branches and tree protected by bricks

School 10

Photo 83: Newly planted vegetable seedlings showing signs of being eaten by insects.

Photo 84: Agapanthus, lily and daisy bush growing well.

School 10

Photo 85: Marigolds in full flower.

School 11

Photo 86: Barren areas in front of classrooms at beginning of project.

Photo 87: Newly tilled ground with runners of kikuyu planted

School 11

Photo 88: Barren areas tilled and ready for planting.

Photo 89: Area planted with Kikuyu runners and annuals at the back.

School 11

Photo 90: Kikuyu runners planted in heart design surrounded by marigold seedlings.

Photo 91: Waste-water used to irrigate banana plants.

School 11

Photo 92: A well-developed vegetable garden with vegetables at different stages of growth.

Photo 93: Well established annuals growing in front of classrooms.

School 11

Photo 94: An attempt at fixing the fence.

Photo 95: Tree protected by bricks and thorn branches.

School 11

Photo 96: Young marigold seedlings protected by thorn branches.

Photo 97: Teachers collecting branches to protect plants

School 11

Photo 98: Pond lined with plastic

Photo 99: Pond with well-established Cyperus plants submerged in water.

School 11

Photo100: Thank you card from teachers to class for helping to develop the school garden.

School 12

Photo 101: Pond partly destroyed by vandals.

Photo 102: Annuals protected by thorn branches.

School 14

Photo 103: Area before showing Elephant Ears and alien Canna plants.

School 14

Photo 104: Beetroot growing.

Photo 105: Spinach growing.

School 14

Photo 106: Lettuce gone to seed.

Photo 107: Tomatoes show an excellent crop.

School 14

Photo 108: Daylilies planted as examples of monocotyledons.

Photo 109: Annuals in full bloom.

School 14

Photo 110: Sesbania tree which is an alien and should be eradicated.

Photo 111: Cannas on fence were split for propagation. It appears sheep don't eat the plants.

APPENDIX G – GARDENING SKILLS

GARDENING SKILLS

For each activity the participants were supposed to:

- write down how they would do the activity
- actually do it while the researcher observed
- then receive instruction on the correct way to do it
- then do it correctly
- and then write down the correct method.

They were all given extra material to take back to their schools to plant with their students.

List in the correct order the steps you would take to prepare a bed for planting
Explain how you would water your prepared bed
List in the correct order the steps you would take to sow seeds in trays
Explain how you would water your seed in the seedling trays
List in the correct order the steps you would take to sow seeds in situ
List in the correct order the steps you would take to plant annual seedlings into the soil (petunias, dahlias, mesembryanthemums, onions and gazanias)
How to control insects and disease
List in the correct order the steps you would take to plant a groundcover (verbena)
List in the correct order the steps you would take to plant a perennial (dietes and agapanthus, cannas, montbrecias and irises)
List in the correct order the steps you would take to plant a bulb
List in the correct order the steps you would take to plant a shrub (viburnum)
List in the correct order the steps you would take to plant a tree
List in the correct order the steps you would take to plant lawn (kikuyu)

APPENDIX H – REFLECTIONS ON THE STATE OF A SCHOOL GARDEN

Name: _____

School: _____

State of garden **POOR** **AVERAGE** **GOOD**

Reason for state of Garden _____

No. of times book Activities used _____

Activity	plants used	page	grade

Actual activities used With the plants, page And grade references

No. of new plants Planted in garden _____

Names of new plants Planted in garden _____

APPENDIX I – "DESIGN A PLANT"

DESIGN A PLANT

Design a plant that is a non-woody dicotyledon or monocotyledon that lives for only one season i.e. it is an annual. The plant must be able to reproduce and live for generation after generation. This plant must be able to survive the following conditions:

SEASON	PRECIPITATION	WIND
Autumn	very little rain	windy
Winter	no rain	moderate
Spring	mostly rain	windy
Summer	heavy rain	moderate

There are flying insects and all the other usual creatures which live in a place such as this.

Draw a leaf of your plant. Annotate (explain your label) your drawing.
Draw the stem of your plant. Annotate your drawing.
Draw the root system of your plant. Annotate your drawing.
Draw the flower of your plant. Annotate your drawing and show how many of each part theris.
Draw what the ovary will become after the egg has been fertilized. Annotate your drawing.
Draw the seed of your plant. Annotate your drawing.
Define "pollination".
How will your plant be pollinated?
Define "dispersal".
How will your plant's seeds be dispersed?
Define "germination".
What are the best conditions for the seeds to germinate under?
Name four adaptations your plant has which will help it to live and compete successfully generation after generation.
Sketch the life cycle of your plant (indicate the seasons).

Choose an equivalent part from the specimens provided (if the part is available) and build up your plant. Glue the parts down on a sheet of paper in the appropriate places.

APPENDIX J – THE "GARDENING WITH FLORA" BOOKLET

"Gardening with Flora"

INTRODUCTION

WHY THESE MATERIALS WERE DEVELOPED

The researcher has always been amazed at how few schools throughout the country have developed their school grounds into areas that are aesthetically pleasing yet at the same time possess plant material that can be used in the teaching situation. Some school gardens have a great amount of the same plant material, which is not often 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 may be due to the lack of the necessary gardening skills.

The researcher has for many years been involved in running gardening workshops for children and has reached the assumption that gardening is an exciting, approachable way to teach children about plants. By integrating a good gardening programme into the curriculum, gardening can be made easy and interdisciplinary. Interdisciplinary projects enhance people's ability to make connections among isolated facts, and to find meaning among facts. It not only educates the head, the heart and the hand, but it aids in the practical application of reading, writing and arithmetic. Gardening increases and develops the power of observation. It makes a person quick to grasp ideas and put these ideas into action. These are important foundations for success in any line of business. It develops moral character. Few things, if any, develop a love of industry better than a well-kept garden. Ever changing nature lures us on to help some favourite plant to grow until we love the work.

It is with these thoughts in mind that this piece of research is being undertaken. The research looks at the topic "plants" as the biological content in the context of developing a school garden, which is an environmental system. Its development can be seen as an example of outcomes-based education. The school garden can be considered a local environmental issue that each and every teacher can relate to. In developing the school garden the teachers must see it as having the potential to be used as a resource for teaching so that their teaching methodology can be improved. It should also help them to learn more about plants in a relevant way. The choice of plant material to be included in the garden will need to be considered very carefully so that the garden can remain sustainable for as long as possible.

Teachers need to be able to critically observe the status of their school grounds and to view the lack of its development as a local problem that needs to be tackled. If the necessary

knowledge, skills and attitudes can be imparted to the teachers, and they can impart these to their pupils, who hopefully will share their knowledge with their parents, then the whole community will be encouraged to uplift their own gardens.

Thus establishing a school garden may change the entire healthiness of a neighbourhood. The school grounds, themselves, may be better planned and healthier. Each pupil may soon want a garden at home. No matter how small the yard, there is room for a garden, even if it has to be established in a tomato-box. Often space in their yards has been used for ashes, tin cans or rubbish. What was once unsightly, unsanitary and unproductive, becomes a place of beauty and utility for a whole family. It can open up a source of revenue, create a love of industry, and a respect for property. If teachers can be empowered with the knowledge, skills and attitudes that will enable them to develop their school grounds in a sustainable manner and impart these attributes to their pupils, then the research will have gone a long way to producing environmentally literate citizens. These teachers can then be said to have developed professionally and become better botany teachers who are aware of their environment.

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APPENDIX K - CLASSROOM TEACHING OBSERVATION MATRIX

FORM 1 - OBSERVATION OF GROUP

Teacher: **Topic:**

School & Class: **Date:**

	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-26	17-28	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50
Verbal Activities																									
1. Asks questions requiring recall of previous learning																									
2. Asks questions requiring pupils' ideas																									
3. Asks for report/description of work																									
4. Asks questions for supervision/control (not topic)																									
5. Answers pupil's question																									
6. Answers own question																									
7. Explains meaning of words																									
8. Comments on pupils' work or answers																									
9. Asks pupils to comment on each others answers																									
10. Gives information																									
11. Gives instructions																									
12. Refers to worksheet																									
13. Other (write in)																									
Non-Verbal Activity																									
14. Uses blackboard to record pupil findings/ideas																									
15. Uses blackboard for other purpose																									
16. Organizes/distributes equipment																									
17. Demonstrates activity/what to do																									
18. Helped with use of specific equipment (not activity)																									
19. Listens to pupils																									
20. Observes pupils/not interacting																									
21. Other (write in)																									

Teacher: **Topic:**

School & Class: **Date:**

	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-26	17-28	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50
Relating to task:																									
1. Making observations																									
2. Raising questions																									
3. Suggesting hypothees (explanations)																									
4. Predicting																									
5. Finding patterms/relationships																									
6. Devising and planning investigations																									
7. Handling materials/equipment																									
8. Measuring/calculating																									
9. Recording																									
10. Other (write in)																									
Relating to teacher:																									
11. Asking about topic																									
12. Asking for help about procedure																									
13. Answering teacher's questions (fact/recall)																									
14. Answering teacher's questions (ideasl)																									
15. Reporting/explaining actions																									
16. Listening to teacher																									
17. Other (write in)																									
Relating to each other:																									
18. Organising task (co-operatively)																									
19. Organising task (argument)																									
20. Talk about topic/task																									
21. Talk about record/report																									
22. Non-tpoic/task talk																									
23. Listening/responding to others' ideas																									
24. Independent working																									
25. Number actively/purposefully working																									
26. Other (write in)																									

FORM 2 - OBSERVATIONS OF TEACHER

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APPENDIX L – QUESTIONNAIRE TO HEADS

School Garden Development Questionnaire to Heads of Participating Schools

Thank you for allowing some of your teachers to join me on the course: “How to develop your school garden”.

Would you be so kind and complete the questions below so that I can assess the course before I run it again. Please circle the correct option.

Has your participating teacher started to improve your school garden? Y or N.
If yes, in what way has it been improved? If not, why has it not been improved?
Have you been asked by your participating teachers for funds to improve your school garden? Y or N. If yes, what were the funds to be used for?
Have you noticed some of your other teachers been encouraged to help develop your school garden? Y or N. If yes, what were they doing in the school garden?
Have you noticed pupils who are taught by your participating teachers being involved in developing your school garden? Y or N. If yes, what were they doing?
Have you seen a change in the teaching methods used to teach plants, to outcomes based teaching, on the part of your participating teachers? Y or N. If yes, please mention the actual changes you have seen?
Do you agree with pupils getting involved in improving their school garden?
Y or N. If yes, why? If not, why not?
Have you had any feedback from parents regarding their children working in the school garden to improve it? Y or N. If yes, please state the type of feedback.
Have you heard any comments about the course on developing your school garden? Y or N. If yes, please list them.
Are you experiencing any problems in developing your school garden? Y or N.
If yes, please list them.
Do you feel that your school garden can be used to produce things that you can sell to raise funds for your school? Y or N. If yes, list what you would like to produce.
If not, why not.

I thank you for your time and hope that your school grounds benefit from your teachers’ participation on the course that was run!

NAME OF SCHOOL: _____ **NAME OF HEAD:** _____

APPENDIX M – QUESTIONNAIRE TO COLLEAGUES

School Garden Development Questionnaire to Colleagues of Participating Teachers within the Same School

Would you be so kind and complete the questions below so that I can assess the course before I run it again. Please circle the correct option.

1. Did your colleague who attended the "School Garden Development Course" give you any feedback on the course? **Y or N.** If yes, was it after every session? If it was not after every session, how often did you get feedback?
2. How was this feedback given?
3. Have you been involved in developing your school garden before this year? **Y or N.**
4. Have you been involved in developing your school garden this year? **Y or N.** If yes, why did you start to develop your school garden?
5. If you have started to develop your school garden what did you do?
6. Have you changed the way you teach any plant topics, to outcomes based teaching? **Y or N.**
7. Has the development of the school garden helped you do this? **Y or N.** If yes, please give examples of these changes.
8. If you have been using the garden as a teaching tool, is the attitude of your pupils negative or positive? **P or N.** If positive, list their reasons. If negative, list their reasons.
9. If you have started to improve your school garden, have you experienced any problems? **Y or N.** If yes, please list them.
10. How do you feel you can overcome these problems?
11. Do you have a garden at home? **Y or N.** If yes, list 10 plants that you have in it.
12. If you have used your school garden as teaching tool, have you had any feedback from parents regarding their children working in the school garden to improve it? **Y or N.** If yes, please state the type of feedback.
13. Have you heard any comments about the course on developing your school garden? **Y or N.** If yes, please list them.
14. Do you feel that your school garden can be used to produce things that you can sell to raise funds for your school? **Y or N.** If yes, list what you would like to produce. If not, why not.

I thank you for your time and hope that your school grounds benefit from your participation.

NAME OF SCHOOL: **NAME OF TEACHER:** **GRADE:**

APPENDIX N – QUESTIONNAIRE TO STUDENTS

School Garden Development Questionnaire to Students of Participating Teachers

What grade are you in? _____

1. Do you like plants? Yes or No

2. Have you got a garden with plants at home? Yes or No

3. Has your teacher taken you into the school garden to teach you about plants? Yes or No

Write down what she taught you.

What work have you done in your school garden?

4. Did you enjoy working in your school garden?

5. Did you tell your parents what you did in your school garden? Yes or No

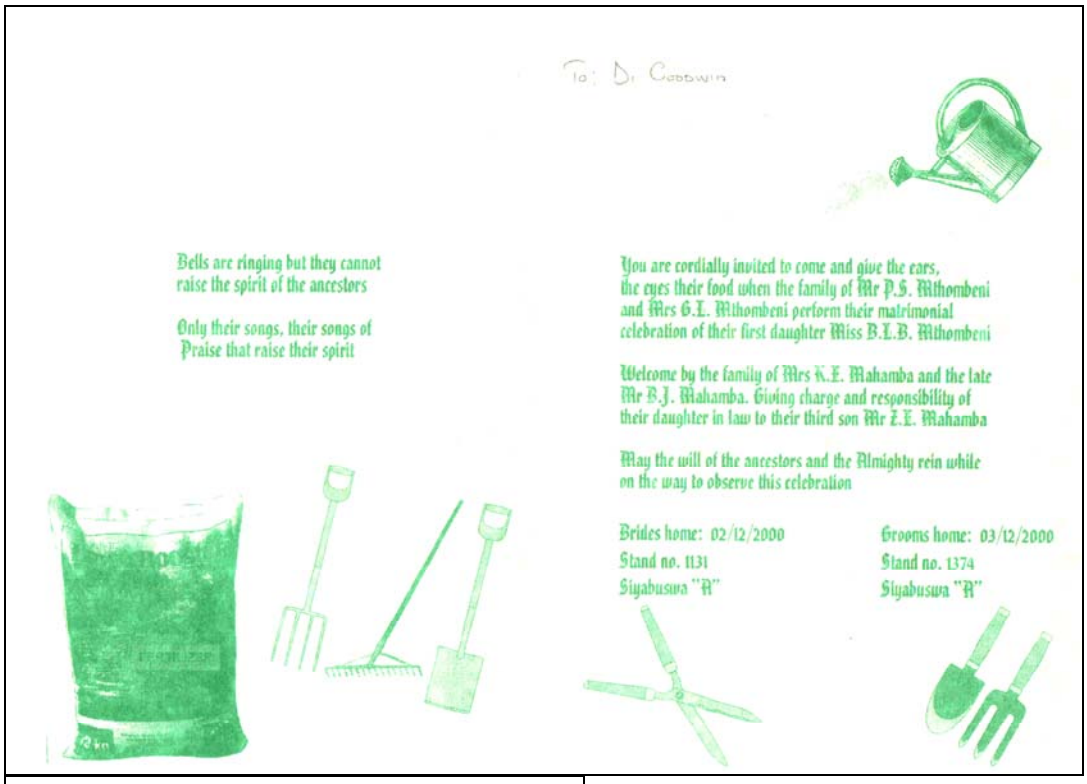
6. Do they like you working in the school garden instead of being in the classroom?

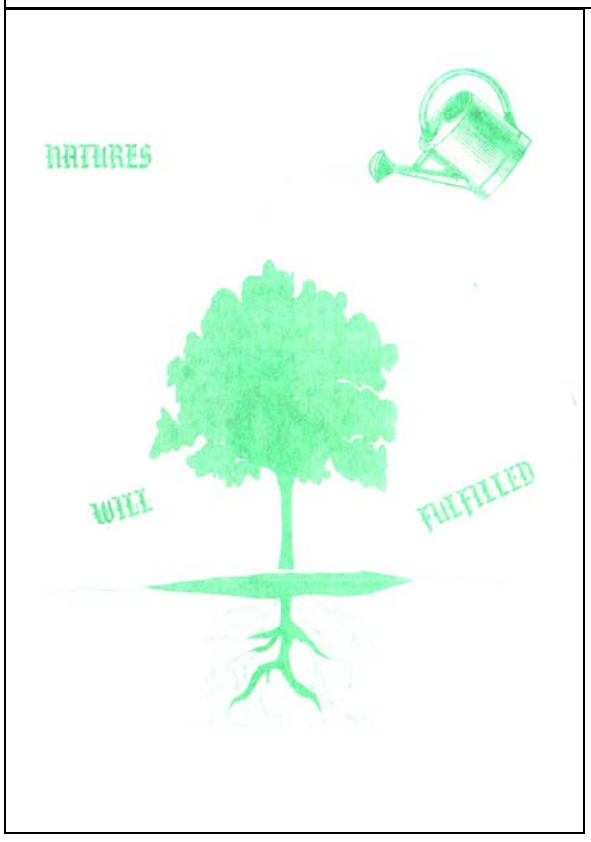
7. Draw a picture of what you like the most in your school garden.

NAME OF SCHOOL: _____ **NAME OF TEACHER:** _____

APPENDIX O – WEDDING INVITATION

TEACHER 4'S WEDDING INVITATION





To: Dr. Goodwin

Bells are ringing but they cannot
raise the spirit of the ancestors

Only their songs, their songs of
Praise that raise their spirit

You are cordially invited to come and give the ears,
the eyes their food when the family of Mr P.S. Mthombeni
and Mrs G.L. Mthombeni perform their matrimonial
celebration of their first daughter Miss B.L.B. Mthombeni

Welcome by the family of Mrs K.E. Mahamba and the late
Mr B.J. Mahamba. Giving charge and responsibility of
their daughter in law to their third son Mr Z.E. Mahamba

May the will of the ancestors and the Almighty rein while
on the way to observe this celebration

Brides home: 02/12/2000
Stand no. 1131
Siyabuswa "A"

Grooms home: 03/12/2000
Stand no. 1374
Siyabuswa "A"

NATURES

WILL

FULFILLED

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