# 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<br><br>skills to be able to conserve water<br><br>skills to be able to know how to keep the environment clean<br><br>skills to be able to know how to respect the environment<br><br>skills to be able to know how to plant trees<br><br>skills to be able to know how to encourage others to look after their environment which includes plants<br><br>skills to be able to know how plants can prevent soil erosion<br>skills to be able to know in which season to plant certain plants<br>skills to be able to know how to organize workshops to teach others how to care for the environment | importance of plants<br><br>the love and appreciation of plants<br><br>encourage the community to produce a community garden<br><br>the necessary skills to run workshops in the community<br><br>the skills to teach the community entrepreneurial skills | improvisation i.e. use branches of thorn trees to protect plants if there is no fence<br><br>discuss the issue with the relevant stakeholders<br><br>communicate with the relevant people<br><br>liaison with local environmental departments<br><br>initiate and co-ordinate workshops about environmental issues<br><br>make posters and speak to the media<br><br>teach people about the importance of plants<br><br>encourage active participation<br><br>develop places like clinics as gardens for the community<br><br>encourage unemployed citizens to develop projects which involve the planting of plants<br><br>make things happen for themselves rather than expect others to do it for them<br><br>read books help solve the issue<br><br>encourage people | 1. planting skills<br>2. how to make tools<br>3. identify the correct soil type<br>4. choice of an initial suitable area<br>5. planning skills<br>6. physical skills<br>7. pest control skills<br>8. preparation of the soil<br>9. knowledge of plants<br>10. mentoring skills<br>11. entrepreneurial skills<br>12. motivational skills<br>13. organizational skills<br>14. communication skills<br>15. watering skills<br>16. plant protection skills<br>17. fertilizing skills<br>18. caring for the plants skills<br>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<br><br>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<br><br>help people to become aware of the necessary legislation<br><br>instill in people the fact that they need to be responsible for their actions<br><br>knowledge of computer to access information and liase with other people who can help solve environmental issues<br><br>introduce campaigns aimed at teaching the communities about nature conservation<br><br>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.

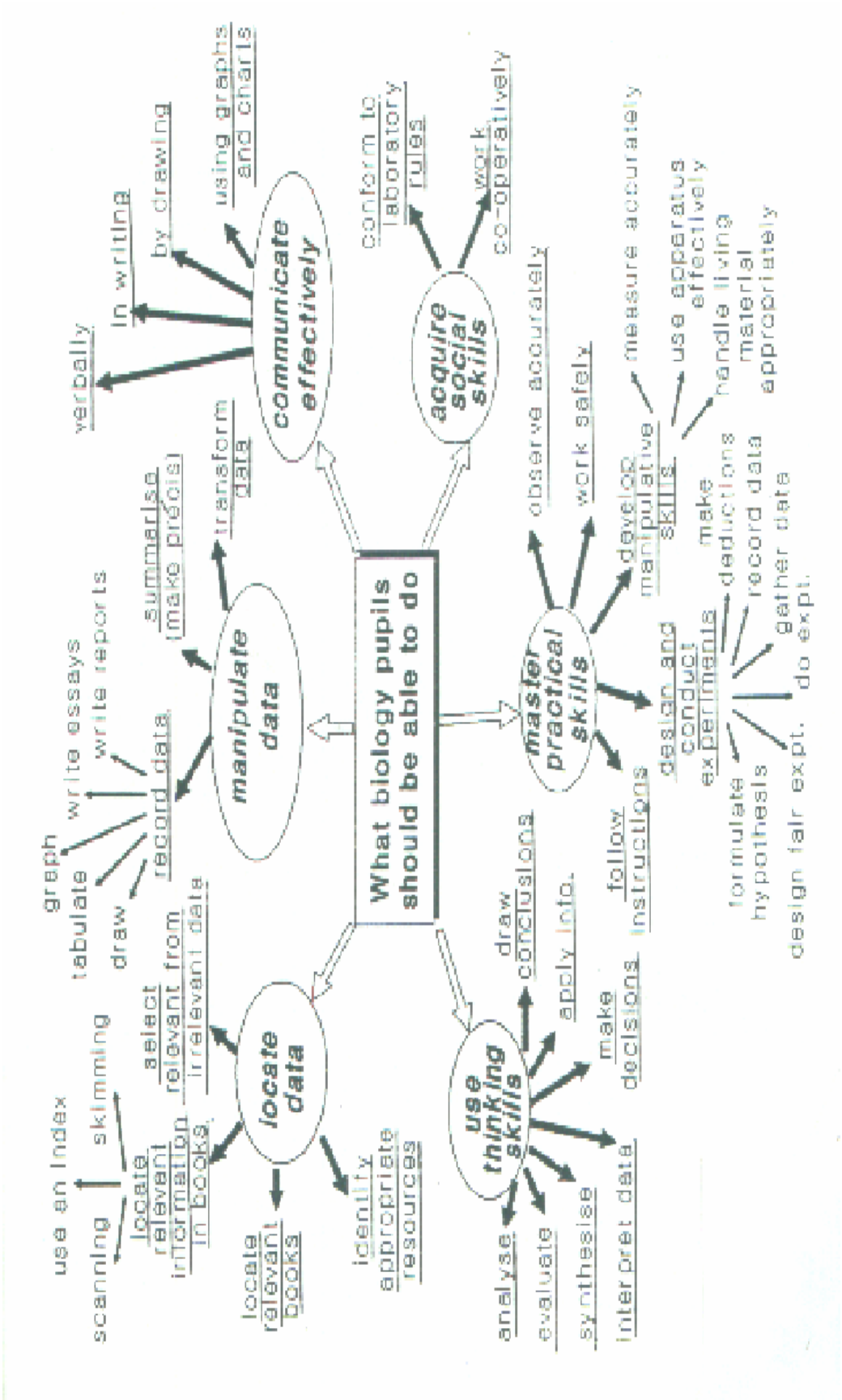


**FIGURE 5.1. "WHAT BIOLOGY PUPILS SHOULD BE ABLE TO DO" (from workshop presented by M. Saunders at University of Witwatersrand – 1999)**

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.