

CHAPTER 6

RESEARCH CONCLUSIONS AND RECOMMENDATIONS

6.A. REFLECTION ON THE PURPOSE OF THE STUDY

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

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

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

An issue underpinning this research was the teachers’ capacity to create their own materials. This research investigated whether the intervention in the main study brought about a change in the participants ability to produce learning programmes. It sought to determine whether the intervention in the main study brought about a change in the teachers’ plant knowledge. It probed into whether the intervention was able to bring about a change in the teachers’ professional development specifically with regard to them assessing their own teaching. It tried to determine whether the intervention was able to bring about a change in the teachers’ method of presenting plant material to their students and whether the development of a school garden and a booklet giving the skills to do this would be sufficient to bring about a change in the participants’ environmental literacy. It also attempted to determine whether there was an increase in the use of the resources for teaching and whether the teachers were facilitative after the intervention of the main study and were now more competent and skilled to teach about plants in a hands-on way.

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

Neathery et al. (1997) showed that over time, with repeated observations, students became conscious that the environment was something to respect and think of all the time. It may take multiple years to develop "awareness" fully, but each garden along the way can contribute to the overall result. This research attempted to duplicate these results as applicable to a reduced number of years.

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

6.B. ASSESSMENT OF THE PROGRAMME

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

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

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

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

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

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

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

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

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

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

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

PROFILE OF IMPLEMENTATION

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

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

CAPACITY TO SUPPORT INNOVATION

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

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

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

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

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

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

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

SUPPORT FROM OUTSIDE AGENCIES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Issue 1: Key support structures are critical to reform success

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

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

- peer coach the classroom teacher.

Thus the “Support Teachers” could:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.G. CONCLUSION

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