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**THE CLASSROOM TRANSFERABILITY OF A
UNIVERSITY-BASED INSET PROGRAMME OF
WORKSHOPS IN PRACTICAL WORK FOR SENIOR HIGH
SCHOOL BIOLOGY EDUCATORS**

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A minor dissertation submitted to the University of Cape Town in partial fulfillment
of the requirements for award of the degree of
Master of Education (Science Education)

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University of Cape Town
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DECLARATION

This work has not been submitted previously in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

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LIST OF ABBREVIATIONS

- ANC – African National Congress
- CeeBT – Continuing Education for European Biology Teachers
- DOE – DoE
- FET – Further Education and Training
- GET – General Education and Training
- HIV – Human Immuno-Deficiency Virus
- ICASE - The International Council for Associations of Science Education
- INSET – In-Service Training and Education
- IUBS-CBE - International Union of Biological Sciences' Commission for Biological Education
- LEA – Local Education Authority
- NCS – National Curriculum Statement
- NQF – National Qualifications Framework
- NRC - National Research Council
- OBE – Outcomes-based Education
- RNCS – Revised National Curriculum Statement
- SACE – South African Council of Educators
- SAQA – South African Qualifications Authority
- STS - Science, Technology and Society
- STSP - Science, Technology, Society and Personal Development
- UNCSTD - United Nations Conference on Science and Technology for Development
- UNESCO - United Nations Educational, Scientific and Cultural Organisation
- WCED – Western Cape Education Department

Professional criteria for assessing (a) the success and transferability of the programme and (b) the quality of the research evidence gathered from the Biology teachers and their learners in Cape Town, were adopted from a combination of the theoretical frameworks for INSET evaluation recommended by several authors, including the American National Science Standards (1996), Tamir (1997) and Dyasi & Dyasi (2000).

The post-workshop data indicated that educators enjoyed the practical activities, and were active in implementing a number of them with their classes in subsequent years. It further revealed that their confidence in engaging in practical work improved significantly. To verify or corroborate these findings, ten educators observed at from the 1999 course were interviewed from 2002 to 2005. One educator was observed at two different schools, with different socio-economic backgrounds. The interviews were transcribed and five of the educators were observed while they dealt with the practical activities learnt during this series of workshops. The visual data from the classroom observations, and the interviews were further processed and compared to the quantitative statistical data.

It was found that, of the eight schools, four well-resourced schools implemented the programme successfully. This was in terms of the number of practical activities from the course that had been transferred to the classroom. Three of the under-resourced schools, with larger classes, also implemented the course successfully. This was due to the skills and motivation which the educators gained whilst participating in this series of workshops. In two of the schools the high rate of vandalism and the heavy workload of the educators was excessive to the point that they could not implement the programme successfully.

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1.1 The origin and purpose of this investigation

The purpose of this investigation is to evaluate the success of a university-based INSET programme of workshops aimed at increasing the practical skills of FET (Further Education and Training) Biology educators through a series of workshops. The need for this INSET programme arose out of the realisation of Dr. Val Abratt of the Department of Molecular and Cellular Biology of the University of Cape Town that many FET Biology educators do not have sufficient skills and/or resources to undertake the amount of practical work required by the Continuous Assessment system introduced in the late 1990s (Francis, 2006) by the DoE (DoE)¹.

Due to one FET educator, Ms X, from an under-resourced school asking for help, Dr. Abratt, designed a series of workshops demonstrating practical activities with inexpensive materials. To obtain feedback, she and her team (Abratt, Miller, Cuiro, and Scholtz, 2000) used a pre-course and two post-course questionnaires. However, a need arose to evaluate their long-term effectiveness and sustainability in order to justify the time and effort devoted to repeating this programme of workshops over several years.

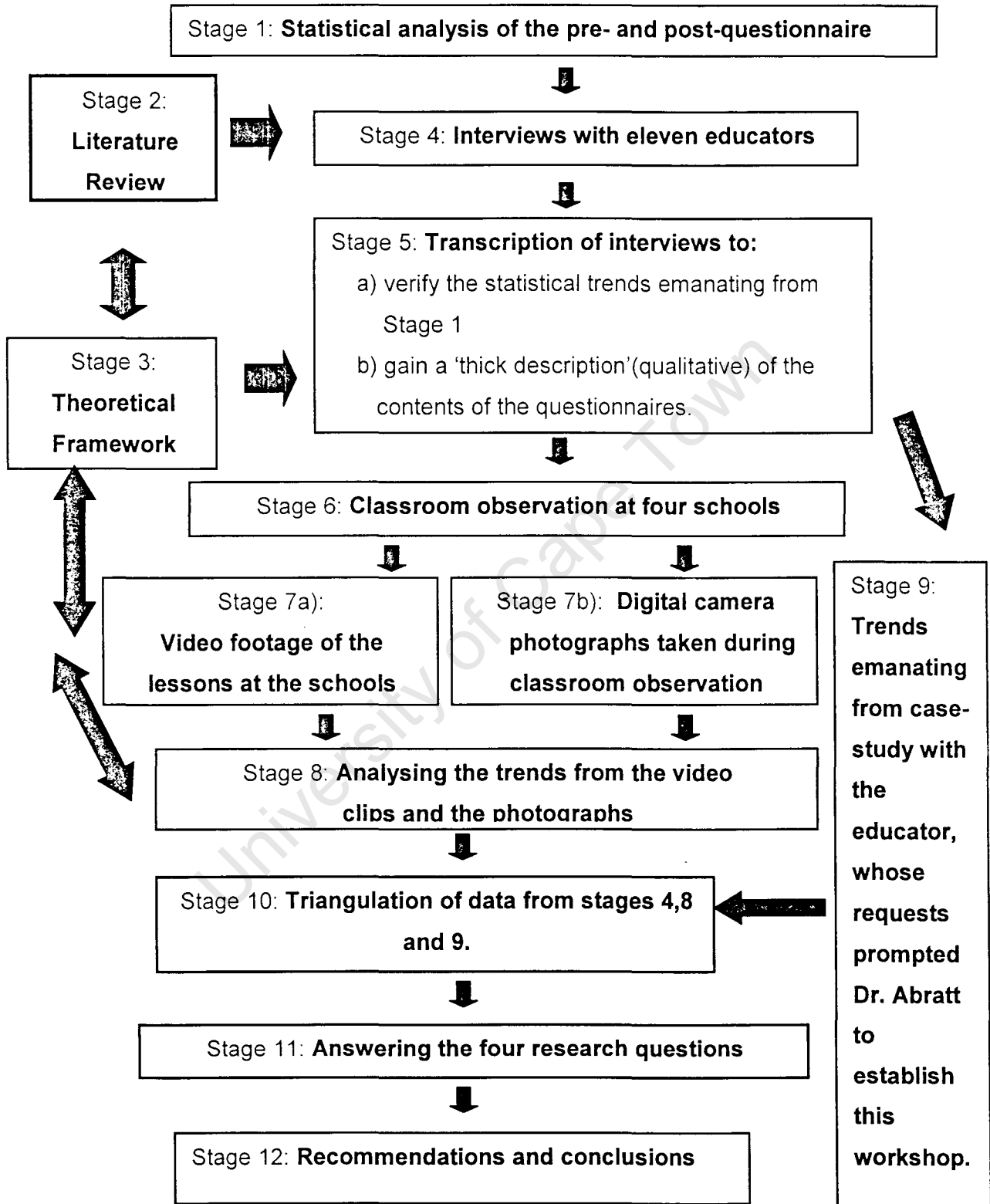
This INSET programme of workshops was to be evaluated in terms of:

- a) the extent to which the biology educators subsequently transferred the activities to their classrooms, and their reported satisfaction and effectiveness in doing so;
- b) the more detailed explanations supplied by a representative sample of eleven educators through interviews and video-recorded lessons of the implemented practical activities.

¹ Department of Education – In this dissertation this denotes any curriculum or policy document of South Africa's Department of Education

An overview of the research design has been outlined in Figure 1.1 on p. 3.

Figure 1.1 Research design for this investigation



1.2 Background and importance of this study: the greater prominence of practical work in the new curriculum.

The theoretical content and the practical outcomes of Biology at FET, Grade 10 to 12, levels appear in the Life Sciences section of the National Curriculum Statement (2003). This document gives much more importance to the application of knowledge and skills than the previous interim curriculum for Biology that had been covered in all our schools since 1995. The four outcomes of Life Sciences extend the foundation laid by the three learning outcomes of the Natural Sciences Learning Area, to which learners are exposed from Grades 7 to 9.

Learning Outcome 1: Scientific Investigation and Problem – solving skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem-solving, critical thinking and other skills

Learning Outcome 2: Constructing and Application of Life Science Knowledge

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

(DOE, 2003:12)

In discussing these three outcomes, the policy document describes how the first outcome involves data-handling and experimental skills. Learners have to make hypotheses in 'order to solve bigger problems.' The second outcome also highlights that Biology learners will need to use 'inquiry and thinking skills' to apply their understanding of concepts, theories, etc.

This new curriculum has taken into account the international research that indicates that process skills should be included as part of investigative work, and that experimental work should involve 'active learner participation' (Jenkins, 1999: 27-30; Millar, Le Marchéhal and Tiberghien, 1999: 36-40 cited in Leach and Paulsen, 1999).

1.3 Continuous Assessment and the new curriculum necessitate the upgrading of educators' practical skills.

According to current timelines, the new curriculum is being implemented in 2006 at FET level, i.e. when the Grade 8s of 2004 enter Grade 10. However, since the late 1990s Grade 12 Biology educators have had to submit a continuous assessment (CASS) mark for each learner. Practical work performance had to form part of this mark. This requirement obliged many teachers not only to teach experiments related to Grade 12 topics out of the textbooks, but also to demonstrate experiments and to allow learners to conduct experiments themselves. Conducting practical work is difficult in schools where there are no laboratories or science apparatus or electricity, as is the case in many South African schools (Monare and Sapa 2001:1; DoE, 2001:20).

For historical reasons such as these, in the late 1990s a Biology educator contacted Dr. Abratt of the University of Cape Town's Molecular and Cellular Biology Department. After bringing her entire matric class to use Dr. Abratt's laboratory facilities to conduct experiments, this teacher's enthusiasm helped Dr. Abratt to decide to design and organise the first INSET Biology workshop in 1998.

Dr. Abratt believes that practical work is an important teaching tool, since it can be useful to teach abstract principles in a relevant way. She and her collaborators from several biological disciplines at two other Cape tertiary education institutions wanted to emphasise and encourage the use of easily obtainable and inexpensive equipment and reagents to perform syllabus-related scientific investigations.

1.4 Objectives of this INSET programme of workshops for biology educators

The first objective of this group in 1998 was to develop the theoretical and practical content of the workshops. The second objective from 1999 to 2002 was to create teaching aids and techniques to suit the needs of large classes.

These two objectives had been reached by January 2002. The third objective has been to create on-going regional networks of enthusiastic biology educators. Their fourth objective was to evaluate the effectiveness of this programme in achieving the other three goals over the period 2003-2004 with samples of participant educators.

1.5 A preliminary evaluation of this workshop highlights the need for further assessment

The responses of 68 participant educators to one pre- and two post-course questionnaires (Appendix A), have already been analysed statistically in a status study (Appendix B). Dr. Abratt then felt that in-depth, follow-up interviews of the participants would be the best method to evaluate the sustained dynamics or efficacy of the programme, in the long term. .

This would imply using selected interviews as one of several means to establish to what extent an individual biology educator's classroom practice regarding investigative work had changed as a result of the programme. This would obviously be seen from the viewpoint of the educator (Abratt et al., 2000: 9)

Many of the educators who attended the first programme in 1998 reported that they did not feel confident about conducting practical work, despite 65% of them being university graduates (Abratt et al., 2000:8). As a group, these teachers did possess the necessary theoretical qualifications for their positions, although many teachers in South Africa do not.

A possible cause of this lack of confidence might have been that participant teachers were so pressurised to prepare students to produce satisfactory results during the final matriculation examination, that they were neglecting practical work. Alternatively, they might not have been given the opportunity to develop the necessary practical skills during their own school career or tertiary education.

In 1998, 17 of the first 25 participants of the workshop rated themselves as 'most interested' in biology (rating 5 out of a possible 5). The remaining eight participants gave themselves a rating of four. Despite the high-level of interest that these educators have in biology, most of the participants regarded their self-reported competence level for conducting practical investigations with their classes as being below average (Abratt et al., 2000:11).

After performing the fifteen activities/tasks in the four weekly sessions of these INSET workshops, there was a significant correlation between the participant educators' levels of interest and their participants' perceptions of their ability to undertake practical work as recorded in Table 1.1.

Table 1.1 Biology teachers' self-reported interest and practical competence before and after attending the course [Ratings: 5 (most interested or skilled) to 1 (least interested or skilled)]. Adapted from (Abratt et al., 2000:11)

	Ranking	Before <i>(no. of teachers giving themselves this ranking)</i>	After <i>(no. of teachers giving themselves this ranking)</i>
Teachers' self-reported interest in Biology	5	17	17
	4	8	8
	3	0	0
	2	0	0
	1	0	0
Teachers' self-reported perception of their practical competence	5	4	9
	4	5	15
	3	11	1
	2	3	0
	1	2	0

When presenting a paper about the first two INSET workshops in 1998 and 1999, Dr. Abratt referred to the work of two Israeli educators, Tamir and Barrenholz (1997). Their work was aimed at attracting children from disadvantaged, developing communities in Galilee to science through an extended study of Biology. This work led Tamir to develop criteria for successful INSET programmes. He concluded that an effective INSET programme is not only one which results in improving teachers' knowledge and skills, but one which also subsequently succeeds in modifying classroom or laboratory teaching practices in the intended direction (Barrenholz & Tamir, 1997: 78-80).

From the onset, Dr. Abratt realised that this INSET programme of workshops, which she and her colleagues were presenting in Cape Town, would have to offer realistic solutions to issues such as conducting practical work in schools with large classes and insufficient facilities, in order to modify the educators' teaching practice in the subsequent months and years from 1998 to 2005.

1.6 The government's commitment to INSET for FET educators contextualises this investigation

At about this time, the leaders in the national DoE had realised that the successful implementation of OBE at FET level would have to involve INSET. Educators were not sufficiently prepared for the implementation of OBE at the lower levels of education, as was revealed in the report of the Review Committee of Curriculum 2005 (DOE, 2001).

This commitment to INSET for educators was evident in a public statement which Reg Brijraj, the chief executive of the South African Council of Educators made to the press. He explained that R100 million had been set aside by the Education Labour Relations Council in order to prepare South African educators for the implementation of Outcomes-based education (OBE) at General Education and Training (GET) and FET levels (Monare and Sapa, 2001:1).

As part of the implementation of a project to raise the quality of science and mathematics education in one hundred schools, the Council of Education Ministers agreed to release funds for INSET programmes for 20 000 teachers (Monare and Sapa, 2001:1). This commitment by the government to INSET for educators was further emphasised by the Skills Development Act (Act no. 97 of 1998) that places certain responsibilities on employers regarding staff development (DOL, 1998:Chapters 1, 2 and 7). The Department of Labour and the DoE co-operated closely in this arena. For any staff development programme to be officially recognised, it had to meet the requirements of the South African Qualifications Authority (SAQA) so that it can be receive credits according to the National Qualifications Framework (NQF). The NQF is a system of registering qualifications (DoE, 1995:2-6). Considering that the largest section of South African educators were employed by the provincial education departments, the state made itself legally responsible for INSET of the educators which they were employing.

These developments did more than merely contextualise Dr. Abratt's INSET workshop: they also had the potential to be a source of finance in the future, if evidence could be found to justify the long-term sustainability of this INSET workshop. This is precisely the aim of this study: to discover and disseminate the supportive evidence, if it exists.

1.7 Research questions

This investigation seeks answers to four leading research questions:-

Theoretical criteria for INSET programmes

- 1 What criteria, derived from the literature, should be used to evaluate the effectiveness of INSET programmes for educators, with special reference to practical work in biology?
- 2 Considering these benchmark criteria for determining the success of INSET programmes, are current theories of INSET appropriate for assessing INSET initiatives for South African FET Biology or Science educators?

3 Quantitative aspects of the school-based implementation of this INSET programme

3.1 Of the 15 biology practical activities rehearsed by the 68 teachers during this INSET initiative, how many did they subsequently use in their normal lessons?

3.2 According to the self-reporting scale used to measure their level of confidence before and after the programme, did the teachers' reported levels of confidence about their ability to conduct practical work improve as a result of participating in this INSET programme?

4 Assessing the classroom transferability of the INSET programme using a qualitative approach

4.1 What were the influences or factors in interviews reported by a sample of eleven educators that led to the successful classroom transferability and the implementation of the practical skills and activities acquired during the INSET programme for FET Biology educators?

4.2 According to the educators who were interviewed, why did these factors or reported influences lead to the successful classroom transferability of this INSET programme?

4.3 What factors did the eleven interviewees identify as constraints to the implementation of those practical activities in their own classroom?

4.4 To what extent have the educators been able to overcome at least some of the above constraints?

1.8 The research task

Research questions 1 to 4 will be answered by generating and analysing data from:

- the 68 participants' existing responses to pre - and post - course questionnaires;
- follow-up interviews with ten educators (eleven interviews in total due to one educator being interviewed at schools in two contrasting environments);
- classroom observations of 5 teachers who were interviewed; and
- a case study based on an in-depth interview with the educator, Ms X, whose requests for assistance from UCT's Molecular and Cellular Biology department led to the creation of this INSET programme.

1.9 Definitions of terms

Reported influences – Factors which the INSET biology educators identify themselves unprompted in interviews, as ones which subsequently impacted on the classroom use of the skills and activities they rehearsed and practiced during the INSET workshop programme.

Transferability – In this context, the extent to which the rehearsed workshop skills and activities were subsequently used by the educators in their school lessons. This implies establishing which of these skills and activities were used and how frequently.

FET Biology educators – Biology teachers who teach learners in Grades 10 to 12 in the FET phase, or the last three years of the current South African school system.

INSET – An internationally recognised umbrella term for in-service education and training programmes/projects/initiatives.

... in-service education and training, may, in the most general sense, be taken to include everything that happens to the teacher from the day he/she takes up his first appointment to the day he retires which contributes, directly or indirectly, to the way in which he executes his professional duties.

(Henderson, 1997:163, cited in Bagwandeem & Louw, 1993:19)

... initial and in-service training, which commences with a more explicit focus on high-level knowledge, in order to equip teachers with both the confidence and knowledge to undertake learner – and more specifically learning – centred classroom practice. Without a secure knowledge base to build on, free standing in-service courses on assessment are unlikely to have any purchase on classroom change

(Taylor & Vinjevold, 1999:203)

INSET workshop – The INSET programme organised for FET Biology educators in Cape Town schools by the Microbiology Department of the University of Cape Town, in collaboration with colleagues from the University of the Western Cape and Peninsula Technikon, and held in the laboratories at the University of Cape Town. The programme comprised four three-hour sessions with one per week for four consecutive weeks.

Bagwandeem & Louw (1993:19) use the following definition of a workshop:-

...almost anything from a series a field trips or a scientific expedition to an intensive study of educational problems.

(Hildreth, 1945:310, cited in Moffitt, 1963:25, cited in Bagwandeem & Louw, 1993:113)

Efficacy – The effectiveness or success of the programme. The number of participants who subsequently used a particular activity conducted on the programme, and the perceived success rating which participants assigned to each activity when they actually used it in the classroom, will be used as indicators of the efficacy and effectiveness of a particular activity. The success ratings given to all activities and the assessment information revealed in the interviews will be used as yardsticks to judge the overall effectiveness of the activities in the workshop.

Curriculum 2005 – The new South African Outcomes-based Education curriculum. In 2001 it was introduced at Grade 8 level. At this stage it is intended to be introduced at Grade 10 level in 2006, so that these learners will graduate with an Outcomes-based school-leaving certificate in 2008.

RNCS – Revised National Curriculum statement. This document contains sections for every compulsory learning area from Reception to Grade 9. It contains the detail for the *General Education and Training (GET)* phase of South Africa's Outcomes-based curriculum. It was published as a result of the Report of the Review Committee of Curriculum 2005. It was implemented in 2004 for the first time in most schools.

NCS – National Curriculum Statement. This document contains the curriculum for Grades 10-12 or the *Further Education and Training (FET)*. It was drafted in 2002 and then printed in 2003. It is being implemented in Grade 10 in 2006. It is also an Outcomes-based curriculum.

DOL – Department of Labour. This refers to South Africa's national DoE. The abbreviation is also used to reference policy documents published by this department.

WCED - Western Cape Education Department. This refers to the provincial education department which governs the schools involved in this study to a lesser or greater extent.

1.10 Chapter summary

The prime objective of this investigation is to evaluate a follow-up on the success of a university-based INSET programme for 90 FET Biology educators. This involves:

- a) assessing what criteria, derived from the literature research, are appropriate to evaluate the effectiveness of an INSET programmes for biology educators, with special reference to practical work in biology ; and
- b) using detailed and comprehensive data gathered during interviews and classroom observation to evaluate how many of the selected criteria, were evident in the implementation of this INSET intervention by eleven selected educators.

Once the two steps above have been completed, an informed judgement about the effectiveness in terms of classroom transferability can be reached and the research questions can be answered.

The origin of this investigation lies in Dr. Val Abratt's need to evaluate the long-term effectiveness i.e., the classroom transferability of her specific context-based INSET programme. Dr. Abratt realised that the new form of Continuous Assessment demanded that educators undertook more practical activities and designed data-response questions, but that many educators did not have sufficient equipment or skills to design the necessary activities. As a result, she designed this INSET programme of workshops. Since it was impossible to visit all 90 participant biology educators in their lessons, a representative sample of eleven educators will be used for in-depth qualitative investigation.

2.1 International trends in biology education

2.1.1 International trends in biology education during the 1970s and 1980s

Internationally, the scope of biology education has changed during the last thirty years.

Biology is no longer an isolated discipline, remote from the concerns of society. In the 21st century, biologically related challenges facing society range from protecting endangered species and fragile environments to deciding whether or not we need to use genetic engineering to cure inherited diseases (El-Nemr & Tolymat, 2000:1). No matter where a young teenager goes to school and under which conditions Biology is taught, biological issues like the effect of substance abuse on the human body and the transmission of HIV (Human Immuno-deficiency Virus) are essential to their daily lives. Therefore, Biology as a discipline, finds itself at the centre of some of the most serious controversial issues of our time (Levine & Miller, 1994 in El-Nemr & Tolymat, 2000:1).

During the 1970s there was a significant thrust for the socio-economic applications of Science to a wide range of changing human needs that began to gain impetus. Trends such as 'science in society' and 'science, technology and society' placed Biology teaching in the context of social needs of everyday life in developed countries like the United Kingdom and the United States. This moved the focus of biology instructions from 'what to know' to 'what to do' (Vohra, 2000: 4). Biology teacher education and training programmes also changed accordingly.

By 1979 at the United Nations Conference on Science and Technology for Development (UNCSTD), Science and Technology were recognised as fields of study which are essential contributors to the national development of any country. Therefore, in the 1980s, the new drive was for Science and Technology to form an important part of general education, enabling students to be responsible and productive citizens in society by the end of their school careers.

This shifted the purpose of biology education and teacher training towards social interaction in a different manner from the emphasis of the 1970s. The emphasis now moved from 'what to do' to 'what to become'.

In the late 1970s and early 1980s, socio-economic changes were occurring as a result of scientific or technological developments. It became apparent that biology education should prepare students to face situations and changing social patterns in a manner that it would satisfy the individual needs of students as well as the collective needs of the society in which they live. This led to organisations like the Association for Science Education in the United Kingdom suggesting that some aspects of the worlds of work be incorporated, into the school science curriculum. Other organisations, like IUBS-CBE (the International Union of Biological Sciences' Commission for Biological Education), devoted meetings to encouraging public awareness of the inter-relationship between Science, Technology and Society, and published booklets on topics that would narrow the gap between traditional Biology topics and the world of work.

Developing countries also realised that Science and Technology education could contribute to national development. UNCSTD was followed by the International Congress on Science and Technology Education and National Development in 1981. The Bangalore Conference, sponsored by ICSU (International Council for Science Unions), UNESCO (the United Nations Educational, Scientific and Cultural Organisation) and ICASE (the International Council for Associations of Science Education) (1985), resulted in science education reform in the context of future human needs and various quality issues such as ethics, social responsibility, agriculture, industry, technology, health, food, energy, environment; land, mineral, and water resources; and information transfer (Vohra, 2000: 3-4). Not only did IUBS-CBE develop documents such as '*Biological Education and Community Development*', but many similar publications followed. This new slant is now an integral part of many biology learning programmes across the world, including South Africa's Revised Curriculum Statement at GET and the new proposed FET programme.

This is discussed in further detail in section 2.1.4, pp 28 - 38.

The implication of these trends for senior biology high school curricula and educators has been:

- to include the socio-economic applications of biology in accordance with science, society and the technology emphasis of the 1970s;
- to include more practical work in biology courses;
- to narrow the gap between theoretical biological knowledge and the application thereof in modern society (world of work);
- to encourage social responsibility and ethics among learners regarding the application of biological concepts; and
- developing countries, including South Africa, have invested in science and technology education in the belief that it will boost national development.

2.1.2 International trends in biology education in the 1990s

This new emphasis towards social action expanded the slogan, 'Science, Technology and Society (STS)' to 'Science, Technology, Society and Personal Development (STSP).' The personal development aspect, as described in the UNESCO Regional Workshop on Science and Technology Education at Lower Secondary Level (1991), now recognized the possibilities within the Science curriculum to improve students' personal life skills. These included: problem solving and logical thinking, expression, personal organisation, self-directed learning, co-operation and responsible action. This approach demanded that teachers pay more attention to teaching children how to learn and how to manage their own learning, analyze problems, as well as design and implement solutions (Vohra, 2000: 4).

All the cognitive skills mentioned in the previous paragraph were important in the new 'integrative approach' that was adopted by the IUBS.

As explained by the French biology educator, Cecile Vander Borght at the BIOED2000 conference in Paris in July 2000, this approach deals with integration across all levels of biological organisation. The integrative approach starts with a problem or project rather than the logic of Biology (Vander Broght, 2000: 2 - 4).

Vander Borght stated that this approach implied that biology concepts should not be taught only because they are part of the scientific knowledge of the discipline. Concepts need to justify their place in the curriculum according to some criteria. She mentioned that the first justification for teaching biology concepts is that they are useful in everyday life (i.e. the utility argument). The second justification is that a global understanding of biology concepts is necessary in order to participate in debate, discussion and decision-making about topics that have a biological component. This is the democratic argument. Thirdly, scientific knowledge is a milestone of a culture and, therefore, students should be exposed to these achievements – this is the cultural argument. These arguments imply that schools need to rethink their educational goals for biology education.

A whole section of the BIOED2000 Conference consisted of papers delivered under the title of the 'integrative approach'. These papers emphasised the need to start with problems or questions associated with a topic and then to use these questions to introduce the information and concepts associated with the topic. They also emphasised the need for an interdisciplinary approach that implies, for example, that when teachers are covering the structure and the functioning of the ear in Biology, they are also exposed to sound in Physics. As an international justification for this approach in secondary schools, Vander Broght refers to other educationalists who reason that we live in a continually changing world – an 'age of uncertainty'. Students need to be given the capacity and confidence to solve their problems in contextualised situations (Giust- Despriaries, 2000 in Vander Borght, 2000: 4).

In one of the plenary sessions of the same BIOED2000 conference Vohra stated that Science and Technology could successfully contribute to the development of a country only if a large proportion of the country is scientifically literate (Yager, 1989; Bowyer, 1990 in Vohra 2000: 4). The goal of an 'appropriate science education for all' started assuming greater prominence.

In Canada the 'Science for Every Student' programme was launched; in America the 'Science for All Americans' Project was launched in 1985. The 'Science for All' programme in Asia and the Pacific started in the mid-1980s (UNESCO, 1983 in Vohra 2000: 4). In the 'Science for All' initiative, science referred to all those aspects of knowledge that result from the application of the scientific method for investigating real life situations relating to natural phenomena. These include: the material world, and the immediate environment, scientific concepts, processes and attitudes. The purpose of these initiatives was to enable the entire population of a particular country to become responsible users of science and technology (Vohra, 2000:4).

Another event that held significance for most biology educators on a global level was the International Commission on Education for the 21st Century convened by UNESCO in 1993. After a global process of consultation and analysis, the Commission highlighted the vital role of education in personal and social development.

The Commission also predicted that the coming century would face some serious tensions between the global and the local; the universal and the individual; tradition and modernity; long-term and short-term considerations, the need for competition and concern for equality of opportunity. Important tensions would also be experienced between the extraordinary expansion of knowledge and the human capacity to assimilate it, and the spiritual and the material.

The Commission believed that, despite diversity of cultures and social systems, education was to become one of the means to foster more harmonious human development to overcome the said tensions and maintain social cohesion.

This resulted in the Commission proposing and describing four pillars as the foundations of education: learning to know, learning to do, learning to be, and learning to live together. The Commission stressed that, in order to deal with the fast change of traditional patterns of life and to meet new situations arising in our personal lives and working conditions, the 'learning to live together' pillar should receive the greatest emphasis from educators.

For individuals to function effectively in an ever-changing world, the Commission emphasised learning throughout life – and this culminated in the concept of 'lifelong learning' gaining importance in the eyes of educational planners (UNESCO, 1996 in Vohra, 2000:5). One way of ensuring that learners in the school system become 'lifelong learners' is for individuals 'to learn how to learn' at a young age (UNESCO, 1996 in Vohra, 2000:5).

The twentieth century has been called the century of Physics and Information Technologies, since it has seen the development of television, computers, satellites and the Internet. Whilst these technologies will continue to affect our lives and our social, cultural, economic and educational systems, the Biological Sciences have also been advancing at a dramatic pace. The research in biotechnology and the success of the Human Genome Project have sparked widespread interest. People will be able to assess their own genetic susceptibilities to various diseases and as a result make necessary lifestyle adjustments. It is predicted that gene therapy could replace some of the current medical practices for the treatment of certain forms of disease.

Genetic manipulation has already been applied to agriculture (Joubert, 2005a) and it is predicted that it could influence almost all our activities. The impact of such manipulation profoundly affects ethical, legal, social, cultural, educational, and development issues. In order to be prepared for this, today's scholars, the media, educational planners and biology educators need to work together to educate future citizens and the public at large. They must be made aware of the responsibilities that accompany the application of these technologies to our daily lives (Vohra, 2000:4).

This emphasises the need for learners to be exposed, not only to the content associated with biotechnology and genetic manipulation, but also to participate in activities where they are required to apply this knowledge. They should participate in for a in which they may make decisions about how the use of this knowledge will affect communities, i.e. looking at how the application of this biological knowledge affects our 'living together'.

Activities like these will also involve linking biological knowledge to other learning areas or subjects such as geography. This links to the new 'integrative approach', discussed on p16.

One of the papers delivered at the BIOED2000 conference included a clear warning about some of the difficulties that educators will face when moving from the more traditional 'teaching' approach to the 'learning approach' in biology lessons (Griffiths & Moon 2000:1). One of these difficulties is that not all students find self-directed learning easy and so educators need to provide structures to help students to learn in a more independent manner. Griffiths and Moon (2000:2) suggested that the processing tasks that they have developed for genetics can be applied in any area of biology or science. Such tasks include: problem-solving activities, simulation of solutions to problems and concept maps, etc. All these tasks are processing tasks, because they promote active engagement with programme material. Griffiths and Moon also explain that educators wanting to a switch from teaching to learning will encounter resistance ranging from: students, parents and even administrators and they suggest that explaining the new strategy or activity beforehand is the best solution to resistance (Griffiths & Moon, 2000:3). These educators go further to say that the switch from learning to teaching will be successful, if a meaningful context is provided in which the biology learning can take place.

Possible implications of these international trends for biology curricula and biology educators are as follows:

- biology lessons can be used to improve the personal skills, particularly problem-solving and other cognitive skills, of individual learners;
- the need to improve the importance of cognitive skills and to make subject content more relevant to the lives of learners, resulted in the 'integrative approach';
- the 'integrative approach' not only emphasises the interdisciplinary approach between biology and other disciplines, but it also requires that subject material must meet meaningful criteria before it can be included in a curriculum;
- biology curricula need to make science more accessible for a larger portion of the population;
- the dramatic developments in biotechnology and genetics have emphasised that the public and the private sector need to work together in order to educate learners to become responsible citizens with regard to the application of biology in their daily lives;
- biology lessons could be used to help learners deal with the modern tensions which exist between for example: global and local needs, tradition and modernity etc.
- biology lessons, like other disciplines, can be used to foster harmonious human development; and
- the curricula incorporate aspects of the integrative approach and developments in learning theories, so that there is a shift from teaching to learning in most classrooms; but caution is needed when implementing this shift from teaching to learning.

2.1.3 The impact of learning theories on biology education

One of the papers delivered at the BIOED2000 conference stated that the 'challenge of the next century' as far as biology education is concerned, is to move from the traditional teaching (lecturing) paradigm to the more effective learning paradigm. The emphasis is placed on learning and it originates from the constructivist approach to education (Griffiths & Moon, 2000:1). One of the biggest motivations or justifications for applying this approach in the classroom is that not only is it student-centred, but it also aims to promote a deep understanding of a topic or concept.

Constructivism takes “root in the spontaneous needs and natural interests of individuals” (Giordan, 2000:2). The developmental psychologist Jean Piaget (1896 – 1980) is seen as the founder of constructivism from a philosophical angle, although another Swiss, Heinrich Pestalozzi, had come to similar conclusions over a century earlier (Crowther, 1997:4).

Piaget viewed intelligence as consisting of two interrelated processes - organisation and adaptation. People organise their thoughts by prioritising the most important ones and by connecting one idea to another. Adaptation occurs in two ways. If new information is added to someone's existing cognitive organisation, this is referred to as assimilation. Accommodation refers to the intellectual organisation that takes place when a person has to make changes to adapt his or her thinking to include new ideas (Berger, 1978: 55 in Crowther, 1997: 4).

It is clear that Piaget felt that humans construct knowledge actively, rather than just receiving it passively from the environment in which they are operating (Dougiamas, 1998:5). This first form of constructivism is referred to as Personal Constructivism, and constructivist theory in education is actually a branch of neo-Piagetian thought.

The American science educator, Crowther, has defined constructivism in laymen's terms:

Constructivism means that as we experience something new we internalize it through our past experiences or knowledge constructs what we have previously established

(Crowther, 1997:2).

Crowther concludes that a constructivist view of education puts the learners, their interests and previous experiences and knowledge as the most important parts of understanding when designing a curriculum (Crowther, 1997:4).

Constructivism began to gain widespread acceptance during the 1980s and 1990s, particularly in science education. However, at the BIOED2000 Conference

the Swiss biology educator, Giordan, highlighted some of the limitations of constructivism when implemented in the biology classroom (Giordan, 2000:2).

Giordan felt that constructivism isolates the individual learner and DoEs not say much about the fact that development takes place within a society. Further, cultural environments provide meaning to situations and many of the forms of constructivism were silent about the contexts and conditions that enhance learning. Giordan's objections are not that valid seen in the context of the development of constructivism.

Social constructivism is based on the theories of pioneering psychologists who focused on the role which society plays in the development of an individual. Salomon and Perkins and Wood (1998) in Dougiamas, (1998: 8), examined the use of social constructivism in education. All teaching strategies using social constructivism as a theoretical framework, stress that teaching should take place in a context which is personally meaningful to students. This could range from class discussions, to small group collaboration, to valuing meaningful activity rather than correct answers (Dougiamas, 1998:8).

Coburn's contextual or cultural constructivism is defined by how the learners interpret and internalise new knowledge in terms of their previous experience and culture (Crowther, 1997:4). He sees the world as the subject matter, i.e. a body of knowledge, and the internal cognitive world of the learner as competing conceptual 'ecologies' (Cobern, 1993 in Dougiasmas, 1998:10). Two other contextual constructivists, Salomon and Perkins, described how tools can redistribute the cognitive load of a task between people and the tool being used, i.e. using a label can save long explanations. Tools can also affect the mind and acquisition of knowledge by changing skills and perspectives etc. (Salomon and Perkins, 1998 in Dougiasmas, 1998: 10).

Critical constructivism examines learning within a social and cultural environment. It is viewed as a social epistemology that addresses the socio-cultural context in which knowledge is constructed and serves as a framework for cultural reform (Taylor, 1996 in Dougiasmas, 1998:11).

Constructivism claims that construction occurs best when the learner is involved in constructing for others, i.e. when the learner is preparing a presentation on a body of knowledge (Dougiasmas, 1998:12). All the various forms of constructivism view the learner as an active participant who processes knowledge to which he is exposed. He is influenced by various factors in the process.

Some educators have examined the relevance of constructivism for science education. Scott (1987) in Crowther (1997:3) states that, in context of science education, a constructivist is a person who views students as active learners who arrive for a lesson with their own ideas about natural phenomena. Learners use these ideas to make sense of everyday experiences.

Tobin and Tippin have added to Scott's work by stating that constructed knowledge in science is:

viewed as a set of socially negotiated understandings of the events and phenomena that comprises the experienced universe.
(Tobin & Toppin in Crowther, 1997: 3).

They further explained that, in order for a body of knowledge to become accepted as valid by the scientific community, it should be coherent with other interpretations and fit in with existing scientific experience (Tobin & Tippin, 1993 in Crowther, 1997:3).

One of the most useful models of constructivist teaching is the 'problem-centred learning approach' of Wheatley. He saw the educator's role as that of providing stimulating and inspirational experiences through negotiation. The educator acts as a guide for learners in the building of their own cognitive framework. The educator chose a task(s) which the learners would find problematic and the learners would work on these in small groups and at the end of the lesson there would be a time of sharing (Wheatley, 1991 in Crowther, 1997:6).

Wheatley's problem-centred approach is simple and open-ended, while the constructivist approach of Saunders is more specific to science education. It consists of four steps:

- 1 First the educator organises a hands-on, problem-centred investigation, which requires learners to use their own cognitive framework or schema to make predictions about possible results.
- 2 Next, the expectation is that the learners become active participants – which often makes their learning more meaningful.
- 3 The third step requires the learners to work in small groups, since this is deemed to stimulate higher cognitive activity among a larger number of students.
- 4 The last step is concordance between the assessment and the way in which learning took place (Saunders, 1992 in Crowther, 1997:6).

Brooks and Brooks (1993) in Crowther (1997:6) concluded that there are generally five principles which characterise a constructivist lesson:

- 1 The problems should be relevant to the learners.
- 2 The lesson should be planned around primary concepts.
- 3 The lesson should value the learners' points of view.
- 4 The curriculum should be adapted to the learners' suppositions.
- 5 The learners' learning should be assessed within the context of the teaching which took place.

Two of Brooks' characteristics are evident in Saunders' four-step approach as described in the previous paragraph. However, Giordan, who objected to the application of the constructivist approach in biology lessons, suggested another approach. Giordan explained that gathering a number of micro-models under the umbrella term: the allosteric learning model, creates a model that goes beyond the constructivist approach (Giordan, 2000:4).

Giordan feels that, when a learner is confronted with a new model or perspective of subject matter that he has dealt with in the past, the learner needs to re-examine his existing cognitive framework. An interaction takes place with the prior knowledge in the learner's cognitive framework and the new, external information.

Giordan feels that learners do not easily change their ideas and learners will only change their existing cognitive framework if they are convinced that the new information is more effective and efficient. Giordan feels that the teaching of biology is becoming more complex (Giordan, 2000:5) and that it is necessary to classify the parameters which facilitate the learning process. He explains how these allosteric learning parameters interact (Appendix C). Giordan's model, like those of Wheatley and Saunders, emphasises that the learning environment ought to be meaningful and that learners should be able to compare new knowledge to their existing cognitive framework.

McDermott (1993), a science educator, in an article on the potential mismatch between the way in which teachers teach and students learn, highlighted that conceptual difficulties are not overcome when learners are passive during lessons. She also felt that the traditional more narrative way of teaching is ineffective for most learners. She argues that learners find contemporary topics inspiring.

McDermott also argued that learning should be more learner-centred, since meaningful learning takes place only when learners are intellectually involved in the lesson. In line with the constructivists, she contended that, in order to gain functional understanding of new concepts, the learners have to experience the reasoning involved in the development and the application of the concept. The learner should also be given the opportunity to transfer the new concept to different contexts (McDermott, 1993:6).

Griffiths and Moon (2000) argue that learning will be enhanced when an educator provides a meaningful context for a biology lesson. They also feel that providing a meaningful context is essential when an educator is in the process of switching from a more traditional, instructive mode of teaching to a learning model (Griffiths & Moon, 2000:3). They propose that biology should not be taught as separate units of knowledge that are isolated from each other and from the real world. This is in line with the 'integrative-approach' which was also discussed in section 2.1.2, p. 15

Possible impacts of the development of learning theories on biology education since 1970 have been:

- highlighting that learning should be more student-centred and not subject-centred, in order to promote a deep understanding of a topic or concept;
- constructivists view learning as adaptations which learners add to their mental schemata when they internalize new knowledge and experiences and then compare it to past experiences and knowledge;
- critical constructivism highlights that learning should occur in a social and cultural context relevant to the learner;
- most models of constructivism imply that educators pose questions and problems and guide learners towards finding their own answer;
- social constructivism implies that educators create opportunities for group work, using co-operative learning strategies and allow time for reflection and discussion;
- constructivism Department of Educations not advocate behavioural objectives or specific content-related outcomes; and
- as far as possible, the subject matter dealt with in lessons should be, interesting and relevant.

2.1.4 Current trends in biology education in South Africa

2.1.4 (a) The outcomes-based nature and other fundamentals of the National Curriculum Statement

The context in which a particular body of content is dealt with has gained new prominence in most learning areas of the new National Curriculum Statement (NCS) (2003) for Grades 10-12.

However, context has been given greater emphasis in the Physical Sciences learning area than in the Life Sciences (Biology) learning area. The context is not prescribed, but is left up to the educator.

This allows the educator not only to choose a context with which she or he is familiar, but also to choose one which is relevant to the framework of the learners in her class.

Context was not emphasised as much in the Reception class to Grade 9 Natural Science RNCS policy document. This document lays the foundation of what a learner must cover in terms of the content, learning outcomes and the accompanying assessment standards. At the end of Grade 9 learners can choose either Life Sciences or Physical Sciences or both subjects as subjects that will form part of the programme that they take to meet formal matriculation requirements at the end of Grade 12.

The RNCS evolved after the original Curriculum 2005 policy documents were redrafted. This followed a national revision process, which resulted in the report of the Review Committee of Curriculum 2005. This implies that the learners, who will be studying Life Sciences according to the NCS FET policy document in 2006, will not have dealt with the content and skills as outlined in the RNCS document. In most schools they would have been exposed to the specific outcomes (now called learning outcomes) in the Natural Science policy document of Curriculum 2005. However, all three documents have been written from an outcomes-based education (OBE) approach and therefore have the following OBE principles in common.

The OBE principles which are the building-blocks for the teaching methodology in these three curriculum include:

- clarity of focus on culminating exit outcomes of significance;
- expanded opportunity and support for success;
- high expectations for all to succeed; and
- design down from ultimate, culminating outcomes.

(Spady, 1994 in Broster & James, 2005:3)

These OBE principles cover a learner-centred and activity-based approach that implies that curriculum advisors include some of the principles of the constructivist approach to education. It is clear that OBE should enable learners to reach their maximum learning potential by setting learning outcomes to be achieved by the end of an educational process (Bezuidenhout, Clarke, Engelbrecht and Wilson, 2005: 2 and Broster & James, 2005:3).

The **fundamental principles of NCS** are:

- social transformation;
- outcomes-based education;
- a high level of skills and knowledge for all;
- integration and applied competence;
- progression;
- articulation and portability;
- human rights, inclusivity, environmental and social justice;
- valuing indigenous knowledge systems; and
- credibility, quality and efficiency.

(DoE, 2003:1)

The NCS builds its learning outcomes for Grade 10 on the critical and developmental outcomes. These two sets of outcomes are applicable to all learning areas and were inspired by the Constitution of the Republic of South Africa.

The **critical outcomes** are of an academic nature and require the learners to be able to:

- identify and solve problems using critical thinking;
- working effectively with others as members of a team, group, organisation or community;
- organise and manage themselves responsibly and effectively;
- collect, analyse, organise and critically evaluate information;
- communicate effectively using visual, symbolic and/or language skills in various modes;
- use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in a vacuum.

(DoE, 2003:2)

The **developmental outcomes** require learners to be able to:

- reflect on and explore a variety of strategies to learn more effectively;
- participate as responsible citizens in the life of the local, national and global communities;
- be culturally and aesthetically sensitive across of social contexts;
- explore education and career opportunities; and
- develop entrepreneurial opportunities.

(DoE, 2003:2)

The critical outcomes and the developmental outcomes give expression to the OBE nature of the NCS and the RNCS and are therefore applicable to all learning areas (subjects).

2.1.4 (b) Biology becomes Life Sciences and the scope of the new subject

In the NCS document the subject of Life Sciences is defined as involving:

...the systematic study of life and the changing natural and human-made environment. This systematic study involves critical inquiry, reflection, and the understanding of concepts and processes and their application in society.

(DoE, 2003:9)

Life Sciences can be chosen by learners entering Grade 10 as one of the subjects that form part of their programme of study for their Grade 12 final school leaving certificate. The basis of Life Sciences (formerly referred to as Biology) is laid in Natural Sciences from Grades 7 to 9. Half the content of this subject deals with Biological topics and the other half with Chemistry or Physics topics.

One of the purposes of the study of the Life Sciences is that it enables learners to examine those concepts that are essential for understanding basic life processes. It should also enable learners to understand the interdependence between abiotic and biotic factors in an ecosystem. In the process, learners will develop inquiry skills and cognitive skills such as critical thinking and problem-solving, since they need these skills to interpret and explain concepts and phenomena in Life Sciences.

Life Sciences will also help learners to understand the impact of all the processes, ranging from technological to social, and associated with life in the environment (DOE, 2003:9).

The scope of Life Sciences has been described in the three learning outcomes of Life Sciences. A learning outcome is a statement of an intended result that serves as a goal for a learning experience. These outcomes describe knowledge, skills and values that a learner should acquire by the end of the FET band in that particular subject (DOE, 2003:7 and Bezuidenhout et al., 2005:4). The three learning outcomes for Life Sciences are based on the learning outcomes for Natural Science and are almost the same as the learning outcomes in Physical Sciences.

An assessment standard consists of criteria that collectively describe what a learner should know at a particular grade in the context of a specified subject. These standards describe the level at which learners should be able to demonstrate the skill or knowledge or value associated with a particular learning outcome in a specific grade (DOE, 2003:7 and Bezuidenhout et al., 2005:4).

The learning outcomes of a specific subject stay the same from Grade 10 to 12, but the assessment standards change from grade to grade. Consequently assessment standards indicate how conceptual progression occurs from grade to grade and also indicate the depth and breadth at which learners need to demonstrate their understanding of a concept or skill (Bezuidenhout, 2005: 4).

Learning Outcome 1: Scientific Investigation and Problem-solving skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem-solving, critical thinking and other skills.

(DoE, 2003:12)

This learning outcome has three assessment standards associated with it and each of them covers aspects of scientific inquiry or problem-solving skills e.g. process skills. They require learners not only to design and conduct investigations, but also to record observations and identify trends. The three assessment standards associated with this learning outcome progress from Grade 10 to 12, but in every grade they focus on the same aspects of this learning outcome.

The focus of assessment standard 2 has been quoted below as examples, but a detailed description of these assessment standards linked to Learning Outcomes 1 and 2, appear in Appendix D.

Focus of Assessment Standard 2: The learner conducts an investigation by collecting and manipulating data.

(DoE, 2003:14)

Learning Outcome 2: Construction and Application of Life Science Knowledge

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

(DoE, 2003:12)

This learning outcome focuses on how knowledge is constructed in Life Sciences by collecting information and linking it to previous knowledge and experiences. The three assessment standards associated with this outcome clearly demonstrate that this involves inquiry and thinking skills.

Learning Outcome 3: Life Sciences, Technology, Environment and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society
(DoE, 2003:12)

This learning outcome highlights that all forms of scientific knowledge need to be examined and critically evaluated. Learners need to be given the opportunity to make informed decisions about the past, present and future use of science and technology in society, so that they can make environmental and lifestyle choices for a sustainable future. Learners also need to explore the historical development of scientific explanations, so that they become aware that it was not just Europeans who contributed to the development of science. They need to become aware of how indigenous knowledge forms scientific perspective, and how this knowledge is often still used today (DOE, 2003:12-13). This is the learning outcome that made many educators from a Western background feel uncomfortable at the recent FET workshops, but some of the new textbooks include some information in this regard.

The NCS also provides content and context to support the assessment standards. The intention is that the content must serve the attainment of the learning area and is not, as it often was in the past, an end in itself. Content in Life sciences is constructed and applied within the following knowledge areas (sometimes referred to as modules). Knowledge areas are vehicles with which to attain assessment standards. They are applicable when dealing with all three learning areas.

Learners need to be able to apply the knowledge within a knowledge area in both familiar and unfamiliar contexts. The order in which these areas are arranged is not fixed, but care needs to be taken to ensure that the NCS principles of progression and integration are applied. All the knowledge areas have the same weighting, but the depth or level in which they should be covered in each grade has been determined by the assessment standards (Bezuidenhout et al., 2005:13).

The following knowledge areas exist:

- tissues, cells and molecular studies;
- structure, control and processes;
- environmental studies; and
- diversity, change and continuity.

(DoE, 2003: 16 and Bezuidenhout et al., 2005:13)

Educators teaching a particular subject in a school need to design a learning programme for that subject. A learning programme is a planning tool that details the learning, teaching and assessment for a subject in the three FET grades. A learning programme consists of 3 stages of planning:

- 1 subject framework;
- 2 work schedule per grade; and
- 3 lesson plans.

(WCED, 2005a:26).

A subject framework for Grades 10-12 is a broad guideline that assists an educator to determine what should happen in a subject across the three grades in the FET band and it shows the conceptual progression in that particular subject by unpacking the skills, knowledge, attitudes and values associated with that subject. It should ensure that the fundamental NCS principles listed on p. 26 are addressed in this subject. The subject framework should also ensure that the policies relevant to, and resources needed for, that particular subject are listed. An example has been included (Appendix E).

A work schedule is a grade-specific subject schedule that shows how learning, teaching and assessment will be organised and paced in a particular grade. It is drawn directly from the grade-specific section of a subject framework for the subject, but it gives more detail to the educator. It shows how all the learning outcomes and assessment standards will be integrated and sequenced – see Appendix F for an exemplar. A lesson plan describes concretely and in detail how the activities will be managed, presented and assessed by the individual teacher and it is normally arranged around a particular body of knowledge and/or related skills.

An exemplar of a lesson plan for Life Sciences has been included (Appendix G). The relationship between these three stages of developing a learning programme has been included (Appendix H) (WCED, 2005a: 26-27).

Work schedules and lesson plans require details of assessment. The purpose of assessment in Life Sciences is to determine the degree to which learners are competent in scientific inquiry, problem-solving and the application of knowledge relevant to this subject.

Assessment is driven by the three learning outcomes through the relevant assessment standards. The three learning outcomes are equally weighted and each learning outcome includes three assessment standards. The three assessment standard of each learning outcome needs to be addressed twice in each of the four knowledge areas listed on p 30 (WCED, 2005b: 7-8).

The Programme of Assessment for Lifestyles consists of tasks that will be internally assessed by the educator and this is weighted 5% in the FET band. The end-of-year, external assessment will consist of two papers set by a provincial or national panel of examiners and will be weighted 75%. In Grades 10 and 11, Life Science learners' internal assessment will consist of seven tasks: two control tests, a research project, two practical tasks and a mid-year examination.

In Grade 12, Life Science will include the learners' assessment of seven tasks: two control tests, two examinations, two practical tasks and one assignment. The Life Sciences documents distributed to educators stress that these are the minimum requirements for internal assessment and that daily assessment should take place informally or even formally for school assessment at the end of a term.

In practical activities Life Science learners will be assessed on their ability to:

- follow instructions; make accurate observations;
- work safely;
- manipulate and use apparatus accurately;
- handle materials appropriately;
- gather data; and
- record data appropriately – drawings, graphs, etc.

(WCED, 2005b :8)

In review, it is clear that some of the international trends in biology education discussed in Sections 2.1.1 and 2.1.2 have been included in the new FET subject of Life Sciences:-

- The realisation that biology lessons could be used to improve the personal skills of an individual learner has been included in Learning Outcomes 1 and 2 of Life Sciences listed on p 32;
- The growing importance of cognitive skills, such as problem-solving, as part of the body of process skills in Biology, has not only been mentioned in Learning Outcomes 1 and 2 of Life Sciences on p 32, but has also been listed in the critical outcomes listed on p 30;
- The developments in biotechnology and genetics will be covered in the new knowledge area of Tissues, Cells and Molecular Studies (DoE, 2003:34-35).
- The relationship between biological knowledge and technology and society which gained importance in international biology education circles in the 1970s and 1980s, has been included in Learning Outcome 3 listed on p. 33;
- Social responsibility and ethics in terms of the application of biological knowledge has been stressed internationally and these aspects have been included in: Learning Outcome 3 of Life Sciences on p. 33; the NCS principles listed on p. 26 and is one of the NCS critical outcomes listed on p. 29
- The aspects of the 'integrative approach' discussed at the BIOED2000 conference has been implemented across the FET subjects due to the existence of the fundamental principles, the developmental outcomes and the critical outcomes of the NCS which are applicable to all subjects;
- Practical work that has gained more importance internationally has become an important form of learning and has to be assessed in Life Sciences.

2.1.4 (c) The impact of learning theories on biology education in South Africa

Many of the principles of constructivism have been included in the NCS and the RNCS. The description of the type of learner which this new OBE curriculum envisages, clearly involves an active learner.

Learners leaving the FET band must:

- have access to, succeed in, lifelong learning and training of good quality;
- demonstrate an ability to think logically and analytically, as well as horizontally and laterally; and
- be able to transfer skills from familiar to unfamiliar situations.

(DoE, 2003:5)

All forms of constructivism emphasise the learner as an active participant who processes the knowledge that he is exposed to in terms of his previous experience or prior knowledge and other social and cultural factors in his environment. Learning Outcome 1 of Life Sciences, discussed on p 32, clearly requires an active learner who is able:

to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem-solving, critical thinking and other skills.

(DoE, 2003:12).

Learning Outcome 1: directly lists problem-solving and critical thinking, which form the basis of the problem-centred approach of the constructivist Wheatley and the problem-solving approach of the science educator Saunders (Wheatley, 1991 and Saunders, 1992 in Crowther, 1997:6) that was discussed on p. 24.

Learning Outcome 2: Construction and Application of Life Science Knowledge, discussed on p. 25, clearly has taken the work of constructivist learning theorists into consideration in its title. The role of a learner's cultural and social environment is emphasised in Learning Outcome 3 of Life Sciences as discussed on p. 32. This outcome lists the environmental or contextual factors which would make the acquisition of knowledge personally meaningful for learners. The work of the social constructivists like Salomon & Perkins (1998) and Wood have been included in the Life Sciences outcomes.

Most of the trends highlighted by learning theorists which have impacted on Biology education internationally have been included in Life Sciences.

2.2 In-service education and Training (INSET)

2.2.1 Scope of INSET

“The strength of an education system must largely depend on the quality of its teachers”

(Bereday and Lawries in Megarry, 1980a:9 cited in Bagwadeen & Louw, 1994:1).

This comment appears to be as relevant in 2006 as in 1963. International literature on teacher education suggests that the initial training of a teacher should prepare him for his future professional role in a responsible way.

South African INSET educators Bagwadeen and Louw (1993) feel that universities and colleges of education accomplish this task. However, it is impossible for initial teacher training to provide “ the fuel and supplies that a teacher needs for a life long journey “ (Taylor, 1982:24 cited in Bagwadeen & Louw:1994:2).

Instructional materials for initial training are plentiful and longstanding. However the design of in-service programmes, which entail more than just programmes and workshops, is challenging and intricate (Bagwadeen & Louw, 1993:9-10).

By the late 1980s most developed and developing countries emphasised the link between initial training and INSET and there was widespread agreement that a well-planned and defined continuum should exist between pre-service (initial) training and in-service training. This continuum became known as the **‘triple-I-continuum of initial, induction and in-service training’** (Bagwadeen and Louw, 1993: 10). These three stages can be thought of as “a career-long process for the growth and development of teachers” (Bagwadeen and Louw,1993:10).

Many countries view these stages as mechanisms for the improvement of education and many education authorities have attempted to restructure their systems of teacher education around the triple-I-continuum.

The **first stage** of this continuum, initial training, covers the areas of knowledge relevant to the phase/ age group for which and educator is training. It also addresses professional coursework and planned field-based (teaching experience) experience. Entry teaching skills like lesson planning, evaluation of students, classroom management are covered to varying extents. Besides the theory of education, knowledge of the school and its environs, the design and purpose of the curriculum, and so on, all form part of the initial training of a teacher (Bagwadeen & Louw, 1993: 10).

The **induction** of the young teacher from the reasonably protected environment of the college of education or university to the realities of the classroom, the second stage of the continuum, has become the vital or pivotal concern of education departments and school administrators in many countries. Forms of apprenticeship or assistance programmes exist in some countries (Bagwadeen & Louw, 1993: 11).

Whatever the nature of these programmes, whether they are formal programmes or of a more flexible nature, experts suggest that induction should be a shared responsibility. The school where the teacher is working, the local education authorities and the college or university where the teacher trained have significant roles to play in the induction process from their perspective and at their level. The physical and social environment in which the teacher is operating should arouse interest and the support that the teacher receives could 'make or break his career as a teacher' (Bagwadeen & Louw, 1993:11).

In-service training, the third stage of the triple-I-continuum, suggests that there is a need for a "sustained programme of retraining to counteract obsolete or defective teaching " (Bagwadeen & Louw, 1993:11). This stage implies the continuation of professional development that does more than merely give support to beginner teachers and specific school systems.

It follows that teachers in the early stages of their careers need support that is of a general nature and they should be able to access a wide variety of in-service experiences.

This will enable them to meet the particular demands with which they are confronted and for which the first two stages cannot thoroughly prepare them. Once a teacher is established in a professional sense, the focus of in-service training can shift to a higher need for professional education, equipping the teachers to interpret their teaching and empowering them to undertake greater responsibility.

The triple-I-continuum clarifies the need for continuing professional development aimed at helping teachers to improve their competence and proficiency. Internationally the goal of INSET is to “develop mastery, even brilliance, in the performance of instructional and educational responsibilities” (Bagwadeen & Louw, 1993:11). INSET should also aid teachers to self-evaluate their performance and assess growth needs, and this reflection should empower them to prepare for various forms of career development. The third or in-service phase of this continuum can be implemented more effectively than at present to meet the needs of teachers at various stages of their careers.

Although all three components have been extensively discussed in the professional literature, more needs to be done to rationalise and co-ordinate the triple-I-continuum. In the past, many educators did not react positively to INSET. This was probably the result of inappropriate activities on courses, unrelated purposes and insufficient skills among organisers of INSET programmes.

These deficiencies led to confusion over the nature and function of INSET (Bagwadeen & Louw, 1993:12). However, in both developed and developing countries the all-encompassing phrase ‘*in-service education and training (INSET)*’, is now commonly used to refer to in-service training of teachers.

In-service education and training may be a commonly used term internationally, but there is still a plethora of concepts and definitions associated with this 'umbrella' term. Perhaps this plethora of associated terms has resulted from the different rationales and needs for INSET that exists not only in developed countries versus developing countries but also at regional levels within a country. The different rationales and types of INSET will be discussed in greater detail in sections 2.2.5 but evaluating an INSET course necessitates an overview of the definitions and concepts associated with INSET.

2.2.2 Concepts associated with INSET

A given definition is determined largely by the emphasis that is placed on it in terms of its plan or design. All-encompassing definitions of INSET, like that of Henderson quoted on p.11, embrace all the experiences in which a teacher participates in order to expand his professional and personal education. To arrive at a definition of INSET that would satisfy every need would be a challenging and complicated task (Bagwadeen & Louw, 1993:20) but, in order to evaluate a specific INSET workshop, it would be beneficial to evaluate some of the concepts associated with INSET.

'Recurrent education' is a concept that was used to emphasise that initial training was often incomplete. Cropley and Dave (1978:41, cited in Bagwadeen & Louw, 1994:21) defined recurrent education as the aspect of education which alternates periods of teaching service with periods of further training or other forms of training. This training could be formal, informal or non-formal. There are other definitions of recurrent education, but they all emphasise the concept of lifelong learning and the need for 'an adaptation to change in society and schools' (Bagwadeen & Louw, 1993:21).

'Continuing education' was another concept that was beginning to gain prominence internationally. Then and now the most important objective of continuing education appears to be the personal growth and enhancement of educators.

Some definitions of this concept refer to it as "... education that refers to the provision of opportunities for qualified professionals to update their professional knowledge, skills and attitudes to enable them to remain competent professionals..." (Kapp, 1987:54-55, cited in Bagwadeen & Louw, 1993:22). In the context of teaching, continuing education is seen by many as the responsibility of the teachers and the professional teacher associations themselves. Bolam (in Hopkins & Holborn, 1983:168, cited in Bagwadeen & Louw, 1993:23) maintains that the education sector sees continuing education either as that which is primarily concerned with the professional development of individual educators, or that which is concerned with the needs of the education system or the school.

'Staff development' has become a common term. Some educators see it as actually implying INSET, whereas others see it as a new term for an existing activity. More recently, staff development is being seen as involving more than INSET or the in-service training of teachers. Staff development involves planning for change. It is clear that staff development comprises activities which go beyond the provision of courses for INSET. These include empowering a teacher(s) to help the school strengthen its present performance in a situation where the school, rather than the teacher(s), is deficient. Improving the teacher's prospects of career development and enabling the school to prepare itself to meet future demands are also activities which are classified as 'staff development' rather than INSET activities (Bradley, 1997:192, cited in Bagwadeen & Louw, 1994:27).

'Professional growth' or **'professional development'** is a concept which is used synonymously with INSET and staff development by some educators. Joyce (1981:117, cited in Bagwadeen & Louw, 1993:26), proposes that professional development activities are those which fulfilled three specific needs. Firstly, a social need for an efficient education system which could adapt to evolving social needs. Secondly, professional development should find strategies to help educational staff improve the wider personal, social and academic potential of young people in the area. Thirdly, a need exists to encourage the teacher's desire to live a fulfilling and satisfying and stimulating personal life and thereby set an example to help his students to develop their desires to reach their own potential.

Joyce's proposition obviously includes the concerns of the society in which the teacher works and the morale of the school. It also says something about the quality of the teachers selected for training (Bagwadeen & Louw, 1993:27-28). The definitions of professional growth vary, but it is logical to view it as any programme that starts at training institutions and then extends well into the years of professional service up to retirement. Professional growth is a complex task and requires a climate that supports learning and change. However, like INSET, it needs to be based upon clear goals and objectives. The responsibility of professional growth and development of all teachers needs to be shared by all those involved with education.

Lynch states that lifelong learning DoEs not just involve the concept of everyone being learners throughout their lives, but also that people have opportunities to "continue to be educated throughout life" (Lynch, 1977:3 in Bagwadeen & Louw 1993: 29). According to Lynch's concept successful teachers are those who are not only well prepared personally and professionally, but who also develop the social skills needed to interact with others successfully. In a world where circumstances change on a continual basis, teachers should be familiar with the times and also need to realise that the preparation of the teacher is never complete. Some commentators view INSET as a special area/type of lifelong learning.

Cropley and Dave (1998) describe **lifelong learning** as being determined by three characteristics. The first characteristic involves vertical integration and is rooted in the philosophy that learning occurs as a normal and natural process, similar to physical attributes developing naturally. This implies that systematic educational experiences must be available to people throughout their lives for manifold purposes ranging from rectifying inadequacies of earlier experiences to acquiring new skills (Copley & Dave, 1978:9 in Bagwadeen & Louw, 1993:30). The second characteristic, horizontal integration, links education and life. The complexities of modern life imply that we can no longer rely just on life experiences. Learning and daily living are so intertwined together formally, informally and non-formally.

To establish the link between education and life it is essential to identify, recognise and improve the people, processes and organisations that possess education potential. The third aspect consists of the prerequisites for learning which constitute the means of life-long learning. Educability, i.e. learning to learn and to share knowledge and to evaluate one's own learning, is one of these prerequisites. Motivation, a positive self-image and the belief that learning is beneficial are also prerequisites for lifelong learning. In this vein, lifelong learning may empower individuals to take responsibility for decision-making and enable them to develop themselves rather than "being forged in other people's crucibles" (Bagwadeen & Louw, 1993:31).

Lifelong learning implies that teachers should become involved in a process of personal updating and renewal. This suggests lifelong learning can be viewed as a tool with which the traditional role of teachers - conceptualised as the authoritative sources of knowledge, keepers of order and evaluators of results - is transformed so that they become the pioneers of change in society. This rather lofty view highlights that lifelong learning can potentially provide the much-needed basis for making INSET theoretically respectable (Bagwadeen & Louw, 1993:31). Ultimately, lifelong learning could prove to be the strategy through which teachers can raise themselves to the level of becoming truly professional. Lifelong learning can preserve the autonomy of teachers, since it suggests that teachers can identify problems, devise plans for resolving these problems and adopt new strategies if necessary.

The need for biology educators to be able to motivate their learners to become lifelong learners was clearly highlighted at the BIOED2000 conference by the Secretary General of the International Union of Biological Sciences. (This was discussed in section 2.1.2, pp 17 – 21.)

'Distance education' involves a form of study in which the teacher is not present in the classroom, but tutors and study material originating from an organisation at a distance from the student support the student. Other media - such as audio-recordings, radio and television broadcasts, video recordings and instructional material on the Internet - can be used in distance education.

It is clear that distance education offers a variety of approaches and has wide appeal in developed and developing countries. Distance education can be one form or mode of INSET for educators with a lot of potential and is already widely used in the United Kingdom, United States and South Africa for the further training of teachers (Bagwadeen & Louw, 1993: 36-39).

'Adult Education' and andragogy (the theory of adult learning) involve more than literacy courses or pottery classes. Some of the principles of andragogy are of relevance to the design and planning of INSET courses for teachers. Adult education highlights the professional performance and how this performance is influenced and arrived at by factors such as individual goals, attributes, needs and beliefs. This supports the uniqueness of teachers as adult learners (Bagwadeen & Louw, 1993:31-33).

'On-the job-training' involves the activities that enable the teacher to gain competency and knowledge experientially. Some commentators see on-the-job-training as the handmaiden to INSET, but it contributes effectively to professional development mainly with regard to activities desired by educators and those needed to perform a role defined in the school programmes. On-the-job-training amounts to learning by doing and is characterised by cycles of input, experience, analysis, application and generalisations. It also provides opportunities for practising teachers to update their ideas and methods and to meet with colleagues and exchange ideas and experiences. These characteristics, and the fundamental goal of the improvement of the teaching-learning process, make on-the-job training part of INSET.

'Renewal' is often used synonymously with INSET and professional development. Renewal is in fact the complex process essential to continuing improvement of personal and professional qualities. Renewal in education is a personal issue and can be encouraged in a school environment where trust, caring, respect, pride and a high morale are evident. In renewal programmes in education, teachers are the bottom-line in the anticipated change. Responsible, continuous self-renewal is obviously the ultimate goal of INSET activities that are designed to encourage personal and professional growth (Bagwadeen & Louw, 1993:35).

2.2.3 International objectives of INSET

Irrespective of the conceptual format on which an INSET course is based, there are certain objectives that are internationally recognised as being general aims of INSET for teachers.

The broad aims of INSET can be gleaned from the various definitions of INSET. These definitions state that INSET includes a range of courses and activities which teachers can participate in order to extend and develop their personal education and professional competencies. Many INSET courses are designed to do this in the school or system in which they operate (Yule, 1987:64; cited in Bagwadeen & Louw, 1993:40).

The **extension of knowledge of educators is seen as the primary and traditional goal**, if not the cornerstone, of INSET. As such, the extension of knowledge of educators receives the most attention. In their respective subject fields and in other areas, educators - like other professionals - need to keep up with the knowledge base in education which is growing at a rapid pace (Hass, 1957:22, cited in Bagwadeen & Louw, 1993:43).

The current exponential increase of knowledge could present new educational situations and sometimes programmes may not have been developed by the time a teacher enters the profession. Time is not always available during initial training for students to learn all the concepts that would be useful in the development of their conceptual framework. Therefore, an objective of INSET is to **consolidate academic achievements and professional philosophies of educators** (Bagwadeen & Louw, 1993:44).

The extension of a teacher's knowledge has already been discussed as an objective of INSET. As has been mentioned on pp 37 and 38, 'lifelong learning' implies that educators need to be learning and acquiring new theoretical knowledge and skills on a continual basis.

If educators are to keep abreast of changing conditions and new knowledge, professional development must continue throughout their careers. This will have the potential to overcome deficiencies of initial training.

INSET can assist in reinforcing experience with sound skills in classroom management and didactics. The **continual acquisition of new knowledge and skills** is another objective of INSET in countries ranging from Britain (and other European countries), to Egypt and South Africa (El-Nemr and Tolymat, 2000:13; Bagwadeen & Louw, 1993:44-45 and Markola, 200:1-3).

In many countries curricula has changed or should change in order to cater for changing circumstances, and so INSET can contribute towards assisting staff in implementing new subject area criteria. The child-centred emphasis on education mentioned in section 2.1.3 implies that teachers need to participate in curriculum development. A fourth goal of INSET is therefore: **familiarisation of teachers with recent curricular development** (Bagwadeen & Louw, 1993:45-46).

Some INSET courses are specially designed to **acquaint educators with recent developments in subject areas which complement and influence education**. INSET courses can be designed so that educators can acquire knowledge about recent developments in the fields of: psychological development, the sociological basis of education and the principles of school organising and administration (Bagwadeen & Louw, 1993:46-48).

Some INSET courses are tailor-made to meet the **needs of teachers returning to schools after a period of absence**. These courses blend a revision of old teacher education concepts with new practices and innovations in schools. This objective is referred to as positive retraining (Bagwadeen & Louw, 1993: 48-49).

Some INSET courses are designed to enable teachers to change the subject(s) or age groups that they teach. These are **conversion courses** and they equip the teacher to cope with the new subject content or other role(s) which they need (Bagwadeen & Louw, 1993: 48-49).

Just as there is a considerable growth in knowledge available to teachers, there is also unprecedented growth in teaching aids and technology in education. Teachers should be able to assess the potential classroom usage of new technology.

If some INSET courses do not have the **mastering of new aids and technology as their goal**, it could lead to an accumulation of equipment in schools which is hardly used, and to decisions about educational policy which could be detrimental to learners (Bagwadeen & Louw, 1993: 49).

In a similar vein some INSET courses are designed to acquaint teachers with **new methodologies of teaching in their own subject**. This stimulates professional development. Many countries have highly centralised systems of education and INSET courses can be used to disseminate and familiarise teachers with local and education policy. In a similar manner some INSET courses have as their goal to familiarise educators with the development of **new and more effective assessment techniques**.

The improvement in transport and communications technology has led to the world being seen as a global village. In both developed and developing countries a new cultural terrain is evolving. Since the classroom is a microcosm of a larger society, many of the controversies of our daily lives can impact on what happens in schools. An important goal of INSET is therefore to provide an understanding and appreciation for cultures in terms of new developments and their educational and cultural effects.

Studies of teacher effectiveness suggest that some teachers who use classroom management and teaching strategies based on research have experienced an improvement in learners' achievement. There is a need to integrate experience and theoretical research by means of INSET courses. If INSET is to support teachers' comprehension of theoretical constructs and the translation of their cognitive frameworks to classroom performance, then educators should be part of current educational research.

INSET can satisfy two objectives: acquainting teachers with research developments and giving them opportunity to participate in organised research (Bagwadeen & Louw, 1993: 52-53).

In many developing countries INSET programmes are aimed at upgrading the qualifications of unqualified or under qualified teachers so that they can meet the legal requirements regarding qualifications of a particular country. Other INSET courses, particularly in developed countries like Germany and the United States of America, upgrade teachers' qualifications in order for individuals to apply for promotions. Teacher stress contributes to teacher burnout. Factors like: unreasonable loads, large classes, excessive paperwork, treatment of teachers as merely the executors of others' orders, and low self-esteem are all causes of stress in the teaching profession. INSET courses aimed at aiding teachers to maintain their professionalism and provide opportunities for combating burnout are necessary.

2.2.4 Providers of INSET

Traditionally the providers of INSET in most countries include: universities, colleges of education, education authorities, teachers' centres and teacher organisations. Other providers include: consultants and international bodies.

In the United Kingdom, **teachers' centres** in a simple form were already proposed as early as the 1920s. Towards 1958 in the United States, there was a great deal of anxiety concerning the retraining of teachers in order to improve the education system to support technological advancement and economic growth.

This was fuelled by the successful launch of *Sputnik* at the beginning of the Cold War period. Research was conducted by the National Institute for Advanced Study in Teaching Disadvantaged Youth in the late 1960s and it led to the establishment of complexes which were the forerunners of teachers' centres in the United States (Bagwadeen & Louw, 1993:89).

By the 1970s teachers' centres were being established in the United Kingdom and the United States. In the United Kingdom the teachers' centres had three functions:

- a setting where innovations and methodology could be discussed;
- evaluation of materials before publication in order to improve them; and
- keeping teachers informed about research and developments in education so that they could appraise these developments in the context of their local needs.

(Bagwadeen & Louw, 1993:90)

By the mid 1970s, in the United States, a teacher's centre was seen as a place, which amongst other things, also "...develops programs directed at the improvement of classroom instruction....". (Bagwadeen & Louw, 1993:90). The range of teachers' centres activities had increased from the 1960s. They were now more than a neutral meeting place where teachers from a particular area could meet and discuss common issues. There are no longer just the clients of INSET providers like universities, but have become INSET providers of their own needs.

The American educationalist Yager feels that teacher centres are in fact 'a subset of INSET'. He highlights that job-related INSET is more likely to originate from teachers' centres than professional-related programmes (Yager, 1975:30 cited in Bagwadeen & Louw, 1994:92). In some countries teachers' centres are viewed as 'power houses for curriculum development' (Bagwadeen & Louw, 1993:93)

Universities have played an important influence on in-service education for a long time. Since many universities have the assessment, evaluation and diagnostic expertise to arrive at the related goals and local school system, it is thought that they are well placed to be providers of INSET. Some educationalists argue that universities have an ethical responsibility regarding INSET (Watkins, 1973:8 and Bottoms, 1975:42; cited in Bagwadeen & Louw, 1994:94-95).

Universities function at the frontiers of innovations and the creation of new knowledge. In this capacity, they should continue updating programmes for educators. They should also enable teachers to acquire the cognitive and procedural skills that they require in order to satisfy the demands of their learners.

Current educational research highlights that INSET activities should reinforce a partnership with teachers. At some universities this has led to reports and publications.

Universities offer two kinds of INSET courses. The first type, award-bearing courses, leads to a specific degree, diploma or certificate being awarded when a candidate has completed a course successfully. There should be opportunity for serving teachers to study for higher academic qualifications. World-wide, it is felt that, the output of research degrees in education is very small and that universities should change the structure of some of their INSET courses to change this situation.

The second type, the non-award bearing courses, is often vacation courses within fields in which that the particular university specialises. These courses are innovatory and meet the needs of some of the educators at the time (Bagwadeen & Louw, 1993:96-97).

Colleges of education, having provided initial training to teachers, have the potential to relate pre-service and in-service training into a continuum of professional education. This could be made possible through constant communication by lecturing staff and serving teachers regarding the provision that the particular college makes during pre-service training. If colleges realise that they have an opportunity to address many of the problems surrounding the pre-service and in-service continuum, they can become more relevant. Due to their board geographical distribution in many countries, collectively many colleges could provide a number of ready-made professional centres catering for the INSET needs of teachers (Bagwadeen & Louw, 1993:94).

By the mid-1970s many colleges of education in the United Kingdom had built up a volume of work in award-bearing courses. These represented a philosophy that advanced professional study should utilise the experience of the teachers attending these courses.

In the Department of Educational Services' (DES) Report of Education it was noted that the B Ed degree offered at Colleges of education in the United Kingdom used teachers' experiences as a base on which to build new insights and improved theoretical understandings. This led to a greater level of confidence in the classroom (DES Report on Education, 1977, in Bagwadeen & Louw, 1993:94-95). Besides often being popular providers of advanced diplomas of education, colleges of education also offered a mixture of intermediate and short courses ranging from one-day conferences to three-week summer schools.

These colleges could also offer correspondence courses, workshops, seminars and short part-time courses. Many of these courses could be designed optimally to meet local needs. Colleges could also provide consultancy courses in the area of INSET- particularly if they retain regular contact with schools in order to help identify areas of need where they can act as consultants (Bagwadeen & Louw, 1993: 98-99).

In conclusion, it would appear that some educationalists feel that colleges of education could have the most impact on the INSET sector if they rely on continual feedback and contact with serving teachers in schools in their area.

The Americans Orrange and Van Ryn (1995:50 cited in Bagwadeen & Louw, 1993:99), felt that education authorities "...have the responsibility to promote, encourage and assist the development of in-service programmes for public school personnel."

These educationalists and others felt that **education departments** should not only maintain the role of primary support mechanism for INSET. Education authorities in all countries also have a legal obligation to ensure that personnel in schools under their control are competent as educators, and that they will develop their competencies further by means of INSET. It follows that the authorities will formulate objectives and establish criteria to ensure that INSET programmes meet these objectives. In this way INSET programmes may empower educators to prepare students to meet the demands of living in a continually changing society.

This implies that authorities should do more than just: provide the financial resources for INSET programmes; co-ordinate mechanisms to render technical assistance to and facilitate dialogue with other providers of INSET; and sponsor country-wide INSET programmes related to specific needs. They should realise that - whilst ethically they ought to play a leadership role - they will also need to work with other INSET providers (Bagwadeen & Louw, 1993:99-100).

Teacher organisations – such as unions and specialised subject groups, like science teachers or early learning organisations – should also be involved with INSET. Organisations can voice the collective opinion of an educator on various issues and are seen by some educationalists as crucial agencies when it comes to the development of INSET programmes.

Teacher organisations can create a readiness among educators to participate in the formulation of INSET courses. Apart from assisting its members to understand that participation in the development of INSET programmes is the professional responsibility of its members, a teacher organisation should also promote quality standards for these courses. They can arrange for a variety of INSET activities ranging from seminars, lectures demonstrations and workshops to conferences. As providers of INSET, many teachers' organisations appear to endorse the slogan 'teachers learn best from teachers' (Bagwadeen & Louw, 1993: 100-102).

As providers of INSET, **consultants** allow external educators to address the needs of individual teachers and institutions. Such an INSET system can strengthen the promotion and consideration of innovation. The success of consultancy lies in the quality of the consultant-client relationship. The relationship must be a partnership highlighting the complementary skills of the client and consultant. Success will be achieved only if this partnership is based on a mutual wish to co-operate to find solutions to problems, rather than the solutions being the result of the superior expertise of the consultant only (Bagwadeen & Louw, 1993:102-104).

International bodies, like the United Nations' agency UNESCO, can play a key role in the provision of INSET. UNESCO has established a network of educational centres and regional seminars have brought educators from the neighbouring countries together for the first time. These centres provide teachers in the surrounding regions with information and research facilitates. In Europe, Andrew Moore, manager of the Science and Society programme at the European Molecular Biology Laboratory (EMBL) brought together EMBL and the European Molecular Biology Organisation (EMBO) and the European Federation of Biotechnology to launch the project "Continuing Education for European Biology Teachers" (CeeBT). CeeBT is funded by the European Union and it aims to provide:

a new layer of professional development for biology educators in secondary schools, a professional group that is recognised as crucial to many aspects of future European success in the area of research and development.

(ceebt.embo.org, 2003:homepage.)

The project gives European teachers the opportunity to meet leading researchers, who deliver talks on the latest biosciences research and re-introduces teachers to state-of-the art laboratory techniques. They also hold workshops in about eight countries including Israel. In a similar manner, the IUBS Commission of Biological Education (CBE) has been funding research in biology education and organising international conferences and workshops (Vohra, 2000:1).

Other relevant international bodies include the Institute for International Education in the United States, the Commonwealth Institute in the United Kingdom and the Danish Institute.

No matter who the INSET provider is, there are various categories of INSET or types of INSET programmes, and a discussion of these now follows.

2.2.5 Categories of INSET programmes

There are many forms or categories of INSET in which teachers can engage, but one of the prominent categories is '**school-focused INSET**'.

In the United Kingdom, the James Report clearly stated:

In-service training should begin in the schools. It is here that learning and teaching take place, curricula and techniques are developed and needs and deficiencies revealed. Every school should regard the continued training of its teachers as an essential part of its task, for which all the members of staff share responsibility.

(DES, 1972:11 cited in Bagwadeen & Louw, 1993:107)

It is clear from this definition, and those of others, that 'school-focused or school-based' INSET should, in most instances, be initiated by the teachers within the school to address a problem within that particular school. This interpretation of school-focused INSET suggests that INSET policy should arise from, and have implications for, every aspect of life and work of the school. The drawbacks of a purely school-based model is that a school relying just on its own resources could degenerate into an isolated, parochial environment.

Smaller schools will not have the same resources at their disposal for INSET that larger secondary schools have.

Griffiths (1984:17) cited in Bagwadeen & Louw (1993:109) synthesised the following assumptions for school-focussed INSET projects:

- teachers within the school should initiate them;
- they should be resourced to a high level to prevent developmental restraints;
- projects should make use of personnel from outside the school;
- they should be a part of an on-going programme of INSET activities with which the school is involved;
- they should be monitored and evaluated by teachers involved in the project; and
- they should form part of an on-going programme of INSET activities.

The types of INSET activities/projects with which schools can be involved can range from a short lecture to a conference, i.e. school-based INSET activities can take the form of any of the other categories that providers also offer.

Short programmes are the most **widely used form of INSET**. 'Short programmes' refer to a wide-ranging set of activities that do not necessarily have a great deal in common with each other, except the duration of time. Short programmes are usually non-award bearing, yet are often valuable for up-dating purposes. Simmons (1980) cited in Bagwadeen & Louw (1993:110). The benefits of these programmes are that they often make immediate feedback possible. Ruddock (1981:32-34) cited in Bagwadeen & Louw (1993:110) differentiates between the purposes of a short programme and the structures that would be appropriate to implement these purposes. Reti (1982:112-116) in Bagwadeen & Louw, (1993:110), on the other hand, provides a typology of programmes based on the contents of the programme, i.e. enrichment programmes versus expertise development programmes. The strength of a short programme is that it provides teachers with access to ideas that they can explore with professional colleagues whose reactions and experiences could be different from those of their colleagues with whom they work on a daily basis. A short programme is not a means to an end in itself, but is one episode in a range of other equally important INSET episodes or activities (Bagwadeen & Louw, 1993:112).

There are **different forms of short programmes**. Single lectures could provide frequent and brief refreshment. Speakers with expertise in a specific field could be invited to address the staff of a school, or staff could attend a lecture elsewhere, or the lecture could form part a series of lectures at a conference. Informal activities like seminars take place when providers organise accommodation and leadership for meetings of teachers who show a particular interest in some professional issue or aspect of educational research. Seminars like these can be a very beneficial mode of INSET, since educators can be involved in planning, etc., and maintain contact in various ways afterwards.

A **workshop** can be anything from a scientific expedition to a discussion or study of an educational problem (Moffitt, 1963:25 cited in Bagwadeen & Louw 1993: 113). Workshops originate to satisfy the existing needs of the participants and expert leaders help the participating educators become key to the whole exercise.

They can be flexible and adaptable to the requirements of diverse groups and situations. The degrees of involvement of participating teachers in the preparation of the programme can vary.

Workshops provide for the polling of information, but participants can also share experiences. The 2000 National Survey of Science and Mathematics Education revealed that, in America, the workshop is currently the most common form of professional development: 70 % of high school biology educators had a workshop in the three years prior to 2002 (Wood, 2002:10).

Conferences can be either half-day, week-end or midweek-conferences where the need for residential facilities is minimal - or they can be longer. Conferences are most often organised with an interesting or controversial theme and experts are invited to deliver keynote addresses.

Delegates can then ask questions; or attend workshops, etc.; or other speakers address other aspects of the theme. Often social arrangements at the conference allow for informal discussion to take place (Bagwadeen & Louw, 1993:112-113). Short week-end programmes can also take place.

Intermediate programmes last for a term – three months - and can take place in the evenings. They are often offered at universities and colleges of education. The one term full-time programme is becoming increasingly popular, but most of them are still non-award bearing courses. Courses of this nature provide the opportunity to test novel ideas in the classroom in between sessions.

Vocation courses at universities in the form of summer school programmes had become very popular in the United States and the United Kingdom by the early 1990s. In Canada, attending two courses held in the summer, followed by a written examination, could lead to an enhanced professional degree. Teachers studying by means of correspondence for academic qualifications often used the vacation periods to complete practical components (Bagwadeen & Louw, 1993:116).

Long courses can vary from one-year full time courses or a longer sustained part-time course. Most of these INSET courses are award-bearing courses and are offered by colleges of education or universities.

Clinical supervision takes place when a superintendent of education or other supervisor interviews the educator or observes the educator in the classroom to give advice in order to improve classroom practice. This has become a powerful mode of INSET and is increasingly becoming more widely used internationally (Bagwadeen & Louw, 1993:118-120).

Correspondence courses or distance education strategies are a common supplement to college- or university-based initial teacher training. This is particularly the case in developing countries with respect to teacher education leading to professional qualifications. The INSET techniques adopted are normally cost-effective and do not just include printed course material. They incorporate the use of: television; video or audio-cassettes; computer-assisted instruction often using the internet; the radio and telephone. One of the big advantages of correspondence courses is that they do not remove the teacher from the classroom (Bagwadeen & Louw, 1993:118- 120). No matter what category of INSET programme is used, INSET is being put more into the context of the school rather than using the top-down or centre-periphery model (Morley 1994:1-4).

Any top-down INSET strategy implied that teachers were told how they had to implement a new methodology or approach. In the 1990s INSET programmes in the United Kingdom become now more schools-based and many programmes involved educators being researchers as well. "INSET is done *with* and not *to* teachers" (Morley, 1994:1- 4)

This emphasis has led to most schools in the UK having a designated INSET/Professional Development Co-ordinator. To gain success, it has been found that active participation by staff leads to a better understanding of aims and priorities of the particular INSET programme and how these aims can be achieved.

In the 1980s emphasis was being placed on 'value of money' where the local British education authorities (LEAs) had to choose INSET providers after a bidding process. The Local Education Authority Training Grants Scheme allocated grants to the LEAs for INSET on an annual basis.

However, since the need developed to take a more holistic approach to school improvement, in the United Kingdom, INSET became more school-focussed in the 1990s, with more of the funding being given directly to the schools. This change resulted in INSET providers, particularly colleges of education and universities, redesigning and repackaging their courses since they were more set in the whole school context and organised in a modular fashion (Morley, 1994:8-11).

2.2.6 Current trends in the continuing education and training of biology educators

Continuing Education for European Biology Teachers (CeeBT) organised by the European Molecular Biology Organisation, as described on p. 48, provides professional development in the form of scientific talks from the forefront of research together with hands-on experiments in their teacher workshops in institutes across Europe. Their Learning Lab runs not only practical laboratory courses but also a visitors' programme in which they work with teachers to develop teaching material. CeeBT's Teaching BASE provides online resources and also provides an exchange forum for teachers. Here the main concern is to improve and continually keep teachers aware of cutting edge developments from a subject content knowledge point of view (CeeBT, 2004:1).

In a similar way there has been concern about subject content knowledge in the United States of America and the National Science Education Standards clearly states that:

Science has a rapidly changing knowledge base and expanding relevance to societal issues, and Teachers will need ongoing opportunities to build their understanding and ability.

(National Research Council, 1996, NSES, Chapter 4:1)

Yet, in the 2000 National Survey of Science and Mathematics Education, Biology teachers in the United States reported low levels of participation in INSET initiatives specific to Science teaching (Wood, 2002: 10). Fewer than 50 % of the biology educators had spent more than 35 hours in Science-related professional development in the three years prior to the survey. However there have been some innovatory initiatives aimed at improving this situation.

The Science Education Partnership for Greater Minnesota was established by the Dean of the College of Biological Science, Robert Edle and by Steven Yussen, Dean of the College of Education and Human Development.

The programme, which started in 2003, pairs university science students interested in teaching with science teachers in north-western Minnesota. The students learn about classroom management and preparing lessons, the mentoring teachers learn cutting-edge biology content from workshops and the students (University of Minnesota, 2004:1).

Half of all the high school Biology teachers indicated that their professional development experiences emphasised how to use technology in the classroom. When they were asked to think of their professional development as a whole in terms of different emphases, and 42% of educators said that they had changed their teaching as a result (Wood, 2002:11)

Yet, there appeared to be a mismatch between the needs of Biology teachers in terms of INSET initiatives where educators could learn to accommodate students with special needs. Insufficient INSET opportunities were being provided in this area (Wood, 2002:11).

However, the National Science Education Standards clearly stated that:

Teachers also must have opportunities to develop understanding of how students with diverse interests, abilities, and experiences make sense of scientific ideas and what a teacher does to support and guide all students.

(National Research Council, 1996, Chapter 4:1)

The National Research Council (NRC) formed a committee to research and write the National Science Education Standards and they emphasise a new way of teaching and learning science, which take the international trends in Biology education discussed in sections 2.1.1 and 2.1.2 pp 14-19 This report contained an entire section on Professional Development of Science Educators.

The Egyptian educationalists El-Nemer and Tolymat delivered a paper at the IUBS BIOED2000 conference entitled: "New prospective roles for Biology teachers relevant to the year 2000 and beyond". They felt that teacher educators should help to create learning environments that can help prospective biology teachers not just to teach thematic conceptions of biology, but also to enable them to use scientific understanding and skills when dealing with personal and broader societal issues. Sustainability, bio-technology, bio-ethics and the value of human life were given as examples of topics with which current and biology educators of the future will be faced with and would need to possess the knowledge, reason and values to interact successfully with these issues (El-Nemer & Tolymat, 2000:12). They emphasised that biology educators should realise the need for developing "...everlasting biological literacy in the young boys and girls.." This literacy, which should be the underlying goal of all learning opportunities offered by educators, is multi-dimensional.

Therefore the quality of prospective biology teachers is vital, since they will be expected to teach in an intellectual environment dominated by a continual flux of information and they will need to teach methods of testing the truth of information.

These Egyptian Educators describe the National Science Education Standards as "most relevant and acceptable" (El-Nemer & Tolymat, 2000:12). These standards include a chapter aimed at the professional development of science teachers. Standards like these set benchmarks when planning and evaluating an INSET programme and their relevance will be discussed in Section 2.2.8, pp 66 -72. The four assumptions about the nature of professional experience is relevant here.

These standards emphasise preparing teachers to aid learners to become scientifically literate. These standards also highlight that the professional development of science teachers is a continuous, lifelong process. The focus of professional development needs to move from technical training to opportunities for intellectual professional growth. In order to transform schools, INSET initiatives need to be appropriately linked to educators' work within the context of the school.

This document explains that many American colleges do not teach science as inquiry and that past teacher-preparation courses and INSET activities used to emphasise technical skills instead of decision making and reasoning. For reform to take place, and in order for the vision of science as described in the National Science Standards document to be implemented in schools, professional development must include exposing teachers to methods of inquiry.

2.2.7 Status of INSET in South Africa

In the 1960s and 1970s the educational sector tended to be fairly stagnant and the motivation behind professional development was to gain higher qualifications in order to earn a higher salary. At this stage the country had many education departments based on racial lines, but all teachers could boost their salaries by improving their qualifications.

This situation continued, but by the late 1980s some educationalists began to meet with the ANC. After the unbanning of the ANC in 1990 and the beginning of the negotiation process, a lot of research and discussion had started to take place about the education system of the future.

By 1993 it was clear that South Africa was going to adopt a new outcomes based education system. This necessitated a lot of in-service training and the newly created provincial education departments organised workshops, lectures, etc. regarding the new curriculum.

These INSET initiatives happened at different paces in the various provinces. Gauteng Education Department, for example did a lot more in-depth training regarding the new curriculum than the Western Cape Education Department did. Gauteng Education Department's training was more thorough and started earlier than in the Western Cape.

The implementation of the new outcomes-based curriculum in the learning area of Natural Science, the RNCS, necessitated that in-service education be provided for intermediate phase and senior phase educators in July 2004. The implementation of the NCS at Grade 10 level in 2006 required FET educators from all subjects to attend a week-long INSET programme in July 2005.

However, the need for INSET to accompany the implementation of the original version of Curriculum 2005, was realised by the government from the start. Reg Brijraj, the chief executive of the South African Council of Educators publicly stated that R100 million had been set aside by the Education Labour Relations Council for this purpose in 2001 (Monare and Sapa, 2001:2).

As part of the implementation of the project to raise the quality of science and mathematics education in one hundred schools, the Council of Education Ministers agreed to release funds for INSET courses for 20 000 teachers (Monare and Sapa, 2001:2).

This commitment by the government to INSET for educators is facilitated by the Skills Development Act (Act no. 97 of 1998) that places certain responsibilities on employers regarding staff development. Since the provincial education departments employ the largest portions of South African educators, the state has made itself legally responsible for INSET for the educators which they employ.

The implementation of the National Qualifications Framework (NQF) by the South African Qualifications Authority (SAQA) also has implications for INSET providers (DOE, 1995: 1-6). Most of the INSET providers have to register their courses with the SAQA if they want the courses to be given accreditation so that participants can use the course as modular points towards an ultimate qualifications.

For a course to be awarded modular points the course needs to be of a certain length and many of the INSET courses like weekend workshops are not of this nature.

There have been problems with the NQF. A focussed study took place in 2001 in order to streamline the implementation of the NQF (DOE, 2001:1-3). It resulted in a report published by the Department of Labour and the DoE and streamlining of the NQF began (DOE, 2002:1). Evidence of this streamlining is the realisation that it that the NQF Credit system is over ambitious and that it presents problems in registering INSET courses for educators.

A proposed PD (Professional Development) Points system that complements the NQF Credit system has been proposed in a report of the Ministerial Committee for Teacher Education (DOE, 2005: 8). The report, *A National Framework for Teacher Education*, refers to INSET for Educators as Continuing Professional Teacher Development (CPTD) and recommends that the South African Council of Educators (SACE) and not SAQA endorse in-service activities and accredit them PD (Professional Development) points (DOE, 2005: 16). This lengthy report also suggests a new Qualifications Framework for Education in terms of existing NQF levels, but none of the recommendations have been implemented yet. (See Appendix I for relevant extracts of this report)

Since the implementation of the Skills Development Act, many schools have put in place strategic plans for professional development over and above the workshops and meetings regarding the implementation of the new curriculum. The schools that are doing this are either independent schools or former Model C or "white schools" where the school fees are significantly higher and the school can not only afford to do so, but will be penalised in accordance with the Skills Development Act, if they do not.

Currently there is a greater realization that INSET is important, but educators no longer receive an increase in salary when they complete a post-graduate qualification such as honors or a masters degree.

There is also realization that the 'cascade method' or 'top down' method of sending one or two people to an INSET programme and then asking them to feed back to the rest of the teachers involved in the learning area or phase group is not very effective.

Grade 8 teachers received a very brief in-service training sessions towards the end of 2000 in the Western Cape to assist them to facilitate the acquisition of process skills and problem solving required by the new syllabus. In most schools one staff member per learning area had to attend the workshop and then disseminate the information and skills of these sessions to the other educators (Davies, 2002).

The INSET programme that accompanied the implementation of the RNCS, as referred to on p 63, was more intensive than previous training. Educators attended a whole week's conference/seminar during the first week of their July school holidays. This was much more in-depth than any of the former INSET initiatives which were previously aimed at preparing educators to implement the new curriculum. However, it meant that educators were required to sacrifice a week of their school holidays.

This was quite a demanding expectation, considering that some educators are working with classes of 45 to 60 learners and are expected to implement the new curriculum without many resources and without the physical space inside their classrooms.

This INSET training for the implementation for the NCS that took place during the July school holidays was also in-depth and teachers left with practical tools such as work schedules which they designed at the course. However, the presenters of the courses, who were curriculum advisors of the different learning areas, could not answer many questions regarding the depth to which certain themes (concepts within a topic) in certain knowledge areas (topics) were to be taught. This led to frustration amongst the physical science educators and the biology educators who attended these seminars in the Cape Town area (Joubert, Odendal, Drew, Botha and Toerien, 2005).

These more comprehensive INSET initiatives of 2004 and 2005 appeared to be more effective than the 'cascade-method' workshops in 2000 and 2001 from an INSET perspective. However, many educators left the 2005 workshops expressing concerns about how learners would be assessed at the end of Grade 12.

They also expressed a need for more INSET initiatives to aid them to implement the NCS in Life Sciences (formerly referred to as Biology) and Physical Sciences at FET level.

Those schools that could afford to send teachers on weekend workshops often send them to courses run by the teachers' union, such as the weekend workshops organised by the National Union of Educators. Often the presenters were experts and the topics revolved around implementing the new curriculum.

2.2.8 Criteria for Effective INSET courses

2.2.8 (a) International criteria for professional development initiatives for science teachers

Many American colleges do not teach science as inquiry and teacher-preparation courses and INSET activities are used to emphasise technical skills instead of decision-making and reasoning. The new vision of science, with greater emphasis on scientific literacy and science inquiry, is described in the National Science Standards document. In the introductory section for the Professional Development of Teachers of Science, it is highlighted that, for the new vision of science to be implemented in schools, INSET initiatives must provide opportunities for prospective and practising teachers to engage in active learning experiences. These experiences should lead to the teachers increasing their knowledge, understanding and reasoning (NRC, 1996, Chapter 4:1-2).

The first three professional development standards are "learning science, learning to teach science and learning to learn". The fourth standard focuses on the quality of INSET programmes.

The first standard regarding the professional development of science teachers requires the learning of essential science content through methods of inquiry.

Professional Development Standard A therefore states that science learning experiences for teachers should:

- involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding;
- address issues, events, problems, or topics significant in science and of interest to participants;
- introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge;
- build on the teacher's current science understanding, ability, and attitudes;
- incorporate ongoing reflection on the process and outcomes of understanding science through inquiry; and
- encourage and support teachers in efforts to collaborate.

(NRC, 1996, Chapter 4: 4)

These requirements highlight methods of inquiry, but they also suggest using the teacher's current knowledge as a starting point. Professional Development Standard B addresses issues surrounding the breadth and depth of the knowledge and understanding of science which a science teacher needs to have in order to teach at a particular grade level. Teachers must have the necessary skills to guide inquiries based on the learners' questions. It is suggested that an appropriate level of understanding for all teachers at all grade levels is the educator's ability to establish what learners understand about science and to use this information to design appropriate activities which will develop the scientific knowledge of the learners even further (NRC, 1996, Chapter 4: 6).

It was argued that, in order for American teachers to implement the new vision of science as described in the *Standards (1996)*, courses for prospective and practising teachers would need to be redesigned. These courses should expose teachers to learning science through inquiry so that they could have direct contact with phenomena and gathering and interpreting data. The INSET programmes should be providing opportunities for teachers to use scientific literature, media and technology in order to solve real, open-ended problems. These courses should therefore prompt teachers to develop the logical reasoning demonstrated in scientific research. (NRC, 1996, Chapter 4:6).

The second professional development standard B focuses on the **integration of knowledge of science, learning and pedagogy and requires the application of the knowledge of science to teaching.**

Learning experiences for teaching should therefore:

- connect and integrate all pertinent aspects of science and science education;
- occur in a variety of places where effective science teaching can be illustrated and modelled, permitting teachers to struggle with real situations and expand their knowledge and skills in appropriate contexts;
- address teachers' needs as learners and build on their current knowledge of science content, teaching, and learning; and
- use inquiry, reflection, interpretation of research, modelling, and guided practice to build understanding and skill in science teaching.

(NRC, 1996, Chapter 4:7)

In the discussion on learning how to teach science, the *Standards (1996)* document highlights that the most pertinent connections between teaching and learning are made through thoughtful practice in field trips, team teaching, collaborative research and peer coaching. Therefore the context of learning to teach science - whether the activity involves pre-service or in-service teachers - should include actual learners and real learning situations and the process should allow for true reflection.

Learning experiences for prospective and practising teachers must address the preconceptions about teaching science which participants bring to any activity. Any learning experience must address questions and difficulties which teachers have (NRC, 1996 Chapter 4: 9).

It was argued that, teacher learning is analogous to student learning and educators need to reflect on learning experiences in order to see where the experience fits into the "larger picture of science teaching" (NRC, 1996, Chapter 4: 10). Finally, it is suggested that the nature of the learning situation or activity is more important than the structure thereof.

The **third professional development standard focuses on the lifelong learning** aspect of professional development and states that any professional development activity should:

- provide regular, frequent opportunities for individual and collegial examination and reflection on classroom and institutional practice;
- provide opportunities for teachers to receive feedback about their teaching and to understand, analyze, and apply that feedback to improve their practice;
- provide opportunities for teachers to learn and use various tools and techniques for self-reflection and collegial reflection, such as peer coaching, portfolios, and journals;
- support the sharing of teacher expertise by preparing and using mentors, teacher advisers, coaches, lead teachers, and resource teachers to provide professional development opportunities;
- provide opportunities to know and have access to existing research and experiential knowledge; and
- provide opportunities to learn and use the skills of research to generate new knowledge about science and the teaching and learning of science.

(NRC, 1996, Chapter 4:10)

Lifelong learning means that teachers' knowledge of current developments in science is up to date. The needs of learners change over time and teachers should be able need to be able to design new problems and tasks in the cultural and economic contexts of their current body of learners. Teachers ought to be able to assess their own learning styles and use the *Standards (1996)* to set personal goals for their own professional development. Teachers need the time and resources to be lifelong learners and often teachers might need to network with teachers in other schools to engage in peer observation, coaching and mentoring (NRC, 1996, Chapter 4:11).

However, any professional development programme for teachers must be coherent and integrated. The characteristics of a quality professional development programme are listed in the fourth development standard.

For such development programmes there should be:

- clear, shared goals based on a vision of science learning, teaching, and teacher development congruent with the *National Science Education Standards*;
- integration and coordination of the program components so that understanding and ability can be built over time, reinforced continuously, and practiced in a variety of situations;
- options that recognize the developmental nature of teacher professional growth and individual and group interests, as well as the needs of teachers who have varying degrees of experience, professional expertise, and proficiency;
- collaboration among the people involved in programs, including teachers, teacher educators, teacher unions, scientists, administrators, policy makers, members of professional and scientific organizations, parents, and business people, with clear respect for the perspectives and expertise of each;
- recognition of the history, culture, and organization of the school environment; and
- continuous program assessment that captures the perspectives of all those involved, uses a variety of strategies, focuses on the process and effects of the program, and feeds directly into program improvement and evaluation.

(NRC, 1997 Chapter 4: 12)

The National Science Education Standards described as “most relevant and acceptable” (El-Nemer & Tolymat, 2000:12) by two Egyptian educators who were presenting a paper on the prospective role of Biology educators. South Africa DoEs not have a specific set of standards for the professional development of science teachers, yet the vision of science embedded in the National Science Education Standards, has much in common with the vision of science and the kind of learner described in the Life Science and Natural Science sections of the Revised National Curriculum Statement.

These *Standards (1997)* for the professional development of American science teachers also highlight the importance of INSET activities taking place in the context of the school and the real difficulties which the science teacher faces on a daily basis.

2.2.8 (b) School-based INSET and relevant criteria for INSET workshops

In the 1990s, one of the benefits of INSET in the UK becoming more schools-based has been making schools responsible for identifying their own priorities in this regard. This has helped to weaken some of the institutional barriers that previously left British teachers frustrated in implementing the skills and knowledge gained (Morley, 1994:10).

The African-born New Yorkers, Rebecca and Hubert Dyasi have done a lot of schools-based INSET in science education in developing communities. Their extensive work in Africa with the Science Education Programme for Africa, their participation in science education workshops and conferences in South Africa and their INSET experience with inner city teachers in New York, makes their strategies for INSET relevant.

Some of the strategies that they have adopted to implement successful INSET programmes are to:

- 1 Utilise teams of differentiated, but integrated staff;
- 2 Focus on school change rather than only change in individual educators and therefore involve groups of educators and administrators in each school;
- 3 Offer sessions for school management on science inquiry and on supporting teachers;
- 4 Give teachers intensive and direct experience in all aspects of science enquiry, using commonly available materials in interactive settings;
- 5 Provide supervised opportunities for teachers to apply their re-conceptualisation of the teaching of science and on-site support with co-teaching experiences in the classroom; and
- 6 Create and sustain recognised, functioning networks of teachers in each school and across school districts

(Dyasi & Dyasi, 2000:30).

In Isreal Tamir and Barenholz (1987) saw teachers as central to the BIGAL program referred to on p7. Like Dyasi and Dyasi, their INSET also included consultations with school principals and on-site visits to participating educators' classrooms. Their INSET course was a balanced mix of pedagogy and subject matter. Tamir therefore believes that effective INSET sessions should not only improve teacher's skills and knowledge, but also succeed in modifying actual teaching practices.

Tamir listed five criteria for 'potential effectiveness' of an INSET course at the at a Science and Mathematics Education Conference in Botswana in 1987. In the light of his more recent work in developing communities in Israel, these are still relevant (Tamir, 1987:218).

These criteria for “potential effectiveness” are:

- **Timeliness** – The first aspects is the readiness of teachers to benefit from INSET in terms of their knowledge, motivation and interest. The second aspect of timeliness refers to the needs of the teacher(s) and /or the school.
- **Feasibility of implementation** - Tamir suggests that factors like availability of laboratory equipment and support of the school principal would affect the success of the educator in implementing the learning experiences of the intervention.
- **Nature of INSET activities** - Tamir argues that there is no substitute for experiential learning as far as a mode for the acquisition of new skills is concerned.
- **Rewarding to teachers** – Since a participant's teaching habits and strategies will probably be challenged on a course, it is important that these interventions are rewarding - whether it be a personal reward like inspiration, or the benefits of networking with other teachers or material benefits such as saving time
- **Organisation** - INSET activities ought to be well organised, interesting and pleasant.

Since Tamir's criteria and Dyasi & Dyasi's suggestions have a lot in common and their relevance to South Africa has been discussed, they will play an important role in evaluating the efficacy of this INSET course for biology educators.

2.3 Biology practical work

Since the 1950s there has been an extensive coverage of the nature, value, aims and assessment of practical work in science and biology. A summary of these developments, made earlier by the writer (Joubert 2004:8-16), is reproduced in Appendix M.

2.4 Chapter summary

At the beginning of this chapter the international trends in science education since the 1970s, but in particular biology education, were introduced. Next, the impact of learning theories on biology education was discussed. The extent to which these trends have been incorporated into the new South African outcomes-based education Biology curriculum, now referred to as Life Sciences, was discussed. Throughout this discourse the emphasis was on practical work, with the learner placed firmly as an active participant in the learning process.

The concepts and scope of INSET were discussed next. The categories of INSET programmes were reviewed. It became clear that the current INSET programme or intervention in Cape Town is a short course with all the characteristics of a workshop. The course is university-based, but is non-award bearing. The current international trends regarding INSET were discussed, and they firmly emphasised that educators need to be viewed as active learners when any INSET programme is designed. Lastly, the international criteria for INSET courses aimed at science educators and their relevance were discussed.

3.1 Introduction

In the first section of this chapter the rationale for using a combination of research strategies is explained. A flow-diagram summarising the twelve stages of this investigation is presented and explained. International criteria relevant to INSET programmes for science educators are tabulated. is presented. A flow-diagram detailing a rationale for the selection of the interviewees and the final three steps of the investigation is presented and discussed. Included in this discussion is an explanation of the table used to process the interviews and the visual data. Matters of research ethics and confidentiality are also covered.

3.2 Rationale for using a 'bricolage' of research methods

'Bricolage' is the term used to describe the research process followed in order to answer the research question(s). The term is used metaphorically to relate educational research to the concept of a quilt consisting of patches, some overlapping and others separate (Lévi – Strauss, 1974, cited in Fraser and Tobin, 1999). The term implies that the researcher becomes a craftsman who selects from multiple theoretical perspectives to frame the research and its methods (Clark, 2000 and Fraser and Tobin, 1998).

Fraser and Tobin decided to use a combination of qualitative and quantitative methods to maximize the potential of research on learning environments. The first flow diagram, Figure 3.1, appears on the following page., illustrates that this research investigation is located in the qualitative and quantitative paradigms. This leads to a 'bricolage' research process.

3.3 The research process explained in stages

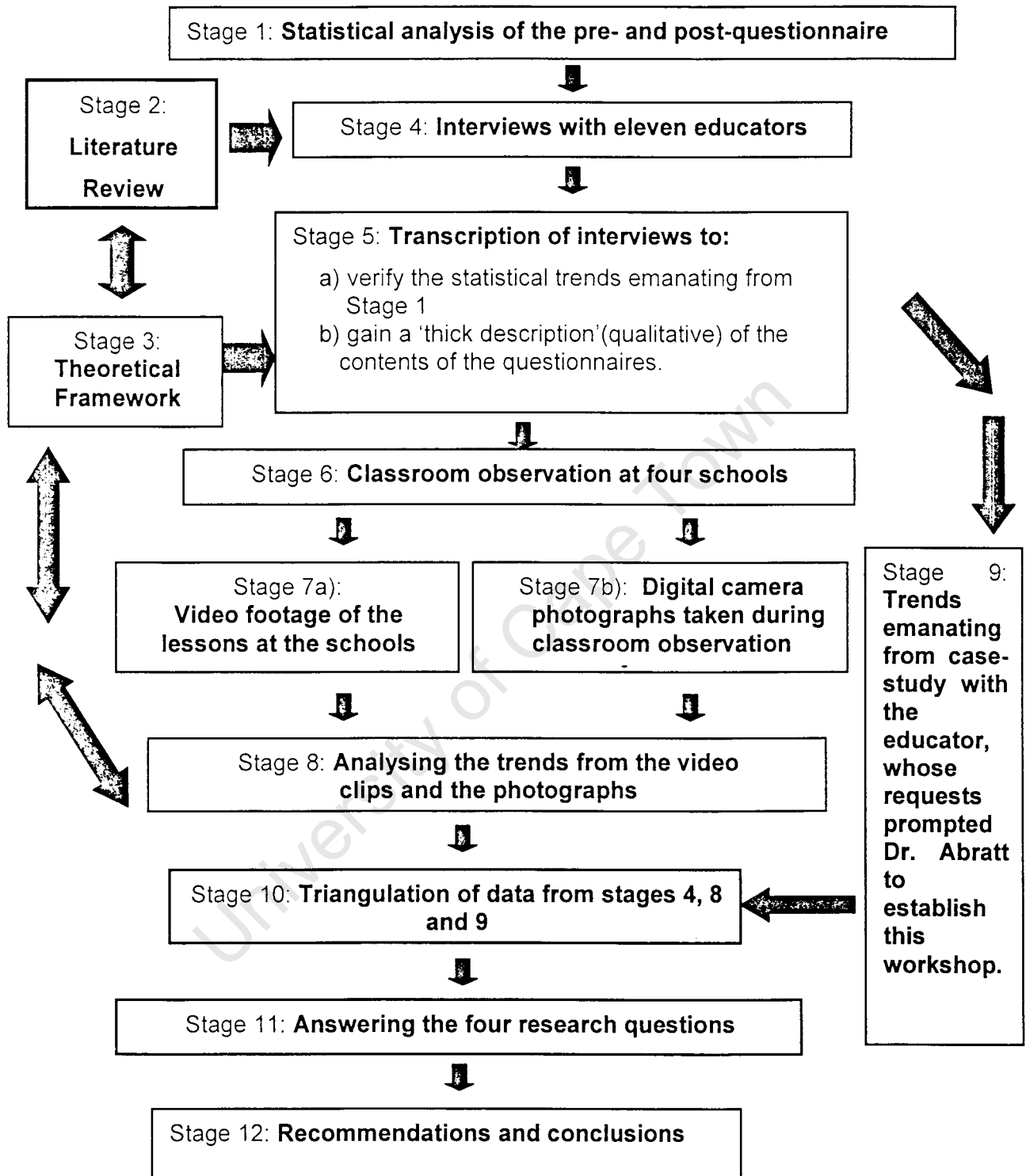
Stage 1: Quantitative aspects of the research design

The existing and available pre- and post-course questionnaires of responses from 90 educators who attended the Biology INSET programme of workshops were analysed statistically for use in a status study.

Subsequently Dr. Abratt, the founder of this workshop, felt that in-depth, follow-up interviews were required to evaluate the sustained dynamics of this particular INSET initiative that had been represented for several consecutive years for groups of 30-40 teachers at a time. This was explained in Chapter 1, pp 1 -13.

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Figure 3.1: Research design for this investigation



Stages 2 and 3: Literature review and theoretical framework

Before interviews could be planned, from a methodological perspective it was decided to establish to what degree the design and implementation of Dr. Abratt's programme met the theoretical criteria, in the literature survey, that describe the features of effective INSET programmes in the field of science education. Table 3.1 summarises the extent to which Dr. Abratt's INSET programme meets these features. Consensus was reached by Ms X and two other educators associated with the programme.

Stage 4: Sample of educators interviewed, ethics and confidentiality

The complete list of 68 educators who attended the programme was considered. The ten educators selected to be interviewed possessed a wide range of academic qualifications and represented a variety of different socio-economic contexts. Their teaching experience ranged between two and ten years. Permission was granted by each educator prior to them being interviewed and before classroom observations took place. Neither the names of the educators nor the schools at which the teachers teach would be disclosed.

Table 3.1 Literature-derived criteria for the systematic evaluation of the effectiveness of INSET programmes for educators, with special reference to school science practical work and Dr. Abratt's programme

Key: X – criterion was not included in this initiative
 √ - criterion was included to a small degree
 √√ - criterion was emphasised to a moderate degree
 √√√ - criterion received a lot of emphasis

Professional Development Standard A states that science learning experiences for teachers should:	
<ul style="list-style-type: none"> • involve teachers in <i>actively investigating phenomena</i>; • address issues, events, problems, or <i>topics significant in science and of interest to participants</i>; • introduce <i>teachers to scientific literature, media, and technological resources that expand their science knowledge</i> ; • <i>build on the teacher's current science understanding, ability, and attitudes</i>; • <i>evaluate the process and outcomes of understanding science through inquiry</i>; and • <i>encourage and support teachers in efforts to collaborate.</i> <p style="text-align: right;">(NRC, 1996, Chapter 4: 4)</p>	√√√ √√ √√ √√ √√√ √√√
The second professional development standard B focuses on the integration of knowledge of science, learning and pedagogy and requires the application of that knowledge of science to teaching . Learning experience for teaching should therefore:	
<ul style="list-style-type: none"> • <i>connect and integrate all pertinent aspects of science education</i>; (NRC, 1996, Chapter 4:7) • occur in a <i>variety of places where effective science teaching can be modeled</i>; (NRC, 1996, Chapter 4:7); • <i>address teachers' needs as learners</i> and build on their current knowledge of science content, teaching and learning; and • <i>use process skills to build understanding and skill in science teaching</i> 	√ X √√ √√
Organisation	
<ul style="list-style-type: none"> • INSET activities should be <i>well organized, interesting and pleasant</i> 	√√√
Rewarding to teachers	
<ul style="list-style-type: none"> • A participant's teaching habits and strategies will be challenged on a course, and, therefore, its INSET interventions must be rewarding, whether it be personal such as inspiration or the benefits of networking with other teachers, or is of material benefit such as saving time <p style="text-align: right;">(Tamir, 1987).</p>	√√

Feasibility of implementation	
<ul style="list-style-type: none"> • Tamir (1987) suggests that contingent factors, such as the availability of laboratory equipment and the support of the school principal, affect the success of the educator in implementing the learning experiences of the INSET intervention 	√√
Criteria related to the objectives of the course	
<ul style="list-style-type: none"> • Four objectives common to most INSSET courses: <ul style="list-style-type: none"> ○ the <i>extension of the knowledge</i> of educators is seen as primary and traditional (Hass, 1957:22, cited in Bagwadeen & Louw, 1993:43). ○ the <i>consolidation of academic achievement</i> and the professional philosophies is another INSET objective (Bagwadeen & Louw, 1993:44) ○ the <i>continual acquisition of new knowledge</i> and skills is another objective of INSET (El-Nemr and Tolymat, 2000:13; Bagwadeen & Louw, 1993:44-45 and Markola, 200:1-3). ○ courses should familiarize educators with recent curricula developments (Bagwadeen & Louw, 1993:45-46). • Staff <ul style="list-style-type: none"> ○ INSET courses should utilize teams of differentiated, but integrated staff (Dyasi & Dyasi, 2000:30). • Timing of the initiative <ul style="list-style-type: none"> ○ Are the educators ready to benefit from the course in terms of their knowledge, motivation and interest? (Tamir, 1987) ○ Does the educator or the school feel that the educator needs to attend the initiative (Tamir, 1987) 	<p style="text-align: center;">√√√</p> <p style="text-align: center;">√√</p> <p style="text-align: center;">√√</p> <p style="text-align: center;">√√</p> <p style="text-align: center;">√√√</p> <p>Most educators were interested and motivated to attend the course, since they applied for the course themselves.</p> <p>Since most educators read the advert in a booklet and applied for the course themselves, this requirement was met.</p>

Stage 5: Transcription of interviews

The interviews with the ten educators were transcribed by a professional and were filed for later use. These interviews will be studied to identify at least some of the factors that reportedly may prevent educators from successfully implementing some or all of the programme. These might include the lack of resources and appropriate classroom space, large classes, insufficient preparation time etc.

Factors that could lead to the successful implementation of the workshop were identified with the aid of the Education White Paper 6 (Section 1.5.3, p 19) cited in (WCED, 2005b:1). This lists factors related to the school and its learning environment that could be barriers. They are:

- the content (i.e. what is taught);
- the language or medium of instruction;
- how the classroom or lesson is organised and managed;
- the methods and processes used in teaching;
- the learning materials and the equipment used; and
- how the learning is assessed.

(WCED 2005b:1)

Based on the preliminary view of a small group of experienced science educators interviewed between December 2005 and January 2006, the following is a list of factors may count as barriers to learning when practical work is considered:

- class-size above 35;
- excessive workload of the educator;
- a demotivated or unmotivated educator;
- the unmotivated learners;
- insufficient access to and inappropriate equipment;
- the absence of a laboratory assistant; and
- the behaviour/discipline of the learners.

It was decided that each of the factors listed above had to be mentioned by at least by two of the four educators (Joubert, Drew, Van der Merwe, Odendal & Rampo, 2005-6). In the same way two headmasters of highly effective schools and a curriculum advisor agreed that a 'culture of learning' could be defined as a phrase widely used, in political and education circles in the 1990s, to identify schools in which a productive learning environment exists. A school which is classified as having a productive learning environment is one in which:

- the Grade 12 results reflect a high pass rate with a good portion of learners gaining a matriculation exemption;
- the attendance rate is high;
- a large portion of the learners are motivated to learn; and
- the educators are committed and motivated.

(Gouws, Sherrif and Rampo, 2006)

Taking these factors into consideration and from reading the transcripts of the interviews, it was decided to compile a comprehensive table of factors that influence the transferability of this INSET programme in the classroom.

The South African Minister of Education, Naledi Pandor (2005:1), reported that factors associated with underachievement among 34 000 learners in Grade 6 Mathematics, Language and Science, in 1000 mainstream primary schools across South Africa, in late 2004 could be classified as 'out-of-school' factors and 'in-school-factors'. [A summary of an article from this report is included as Appendix J.]

Based on Pandor's report, the possible factors were divided to three 'in-school' categories and one 'out-of-school' category as shown in Table 3.2. The transcripts will indicate whether these factors impacted positively or negatively on the implementation of this INSET initiative. A copy of this table will be used to systematise and code data from each transcript.

Two columns, positive and negative, have been added to the right-hand side of the table, to record whether the factor is mentioned in interviews as having had a positive or negative impact, or whether it is not mentioned.

If a factor, such as the workload of an educator, is mentioned once as a negative influence, it is given one minus (-) sign, in the left hand corner of Table 3.2. If mentioned more than twice as having a negative influence, it receives two minus (- -) signs. If the educator mentions the workload as a repeated negative factor, e.g. teaching all the lessons every day or teaching more than six groups of students and having large classes, the factor is given three minus signs (- - -). The average provincial workload of six groups of learners per educator with a suggested class size of 35 per group is viewed as the norm. However, if the educator taught fewer groups of learners or had small classes, the factor of workload is viewed in a positive light - one positive sign per factor (+). If the classes are smaller than eighteen learners, this is viewed as more positive with two plus signs. This leads to a weighted frequency per reported factor.

This process of data capturing involved a highly experienced educator with knowledge of this research project. They would not have viewed the individual transcripts prior to reading them to the researcher. The researcher used the Microsoft Word programme to capture the data onto a copy of the table as below.

Table 3.2: Template of factors which reportedly influenced the implementation of this INSET programme

In- school factors	Factors viewed as having a positive influence	Factors viewed as having a negative influence
Factors associated with the school – beyond control of the Educator		
(A1) Medium of instruction		
(A2) Availability of resources in terms of media		
(A3) Equipment available for practical work		
(A4) Finances available for consumable resources		
(A5) Physical classroom space appropriate for biology practical activities.		
(A6) Class sizes		
(A7) Presence of a learning environment.		
(A8) Workload		
(A9) Support of management for practical work		
(A10) Vandalism		
B) Factors associated with educator		
(B1) Classroom layout		
(B2) Methods and processes used in practical work.		
(B3) Management of the lesson– discipline		
(B4) Preparation for the practical		
(B5) Confidence in own practical skills		
(B6) Personal motivation to conduct practical work		
(B7) Fear of conducting with a safety risk		

C) Factors associated with learners		
(C1)	Motivation to do practical work	
(C2)	Behaviour of class as a group	
(C3)	Bringing practical apparatus	
(C4)	Behaviour of one or two 'unco-operative' learners	
(D1)	Geographic location of school – town vs. rural, in the middle of gang area, etc.	
(D2)	Socio-economic demographics of the school (unemployed parents, etc.)	
(D3)	Parental interest and stimulation	

Stages 6 and 7: Classroom observation and data capture

Permission to observe educators conducting one of the practical activities rehearsed on the INSET programme was requested of five teachers in different schools. Basic facts regarding the school and the physical layout of the classroom/laboratories were established. The lessons were recorded on video, and digital pictures were also taken at each school. Table 3.2 will also be used to evaluate this visual data with regard to reported factors that may influence the implementation of this programme. Once again the factors listed in Table 3.2 will be analysed and weighted as described on p 82. The photographs will be studied to identify possible which factors which might be influencing the implementation of the programme in that particular lesson, and how many times each factor appears.

Stage 8: Analysis of the trends from the classroom observations

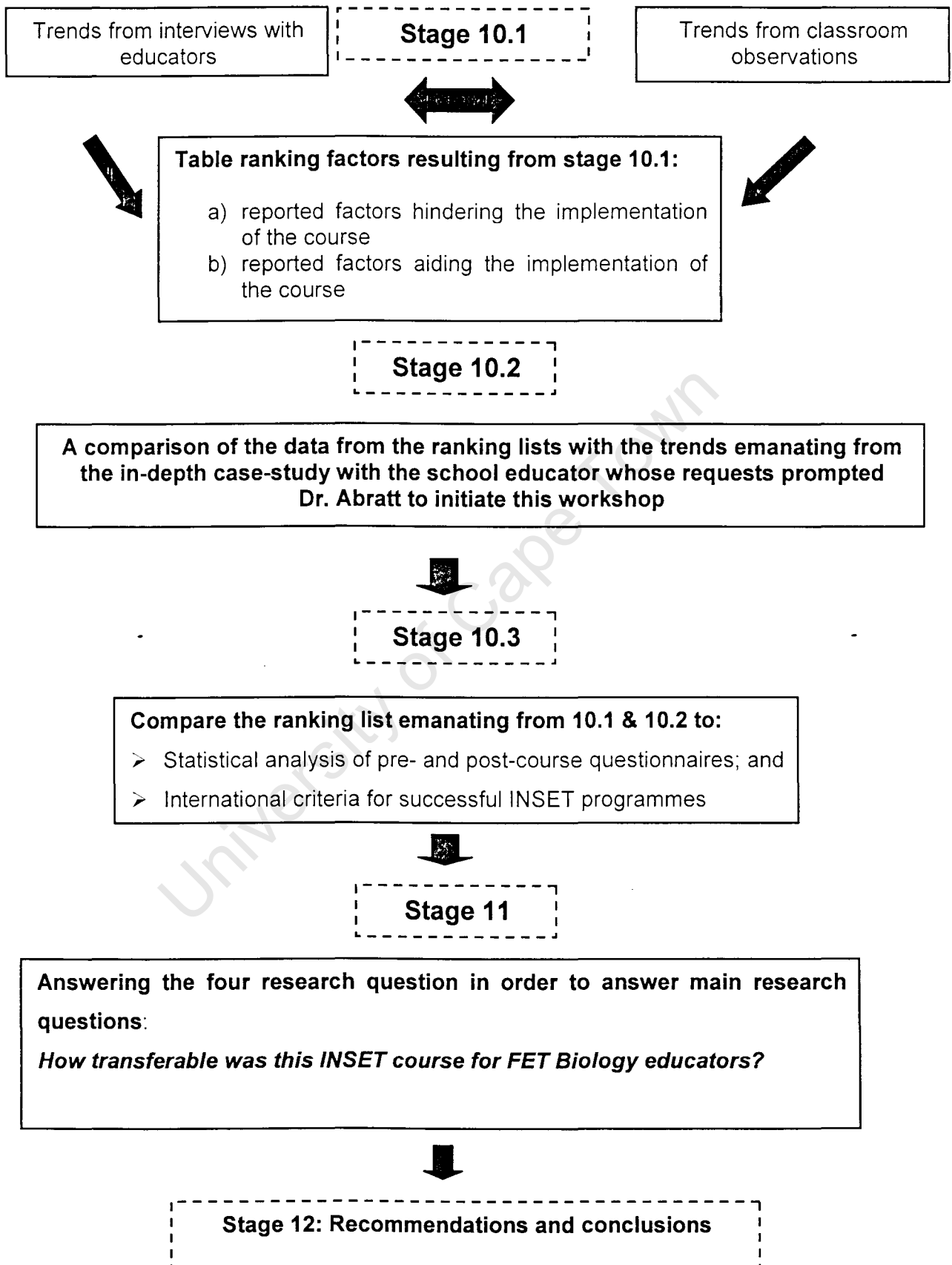
The visual data gathered will be analysed to identify whether the trends observed during the interviews were also evident in the practical activity.

Stage 9: Trends from one case-study interview

Dr. Abratt initiated this programme of workshops subsequent to a local educator, Ms X, requesting the use of UCT 's Molecular and Cellular Biology Department laboratories and equipment to conduct practical activities with her Grade 12 learners. This educator attended the programme several times and recommended that her colleagues should also attend the programme. The school at which she teaches is in a busy suburb of Cape Town. Many of her the learners, however, come from outlying areas and have socio-economically deprived backgrounds. Ms X's school has no laboratories and little equipment. The same template of category of factors was used to analyse the information from her interview.

University of Cape Town

Figure 3.2: Flow-chart illustrating the data analysis process and the application thereof to answer research question no. 4



Stages 10-12: Data analysis through triangulation

Figure 3.2 illustrates that, to process and analyse the results (Stage 10.1), the trends from the interviews with educators, and those from the visual evidence, gathered during the classroom observations, will be compared to each other. The factors that reportedly hindered the implementation of this programme in schools will be ranked from most to least important, following the comparison between the trends that resulted from the interviews and the classroom observations. The same procedure will be carried out with the factors that aided the implementation of the programme. This stage has a quantitative as well as a qualitative aspect.

Secondly, in Stage 10.2, the ranking list of the factors that hindered and aided the implementation of the INSET programme will be compared to the information gained from Stage 9. This comparison will refine, verify and contextualise the ranking lists, since the educator in question attended this INSET programme several times.

Stage 10.3 is the third stage of the triangulation process. The ranking lists the factors that were reported to hinder or aid the implementation of this initiative. As discussed in Stage 10.2, this is then compared to the qualitative information generated during Stage 1. Thereafter the ranking lists will be compared to relevant international criteria for INSET initiatives in science education, as discussed in section 2.2.8

Stage 11: Answering the research questions / discussion of results

Once the data analysis is completed, the results will be discussed within the context of the four research questions listed on pp 8-9 of this proposal.

During this discussion reference will also be made to the book which resulted from this INSET programmes. Dr. Abratt and her team (Abratt, Collett, Miller-Butterworth and Suiro-Stheeman, 2002) published, *Practical Biology – A classroom resource for teachers*, after they had refined the activities and theoretical material covered by this programme.

3.4 Chapter summary

This chapter has explained the rationale for using the multi-dimensional research approach to evaluate the transferability to the classroom and the long-term sustainability of this INSET programme of workshops.

The flow-diagram summarising the twelve stages of this investigation was presented and discussed. International criteria relevant to INSET programmes for science educators was presented and the content of this INSET programme was compared to these criteria. The rationale for the selection of the interviewees and the final three steps of the investigation was discussed. These final steps would involve a triangulation process. The table used to process the interviews and the visual data was explained. Matters of research ethics and confidentiality were also mentioned.

4.1 Introduction

The data recorded from the interviews with the representative sample of educators who attended this programme was captured with the aid of Table 3.2. The visual data from the classroom observation was also captured with the aid of Table 3.2, processed using Microsoft Excel. The factors that, reportedly, hindered or aided the implementation of this INSET programme could, therefore, be identified and categorised. This data-analysis process then compared the trends observed during the interviews with those that were observed during classroom observations. They were then compared to the information gathered from the 'in-depth' case study of the one educator, Ms X who attended the programme several times. This process enabled the research questions to be answered.

4.2 Trends that emerged from the interviews

The data contained in these transcripts was processed in terms of categories of factors that could have impacted on the transferability and implementation of this programme. The influence was recorded as negative or positive with varying degrees of weighting. The weighting of the factors has been described on p 70. Factors beyond the control of the educator (such as workload and class-size), which according to them, impacted negatively on the implementation of the programme have been ranked from the most to the least negative (see Table 4.1).

Table 4.1 'In-school' factors, beyond the control of the educator, reported as negatively impacting on the implementation of the programme

Factor	Weighted frequency
(A10) Vandalism of equipment etc.	16
(A 8) Workload of educator	14
(A6) Class size – more than 35 seemed to be problematic	13
(A5) Physical classroom space appropriate for biology practical work	
(A3) Equipment available for practical work	11
(A4) Finances available for consumable resources	10
(A7) Learning environment – DoEs the school have a culture of learning or not	9
(A9) Support of management for practical work	6

It emerged from the interviews with the educators that vandalism was the most inhibiting factor that prevented them from implementing the practical activities to which they were exposed on the programme. This specifically affected the equipment in the laboratories. In cases where the educators had to share a classroom, any advanced preparations for a practical became ineffective as the equipment was interfered with and damaged. One educator described disappointment as a result of this situation, saying:

...and I could not leave anything because if the next class came there, they destroyed everything. If, for example, the teacher did not control the class or lock the door, equipment was destroyed. Faced with these problems, one does not want to do it (prepare practical work) anymore.

The same educators also complained about the general vandalism in the school. In one case, in which two educators were interviewed, the vandalism in the school was so severe that the laboratories were not used for two years. When they were made use of again, it was as normal classrooms. The educators themselves changed classrooms and did not tackle any practical work. Further, many of the educators explained that, when others used their classrooms due to large classes, they could not control factors outside their own lesson.

The workload of an educator (weighted frequency of 14) was, in most cases, decided by the management team of a school. Factors taken into consideration included: qualifications and experience of the teaching staff, subjects offered and the enrolment at the school. The reports indicated workload was the second most negative or hindering factor in the implementation of this programme. Workload was directly influenced by the size of the class. In many cases educators reported class sizes of 30-35 and more. Consequently class size resulted in a weighted frequency of 13, the third highest factor which had a negative impact on the programme implementation. In one case, however, the visual evidence contradicted this factor., as will be discussed on pp 98 –100 contradicted this factor.

Educators indicated that when implementing the INSET programme, classroom space appropriate for conducting practical work in Biology was as important as class size. Table 4.2 shows that support from management, in the form of the provision of a budget for practical work and/or the presence of a laboratory assistant, was the most important positive factor in terms of the programme being successfully implemented. The lack of equipment and of finances to purchase consumables, such as iodine and Vaseline, prevented educators from implementing this INSET programme. In schools where educators did not have the support of management and/or a laboratory assistant, the implementation of the programme was impeded.

In schools where a recognised 'culture of learning' has been established and was is a positive attitude towards learning, the INSET programme was implemented with a greater degree of success. (See Tables 4.1 and 4.2) Where negative factors had higher weighted frequencies, the educators tended to focus more on the difficulties involved than with the implementation of the programme.

Table 4.2 'In-school' factors, beyond the control of the educator, which was reported to impact positively on the implementation of this programme

Factor	Weighted frequency
(A9) Support of management for practical work	10
(A7) Learning environment	6
(A3) Equipment available for practical work (A4) Finances available for consumable resources (A5) Physical classroom space appropriate for biology practical work	4
(A6) Class size	3

Personal motivation to perform practical work was viewed by the educators as the single most important indicator with regard to predicting the successful implementation of this programme (see Table 4.3). The confidence of the educator to conduct practical work was identified as the second most important factor. Adequate preparation for the practical investigations was also an indicator of success.

Table 4.3 Factors relating to the educator, which reportedly impacted positively on the implementation of the programme

Factor	Weighted frequency
(B6) Personal motivation to do practical work	10
(B5) Confidence in own practical skills	9
(B4) Preparation for practical activities	6
(B1) Classroom layout (B2) Methods and processes used in practical work (B3) Management of lesson – (discipline, etc)	2

The classroom layout refers to the utilization of the space available in the classroom. Many educators felt that they did not have sufficient space in their classroom in terms of the number of learners who would be involved in practical work. This was the case regardless of how the desks and chairs were arranged.

Consequently this factor is viewed as having a negative impact on the implementation of the programme. This is unrelated to factor A5 – physical classroom space appropriate for practical work – since some schools have laboratories. In most cases these were designed for class sizes of a maximum of 25 learners. In many schools class sizes are larger than this, leading to overcrowding. Therefore classroom layout, factor B1, is not the choice of the educator, although it was initially thought to be so. Whatever the classification, where educators identified classroom layout as a hindrance to the implementation of this programme (see Table 4.4), it was due to overcrowding of the school as a whole and not the choice of the educator. This factor, therefore, should be classified under category A.

Table 4.4 Factors relating to the educator, which reportedly impacted negatively on the implementation of the programme

Factor	Weighted Frequency
(B1) Classroom layout	7
(B7) Fear of conducting practical activities with a safety risk	5
(B3) Management of the lesson	3
(B4) Preparation for practical	2

Some educators reported one or two dangerous explosions, which made them anxious. However, since the practical exercises conducted during this INSET programme are safe, this factor should not have hindered the implementation of the programme.

Table 4.4 reveals that ineffective management by the educator during a lesson, especially with regard to discipline, hampered the implementation of the programme. This was substantiated by the educators who identified the behaviour of a class as the likely factor which prevented the execution of the programme. Five of the educators taught in three under-resourced schools. In such cases the learners were often required to bring items such as gloves or Coke-Cola bottles from their home. When learners were unable to produce these items, the educators were prevented from conducting the particular practical.

Table 4.5 Factors relating to the learners which reportedly impacted negatively on the implementation of the programme

Factor	Weighted frequency
(C2) Behaviour of the class as a group	9
(C3) Bringing practical apparatus, if school DoEs not have sufficient supply	5
(C4) Behaviour of one or two unco-operative learners	4

It is assumed that learners who are motivated about practical work will contribute positively to the successful implementation of this INSET programme - the weighted frequency of this factor is 7. The learners identified that this is the only factor related to the learners that would hamper the implementation of the programme.

Table 4.6 clearly illustrates that 'out-of-school' factors did not impact on whether the educators implemented the programme.

Table 4.6 Out-of-school factors which reportedly impacted negatively on the implementation of the programme

Factor	Weighted frequency
(D2) Socio-economic factors. All educators who referred to this factor mentioned unemployment and gangsterism	7
(D1) Geographical location of the school. (D3) Parental involvement – the lack thereof	6

All three sets of educators stated that unemployment and gangsterism are primary influences as a hindrance to the implementation of the programme at the under-resourced schools in township areas. According to social workers, the parents of learners in these areas, were concerned about their childrens' educational progress. However, their primary concern was to put food on the table (Rogers, Andrews and Janjies, 2005). This, in turn, impacted on learners' interest and motivation at school and, therefore, indirectly affected the implementation of this programme.

A clear picture emerged from the interviews about which factors affected the successful implementation of this programme. These factors can be regarded as trends and are summarised on Table 4.7 on p. 96.

Table 4.7 The factors which led to the successful implementation of this INSET programme, as reported by the educators during interviews.

The programme can be implemented successfully if the following 'in-school' factors beyond the control of the educator are present in the school:	
✓	the classroom is in a safe area and equipment is not vandalized;
✓	the availability of equipment for practical work;
✓	finances are available for consumable resources such as scalpel, blades etc ...;
✓	workload of the educators is reasonable;
✓	class size is no larger than 35;
✓	a culture of learning exists at the school; and
✓	school management supports practical work and a laboratory assistant is part of the budget.
The programme can be implemented successfully if the following 'in-school' factors associated with the educator are present:	
✓	personal motivation to undertake practical work;
✓	confidence in his/her own practical abilities and skills;
✓	the classroom layout makes practical work easy;
✓	the work space DoEs not have to be shared;
✓	avoid dangerous practical activities;
✓	adequately preparation is done practical work; and
✓	classroom management and discipline are maintained.
The programme can be implemented successfully if the following 'in-school' factors associated with the learners are present in the school:	
✓	good individual behaviour and group participation;
✓	positive motivation to engage in practical work; and
✓	learners are prepared to supply to simple apparatus such as gloves, etc in under-resourced schools..

4.3 A comparison of the trends which emerged from the videos with those that emerged from interviews

Table 4.8 The video-recorded factors which reportedly had a positive influence on the implementation of this INSET programme

Factor	Weighted frequency
(A6) Class size	6
(A3) Equipment available for practical work.	5
(A7) Learning environment – DoEs the school have a culture of learning or not?	
(A9) Support of management for practical work	
(A5) Physical classroom space appropriate for biology practical work.	4
(A2) Availability of resources in terms of media.	
Factor	Weighted frequency
(B1) Classroom layout	7
(B2) Methods and processes used during the conduction of the practical work	
(B4) Preparation for practical activities	
(B5) Confidence in own practical skills	6
(B3) Management of practical activities	
(B6) Personal motivation to do practical activities	5
(B7) Fear of conducting a practical with a safety risk	2
(C1) Motivation to do practical work	5
(C2) Behaviour of class as a group	

Data gathered from the five video recordings were weighted, as clarified on p 83. Due to the nature of this form of media some factors such as workload could not be observed. Class size, availability of equipment, a culture of learning at the school, appropriate classroom space and support of management for practical work – were ranked as the most important factors which positively influenced the implementation of this programme. The data did not reveal the workload of the educator.

These factors also ranked highly as positive effects after processing the data from the interviews. Support of management for practical work included a laboratory assistant, and was given a second + sign (see Table 4.2 on p. 90) No vandalism was observed during any of the sessions.

Appropriate classroom layout, educator's confidence in his/her own practical skills and motivation to attempt practical work, were regarded as important factors during the interviews. These were confirmed in the videos and photographs. However, the video of the classroom observation indicated that the educators with a good working relationship with their classes ensured that effective learning took place regardless of any obstacles such as large class sizes or the lack of equipment. The Grade 10 dissection of the heart, conducted again using the same set of instructions, was observed in a privileged single-sex school environment where a laboratory assistant was present and the group size was three to four learners. More learning occurred when the same practical was done in an under-resourced school in a class of 50 which was divided into groups of eight to ten learners. The determining factor in the under-resourced school, was a comfortable yet disciplined relationship that the educator enjoyed with his learners.

The videos and digital photographs confirmed that the educators were motivated to engage in practical work and the learners were well behaved - and this impacted positively on the successful implementation of this INSET programme.

Table 4.9 Factors which emerged from the videos of classroom visits, and which impacted negatively on the implementation of the programme

(i) Factor	(ii) Weighted (iii) frequency
(A3) Lack of equipment available for practical work (A4) Lack of finances available for consumable resources	3
(A5) Physical classroom space inappropriate for biology practical work (A6) Class size over 35	2
Not very strong negative factors	
(B3) Management of the lesson – discipline (B4) Insufficient preparation for the practical	1
Not very strong negative factors	
(C1) Insufficient motivation to do practical work (C2) Inconsistent behaviour of class as a group (C3) Learners forget to bringing equipment for practical activities (C4) Behaviour of one or two 'unco-operative' learners	1

The workload of an educator could not be judged by observing only one lesson and no vandalism was observed during the classroom observation. The interviews indicated that these were the highest ranking factors impacting negatively on the implementation of the programme. Factors such as: class-size, physical classroom space appropriate for practical work, available equipment and finances available for consumable resources, were also ranked as negative factors.

In addition large class size and lack of appropriate classroom space negatively influenced on the implementation of the programme.

The video and from the photographs indicated that there were few factors associated with educators and learners which, reportedly, contributed to a negative impact on the implementation of this INSET programme.

Table 4.10 Ranked lists of factors which reportedly impacted positively on the implementation of the programme (Ranked from most positive to least)

<p>The following 'in-school' factors, beyond the control of the educator, should be present in the school:</p> <ol style="list-style-type: none"> 1. Support of management for practical work – in terms of attitude and laboratory assistant. 2. Class-size less than 35. 3. (a) Productive learning environment. (b) Sufficient equipment for practical work. 4. (a) Physical classroom space appropriate for biology practical work. (b) Finances available for consumable resources.
<p>The following 'in-school' factors, associated with the educator, should be present:</p> <ol style="list-style-type: none"> 1. Personal motivation to do practical work. 2. (a) Appropriate classroom layout. (b) Effective methods and processes used during the lesson and preparation for practical activities. 4. Confidence in own practical skills. 5. Management during the practical.
<p>The following 'in-school' factors, associated with the learners, should to be present:</p> <ol style="list-style-type: none"> 1. Motivation to do practical work. 2. Appropriate behaviour of the class as a group.
<p>The following 'out-of-school' factors were mentioned by a few educators:</p> <ol style="list-style-type: none"> 1. Favourable socio-economic conditions such as a high rate of employment and income. 2. Parental interest and stimulation.

Table 4.11 Ranked lists of factors which reportedly impacted negatively on the implementation of this programme

The following 'in-school' factors, beyond the control of the educator, should not be present in the school:
<ol style="list-style-type: none"> 1 Vandalism of school and equipment. 2 Excessive workload – in terms of size of classes and/or in number of periods taught 3 a) Class-size over 35. b) Classrooms which are inappropriate for practical work. 5 a) Insufficient equipment for practical work. b) Finances available for consumable resources; 7 Lack of an effective culture of learning in the school. 8 Lack of support from school management for practical work.
The following 'in-school' factors, associated with the educator, should not be present:
<ol style="list-style-type: none"> 1. Inappropriate classroom layout most often due to overcrowding. 2. Fear of conducting practical activities with safety risk. 3. Ineffective management of the lessons most often from a discipline angle
The following 'in-school' factors, associated with the learners, should not be present:
<ol style="list-style-type: none"> 1. Disrespect and bad behaviour of a class as a group. 2. In appropriate behaviour of unco-operative learners.
The following 'out-of-school' factors were mentioned by a few educators:
<ol style="list-style-type: none"> 1. Unfavourable socio-economic conditions such as a high rate of unemployment and financial income; and 2. Lack of parental interest and stimulation..

4.4 A comparison of the ranking lists which emerged from the videos and interviews to the case-study of the biology expert Ms X (Stage 10.2)

Ms X attended the programme four times and in successive years encouraged her staff members to attend. She credited the programme for her successful career path, including her appointment as a national examiner and subject advisor.

In an in-depth interview with Ms X her feelings regarding the programme were compared to those of other participants. For her the lack of equipment was the most negative influence outside of her control. This, class-size and lack of sufficient funds for consumable resources acted as negative influences to the successful transfer and implementation of the INSET programme, she said.. Unlike others interviewed, she did not feel that workload was a problem for her.

Her motivation to tackle practical work and her belief in the value of practical work contributed the most positively to her implementation of the programme, she said. Her confidence in her ability deal with practical work was high and had increased each time she attended the programme.

However, she did remark that not all the staff, she had encouraged to attend the programme were able to implement it with the same degree of success. She attributed this to the work ethic and self-motivation of the individual educators. Overall Ms X felt that successful implementation of the programme depends more on the educator, than on the school or learners.

She commented further that other benefits of this programme were that it motivated her to undertake practical work, refreshed her interest in Biology and taught her how to use simple and cheap materials to conduct the work. This was echoed by six of the other ten educators interviewed.

4.5 A comparison of the data from Stage 10.1 and Stage 10.2 to the statistical data from the pre-course and post- course questionnaires

The 68 educators who attended the programme in 1998 and 1999 were overwhelmingly positive during the informal post-programme follow-up. They completed two post-course questionnaires to determine the short-term sustainability of this INSET programme (Abratt et al, 2003).

Table 4.12 Teachers' self-perceptions of their ability to conduct classroom biology practical sessions, before and after the INSET programme, rated on a scale of 1 (very poor) to 5 (very good).

	N	Mean	T	SD	Df	p
Pre-INSET	68	3.10		± 1.01		
Post-INSET	68	4.29	9.44	± 0.57	67	0.0000

Statistically, the measured increases in self-rated ability or perceived level of self-proficiency are highly significant (Table 4.12). This was verified in the eleven interviews conducted with educators in 2006 who attended the programme in 1999. These educators weighted the confidence in their practical skills as the second most important factor in implementing the programme (see Table 4.3 on p 92).

Confidence in their practical skills was identified as the positive factor with the second highest weighted frequency. This was a finding from the video material gathered during the classroom observations as well.

The data from this interviews and videos confirm that the educators identified personal motivation to do practical work as the most important factor that could lead to the successful implementation of the programme (Tables 4.3 and 4.8). These verifications of the positive factors corroborate the high levels of interest in Biology by the teachers who participated in the programme.

One or more years after the workshops had been completed, 15 of the original 68 participating Biology teachers were conveniently available for regular follow-up reports. They reported that they had used an average of five of the 15 practical activities. The interviews with eleven educators and with Ms X indicated how many, and which of the 15 practical activities conducted during Dr. Abratt's INSET programme, were still being used. However, due to technical problems with recording equipment, it was difficult to determine this information from two of the ten educators.

Therefore, omitting these two educators, an average of 4,1 practical activities that were offered on the programme were still being carried out by these educators in 2002.

Table 4.13: A ranking list of the activities conducted on the Dr. Abratt's programme, which were still used in the classroom by the educators interviewed.

Name practical activity	Number of educators using activity in the classroom
Lung model	8
Chicken wing dissection (dissection as a skill)	7
Food groups	6
Population Dynamics activities	4
AIDS activities	3
Osmosis activities	3
Transpiration	3
Photosynthesis	3

(Abratt et al, 2003)

The three most popular activities have three elements in common:

- they are inexpensive.
- they are directly related to syllabus topics.
- they are not complicated to organise or perform.

The lung model and the food group activities were rated as the most enjoyable by the 68 educators who attended this INSET programme in 1998 and 1999. The other two activities they rated as most enjoyable were the epidemic (part of the population dynamics activities) and the transpiration activity. Both appear in Table 4.13 and are still being carried out by some of the educators who were interviewed between 2002 and 2004. When two of these educators were questioned, during the classroom observations, about these particular practical activities, they explained that they would have attempted these activities if they had the necessary equipment.

They explained that since they had been given a copy of the book, *Practical Biology – A classroom resource for teachers* (Abratt et al., 2002), they could attempt the practical activities with their learners. The three educators who did perform the two sets of activities had access to the correct equipment.

During the interviews it became clear that a practical activity being used in the classroom by an educator depends on whether suitable equipment is available and whether the educator had sufficient time, in the context of the curriculum for that grade.

Eight of the 68 educators who attended the 1998 and 1999 programmes estimated, and recorded, the perceived levels of success with the learners of the 15 practical activities performed. A scale of 1 (not interested) to 5 (very interested) was used. For the different practical activities, the recorded mean scores ranged from 4.1 (strongly interested) to 5 (maximally interested). This verified the popularity of the programme content.

The eleven educators who were interviewed and Ms X were asked what they found were the greatest benefits of this INSET programme. The nature of these qualitative interviews was to gain a 'thick' description of the programme. Hence the intention of the open-ended questions was gain truthful answers. Six educators (or 50 % of the educators) said that one of the greatest benefits of the programme was that it inspired them to attempt practical work. Six of them also said that the programme improved their practical skills. Seven of the educators stated that they gained ideas for using alternative and cheaper equipment in their practical work.

4.6 Comparing the data about the reported factors which influenced the implementation of the INSET programme to international criteria for successful INSET programmes (Stage 11 of investigation)

In this section the ranking lists, Tables 4.10 and 4.11, that emerged as a result of identifying factors, which positively or negatively influenced the implementation of this programme, will be compared to the literature-derived criteria for evaluating the effectiveness of science-oriented INSET programmes, as contained in Table 3.1.

In the first section of Table 3.1, a series of requirements describing the nature of science learning experiences for educators, which make up Professional Development Standard A for American science educators, are listed. The first requirement stated that teachers need to be actively involved in investigating phenomena.

Several educators remarked on the hands-on approach in the interviews. The statistical status study, Appendix C, in its description of the activities contained in this INSET programme, described hands-on or active participation by the educators attending the programme.

The third requirement of Professional Standard A stated that INSET programmes should ...

introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge ...
(NRC, 1996, Chapter 4:4)

The second requirement of Professional Development Standard A was that programmes should "...address issues, events, problems or topics significant in science and of interest to participants.... "
(NRC, 1996, Chapter 4:4)

Since practical work was the focus of this Cape Town INSET programme, it had more to do with skills than topical content. However, the activities did cover topical issues such as HIV/AIDS and population growth. The high enjoyment ratings which educators gave the activities clearly showed that the educators must have found the activities interesting. The second requirements of Professional standard A were met.

This particular Biology INSET workshops programme aims specifically at improving the practical skills of educators. It was not necessarily exposing educators to current scientific research. However, the contents pages of *Practical Biology – A Classroom resource for Teachers* (Appendix K) does include some topical developments such as HIV/AIDS, elephant culling and population growth. All of the practical activities conducted on the programme covered topics in the Biology curriculum. Also the way in which they were conducted clearly built on the prior knowledge of the educators attending the programme. Therefore the third requirement of Professional Development Standard A was met.

The fifth requirement of Professional Development Standard A detailed that INSET programmes should:

incorporate ongoing reflection on the process and the outcomes of understanding science through inquiry (NRC, 1996, Chapter 4:4).

According to Ms X, who attended the programme three times, educators discussed the practical activities after they conducted them. Therefore, informal reflection regarding the inquiry process occurred.

The last requirement of this standard was that it should encourage collaborative work. One of the objectives of the programme was to encourage the networking of Biology educators. The positive progress made in this regard was described in the statistical status study, Appendix C.

One educator's response to the question of what she gained by attending this programme with a group of fellow biology educators was:

O, yes, and you also could exchange ideas. Because out of that group, I actually have been in touch with quite a few other educators at Grade 12 level.

This sentiment was echoed by other participants.

Professional Development Standard B focuses on the integration of knowledge of science, learning and pedagogy. Therefore it involves the application of scientific knowledge to teaching. The first two requirements are not applicable to this Biology INSET programme due to its focus on practical work.

The third requirement of Professional Development Standard B focuses on the educators' needs as a learner. It emphasizes the fourth requirement of Professional Standard B, namely, that the programme content should build on the educators, prior skills and knowledge. As mentioned in a previous discussion in pp. 93-94, this did occur. The practical nature of the programme, in which the educators participated in investigations themselves, implied that the last requirement of Professional Development Standard B, regarding process skills, was met.

The educators who attended the programme from 1998 to 2002 and who completed the questionnaire clearly enjoyed it. The Israeli science educator and teacher trainer, Tamir, felt that these INSET programmes should be "well - organised, interesting and pleasant "(Tamir, 1987).

Indications of the educators' enjoyment rating show they found the programme pleasant and interesting. The programme that the researcher witnessed in 2002 was well-organised. This was verified by an educator who attended the 2002 programme (Anon, 2004) and by Ms X (2005).

A further criteria of Tamir is that an INSET activity should be positively satisfying to the educators. In speaking at a conference in Botswana in 1987 he stated that an INSET programme needs to be rewarding for participants, even if that reward is of a personal nature, such as inspiration or included the benefits of networking. As such, networking is one of the objectives of this Biology INSET programme. In the interviews which took place between 2002 and 2004 educators expressed informally that networking was taking place as mentioned in the statistical status study. Five out of the eleven educators that were interviewed indicated that the programme had given them opportunities to network in a beneficial manner with colleagues. Tamir also suggested that contingent factors, such as availability of laboratory equipment and the support of the school principal, would affect the educator's ability to implement the content of any INSET programme.

As Table 4.10 and Table 4.11 showed that the support of school management for practical work was ranked as the most important factor which could aid the positive implementation of this INSET programme. Other important factors included the class-sizes being less than 35 learners and sufficient laboratory equipment.

This INSET programme also presented educators with ideas on how to do practical activities with cheaper equipment and it suggested elements to make it easier for educators to implement practical work in the classroom. Therefore it met the criteria of feasibility of implementation.

The four objectives which are internationally viewed as common to most INSET programmes were summarised in Table 3.1. It is evident from discussion based on Table 4.12, p 103, that the educators' self-perceptions as to their ability to conduct classroom biology were verified in the interviews with the ten educators and Ms X.

This illustrates that the traditional INSET objective of extending educators' knowledge, had been met. The educators also acquired new skills and knowledge on the programme, as discussed on p89. This was another objective of international INSET which was satisfied on the programme.

Continuous assessment and data response questions are two recent curriculum developments in Biology. These requirements were met. However, changes will be required to ensure that the content of the INSET programme keeps abreast of the new developments in the FET Life Sciences curriculum. From evidence, and in particular the interview with Ms X, the international INSET objective of consolidation of educators' academic achievement occurred.

Table 3.1 contains a section of criteria for INSET programmes pertaining to the sharing of information amongst educators. As mentioned previously, the programme did encourage and support educators to collaborate or network with each other. This criterion was common to three sources relevant to INSET programmes for science educators.

Four other international criteria associated with the sharing of information were not objectives of the organisers of this INSET programme. They focused more rather on school aspects rather than on biology educators. The improvement in the skills of the biology educators was the focus. To some extent this programme met the criterion of providing educators with opportunities to be exposed to and have access to existing research and experiential knowledge – which occurred on an informal basis, during discussions.

Dyasi and Dyasi (2000), American science educators with specific experience in developing countries, suggested that INSET programmes be presented and organised by teams of staff with differing areas of expertise and who work together in an integrated manner. The content of this INSET programme was designed by biologists with different areas of expertise, yet according to Ms X they worked well together.

According to Tamir (1987) the timing of any INSET programme is crucial. Educators need to be ready to benefit from the programme and the school should feel that the educator is required to attend the programme. Most of the participants of this INSET programme attended because they had read a brochure at the local Teacher's Centre or others told them about the programme.

Since most educators attended the programme voluntarily, it appears that this criterion was met.

4.7 Answering the research questions

4.7.1 Answering the first two research questions

Theoretical criteria for INSET programmes

1. What criteria, derived from the literature, should be used to evaluate the effectiveness of INSET programmes for educators, with special reference to practical work in biology?

The Professional Development Standard A (1996) which is applicable to American science educators, lists the requirements for the nature of the science learning experiences. These requirements are relevant in evaluating INSET programmes for science educators, even in developing countries. These requirements are summarised as follows:

- involve teachers in actively investigating phenomena;
- address issues, events, problems, or topics significant in science and of interest to participants;
- introduce teachers to current scientific developments and topics by making a variety of media accessible;
- build on the teacher's prior scientific knowledge;
- incorporate ongoing reflection on the process and outcomes of understanding science through inquiry; and
- encourage and support teachers in efforts to collaborate.

(NRC, 1996, Chapter 4: 4)

Some INSET programmes require the active involvement of educators in investigations and the recognition of prior learning. These have much in common with the learning outcomes, assessment standards and principles underlying in the Revised National Curriculum Statement for GET Natural Science and the National Curriculum Statement for FET Life Sciences (Biology) as discussed in Chapter 2.

The second professional development standard B relevant to American Science Educators focuses on the integration of knowledge of science, learning and pedagogy and thus requires the application of that knowledge of science to teaching. These requirements are summarised as follows:

- connect and integrate all pertinent aspects of science and science education.;
- occur in a variety of places where effective science teaching can be illustrated and modelled, permitting teachers to struggle with real situations and expand their knowledge and skills in appropriate contexts;
- address teachers' needs as learners and build on their current knowledge of science content, teaching, and learning; and
- use inquiry, reflection, interpretation of research, modelling, and guided practice to build understanding and skill in science teaching.

(NRC, 1996, Chapter 4:7)

The requirement that INSET programmes "occur in a variety of places where effective science teaching can be illustrated and modelled" implies complex logistical arrangements and a financial outlay which is cost effective in a developing country such as South Africa.

The other three requirements, and, particularly that INSET programmes for science educators should include process skills, have relevance in the current South African context of changes in the education system. INSET programmes for Life Sciences and Physical Science educators are being organised by some education departments in collaboration with the tertiary institutions. Many of these programmes focus on process skills (Kesten, 2006).

The criteria of Tamir (1987) that INSET programmes need to be rewarding for educators, well-organised and well-timed, is relevant to all INSET programmes. They are especially relevant in countries where education spending requires careful planning and educators have to deal with transformation in the place of work and as well as in their communities.

The four international objectives for INSET are relevant to any INSET programme. These have been discussed in Chapter 2. These are:

- extension of the knowledge of educators;
- consolidation of academic achievement and the professional philosophies;
- the continued acquisition of new knowledge and skills; and
- programmes should familiarise educators with recent curricula developments.

Tamir (1987) and Dyasi and Dyasi (2000) comment on the need for INSET programmes to encourage educators to share information that is relevant (i.e. engage in networking). The designer of any INSET programmes should be reminded of this fact. Also as Dyasi and Dyasi (2000) suggest that staff who present programmes to science educators should be experts and drawn from different science or biology disciplines. Further they stress integration and co-operation is required. This is relevant to any INSET programme. Ms X (2006) agreed with these conclusions in a final interview (Ms X, 2006).

2. Considering these benchmark criteria for determining the success of INSET programmes, are current theories of INSET appropriate for assessing INSET initiatives for South African FET Biology or Science educators?

In the last section it was clarified that most of the criteria for INSET programmes for science educators are relevant to the South African context. However, to arrive at a comprehensive list of criteria an extensive literature research was required. Several criteria for INSET programmes relevant to science educators. This is particularly true for developing countries.

Some of the American Professional Development Standards (1996) are relevant to the South Africa; however, some are costly and/or idealistic. Although Dyasi & Dyasi (2000) and Tamir (1987) do list criteria, never the less most of their work is not in developing African countries.

Therefore they are not necessarily familiar with all the unique challenges and problems of Third World nations. It is felt that current criteria are not that practical in the South African context.

4.7.2 Answering the third research question

3 Quantitative aspects of the contents of this INSET programme

3.1 How many of the 14 biology practical activities, rehearsed by the 90 teachers during this INSET programme, were subsequently used in normal lessons?

Fifteen of the 68 educators, who attended the 1998 and 1999 programmes, reported that they use an average of more than four of the original 15 activities which they attempted on the programme. (Abratt et al 2003:14). When eleven educators and Ms X, who attended the programme in 1999, were interviewed between 2002 and 2004, they reported that they used more than four of the activities.

3.2 According to the scale used to measure their levels of confidence before and after the programme, did the teachers' self-reported confidence about their ability to conduct practical work improve as a result of participating in this INSET initiative?

Table 4.12 illustrates that the 68 educators, who attended the programme in 1998 & 1999, report that their level of confidence to embark upon practical work had increased. This was verified during the interviews with eleven educators and Ms X. 50 % of the educators voluntarily reported that two of the greatest benefits of attending the programme were that it inspired them to do more practical work with their learners. Furthermore, they stated that the programme improved their practical skills. Both these factors contribute to the individual educator's confidence to deal with practical work.

4.7.3 Answering the fourth research question

Assessing the classroom transferability of the INSET programme using a qualitative approach with a few quantitative research elements

- 4.1 What were the influences or factors in interviews reported by a sample of eleven educators that led to the successful classroom transferability and the implementation of the practical skills and activities acquired during the INSET programme for FET Biology educators?

The factors, which reportedly lead to the successful implementation of this INSET programme, were ranked and are summarised below.

'In-school' factors, beyond the control of the educator, need to be present in the school:

- support of management for practical work – in terms of attitude and laboratory assistant;
- class-size less than 35 and corresponding classroom space in which to conduct practical work
- productive learning environment; and
- sufficient equipment for practical work and finances available for consumable resources;

'In-school' factors, associated with the educator, need to be present:

- personal motivation to do practical work and confidence in own practical skills; and
- effective methods and processes are employed to manage learners' behaviour during practical lessons.

'In-school' factors, associated with the learners, need to be present:

- motivation to do practical work and willingness to behave in a disciplined manner during practical lessons.

4.2 According to the educators who were interviewed, why did these factors or reported influences lead to the successful classroom transferability of this INSET programme?

When educators had the support of school management with regard to a budget for Biology, it enabled them to do practical work more frequently. Consequently the implementation of the programme could be done with greater ease.

The researcher taught at one of the schools where the Biology teacher had attended this INSET programme. I established that, in terms of finance the support of management, in terms of finance, aid the implementation of the programme, but, in addition, the fact that a laboratory assistant who set up and/or organized many of the practical investigations facilitated it.

One of the educators, who attended the programme in 1999, and who previously did not have assistance in a class of between 30-35, clearly felt that her teaching had benefited from the presence of a laboratory assistant.

Some of the smaller classes, with fewer than 35 learners, were easier to organise and conduct practical work. An educator at a well-resourced school who when she realized that her class size was increasing from 12 to 18 had the following to say: "I'm now beginning to wonder how I'm going to manage with 18" When asked whether she felt more enthusiastic and inclined to do practical work when the class-size was 'manageable' she responded: "Absolutely!"

Another educator, at a less well equipped school with larger classes stated that the greater the number of learners in a class, the greater the impact on one's ability as an educator to carry out practical work effectively.

The more (learners) you have, the greater the logistics ... the more stressful the practical becomes So yeah, definitely the number of students in a class play a very important role.

Although some educators believe that smaller classes lead to better academic performance, research has not proved this (Onwu, 2000:122). Some studies imply that learners do better in small classes (Smith & Glass, 1979; Walberg, 1991 in Onwu, (2000:122); others suggest that larger classes are more effective, as long as appropriate teaching methods are used (Moock & Habrison, 1987 and Hanushek in Onwu, 2000:122).

Empirical studies carried out by the World Bank and other agencies confirm that a range of factors effect the achievement of learners. Fuller and Heyneman (1988 in Onwu, 2000:122) rank eight factors that enhanced learning in Third World countries:

High effective factors	%
• Length of instructional programme	86
• Pupil feeding scheme	83
• School library activity	71
• Textbooks and instructional materials	67
Less effective factors	%
• School laboratories	36
• Teacher salaries	36
• Reduced class size	24
• Pupil grade repetition	20

These factors analyse learner achievement from a global perspective rather than for the implementation of one programme. It is important to note that international research has not resolved the argument about class size and learner achievement. Class size and the other factors listed above may not effect learner performance in examinations that test rote-memory, however, these factors may be relevant where examinations assess higher-order thinking skills (Onwu, 2000;123). In a statement to the press, the Minister of Education Naledi Pandor suggested that the slight drop in the national Grade 12 results for 2005 could be related to the fact that more of the examinations required higher-order thinking skills than in previous years (Pandoor, 2005). Science and Biology educators have yet to reach consensus regarding this issue.

There is a high correlation between schools where a productive learning environment existed and the successful implementation of this INSET programme. The ten educators who were interviewed and Ms X represented eight different schools. Six of them came from three schools and one is now teaching at another school. At four of the eight schools, more than four of the 15 activities from this INSET programme in 1998 and 1999 were still being undertaken with learners in 2002.

All these schools met the criteria which describes schools as having a 'culture of learning' or in which a productive learning environment existed as classified on page 71. They were also schools that are moderate to very well resourced. Three were former 'Model C' schools and one was a private school. At three other schools that were not well-resourced, and which had classes of between 30-55 learners, more than four of the 15 of the practical activities carried out on the INSET programme, were also still being conducted in 2002.. The latter three schools did not have budgets for practical work and a fair portion of the learners were observed to not be very motivated. Nevertheless, due to the inspiration of the educators and their belief in the value of practical work, this INSET programme was being implemented successfully. This was clear from the interviews and the video and digital camera material captured during the classroom observations.

In the lessons observed at the three under resourced schools most of the learners were motivated to participate in the practical work. They were disciplined and their co-operative behaviour facilitated practical work. This same combination of positive factors was observed at the four of the well-resourced schools.

At the three under resourced schools the educators were well organised and confident about their ability to conduct practical lessons. When interviewed the educators at these schools, stated that this INSET programme not only inspired them to undertake practical work, but it had also improved their skills. Ms X, who taught at the third school and trained more than one of the Biology educators in her school, echoed this sentiment. She also said that it did not necessarily aid the implementation of the course if two educators from the same school attended, since in her experience it depended predominantly on the motivation of the individual educator. An educator from one of the well-resourced schools echoed this sentiment.

4.3 What factors did the eleven interviewees identify as constraints to the implementation of those practical activities in their own classroom?

The factors, which reportedly hampered the implementation and classroom transferability can be summarized as follows.

The following 'in-school' factors, beyond the control of the educator:

- vandalism of school property and science equipment;
- excessive workload – in terms of size of classes and/or in number of periods taught;
- class-size over 35 and classrooms which are inappropriate classroom space for practical work;
- classrooms which are inappropriate for practical work;
- insufficient equipment and finances available for practical work; and
- lack of an effective culture of learning in the school and no support from school management .

'In-school' factors, associated with the educator:

- fear of conducting practical activities with safety risk; and
- ineffective management of the lesson from a discipline angle.

'In school' factors associated with the learners:

- disrespect and bad behaviour of a class as a group; and
- inappropriate behaviour of unco-operative learners.

The following 'out-of-school' factors were mentioned by a few educators:

- unfavourable socio-economic conditions such as a high rate of unemployment and financial income; and
- lack of parental interest and stimulation..

Vandalism is the greatest hindering factor. Educators mentioned that, at schools where vandalism of the science equipment and apparatus set up in preparation for practical lessons took place, the rest of the school was neglected. Educators spoke of vandalism and theft in their response about vandalism, for example;

...they (the learners) stole the stuff,...the gas taps? Its gone, someone stole it.

At a school from which two of the educators attended the programme, vandalism in the laboratories and to the equipment resulted in no practical work being attempted and, therefore, the activities of the INSET programme were not implemented. All three of the socio-economic, 'out-of-school' factors were present at this school. At a second school, educators complained about: unmotivated learners, lack of parental interest and unemployment. Nevertheless, the two educators, who attended this programme, both tackled some of the 15 activities conducted on the INSET programme. They remarked further that their learners fared better in theoretical examinations in the particular sections of work in which the learners had been exposed to practical investigations. It is suggested that this might be due to the learners recalling the work better when they had 'hands-on' experience.

When referring to the answers to Questions 4.2, it is interesting to note that educators in three under-resourced schools did not allow factors such as vandalism, inappropriate space and large classes to limit them from undertaking practical investigations and therefore implementing the programme successfully. These educators had created solutions to deal with the negative factors as listed in Table 4.11.

4.4 To what extent have the educators been able to overcome some of the constraints?

As explained above, educators at three under-resourced schools implemented the practical activities and skills dealt with on this programme to the same extent as educators at four well-resourced schools. This was due to the fact that the INSET programme inspired them with a conviction as to the value of practical work.

One educator, who had previously not tackled much practical work, after attending this INSET workshop, stated that with regard to the value of practical work for learners:

It (practical work) DoEs motivate them. They (the learners) work hands-on. They can do something, like visualise things.

He went on to say that learners had enjoyed the practical work and that:

...Actually we do some injustice towards the learners. Not doing practical activities every week, because that is actually what Natural Science is all about and Biology is all about, practical activities. They (the learners) actually enjoy practical activities, they actually enjoy going to the lab.

This particular educator had devised strategies to cope with the classes of 55 learners in a small space. One such strategy was that he awarded only group assessments with regard to practical work and subtracted marks if the group did not co-operate. These strategies may not be educationally sound, nevertheless he was able to complete practical work effectively and learning occurred. He felt that the system, adopted at his school in which educators teach many classes of one grade, from Grade 8 to Grade 12, rather than taking several classes of different grades every year, helped him to train learners to do practical work effectively.

In a lesson involving the dissection of a mammalian heart, his learners were exposed to a more effective learning experience than occurred for another educator at a privileged school. Although she had a laboratory, a smaller class 24, (compared to his of 50), running water and ample dissection equipment, his management of the lesson and the manner in which he had trained his learners to deal with practical work, led to more effective work taking place.

He used corrugated cardboard covered in newspaper instead of dissection boards and small blades instead of scalpels. It should be mentioned that he was not the only educator who engaged in practical work in this school. Another educator who attended this INSET programme, conducted practical work and organised field trips. The Grade 12 learners attended practical investigations on Saturdays so as to meet the requirements for Continuous Assessment. This indicated motivation of the learners and educators in an area that suffers from socio-economic problems such as unemployment, alcoholism and gangsterism.

Therefore it is clear that this school's biology educators did not allow the out-of-school factors such as attacks on learners on their way to school and on the school premises to demotivate them.

Recent incidents made the front pages of Cape Town's daily papers and clearly the situation has escalated since the classroom observation took place in 2004. A further example of using alternative equipment comes from an educator at an under-resourced school who used rocks and paper instead of mortar and pestles. She also used straws instead of pipettes for sucking up liquid. Ms X used kettles and alternative equipment to heat substances and an educator trained by her does the same.

4.8 Chapter summary

The data recorded from the interviews with the representative sample of educators who attended this programme was analysed. This process led to two ranking lists. The first list contained all the factors which reportedly aided the successful implementation and classroom transferability of this INSET programme. The second list ranked the negative factors which reportedly hampered this implementation and transferability. The visual data from the classroom observation was also analysed and used to verify these two ranking lists. This information was compared to the data gathered from two interviews with Ms X . The data from the interviews and classroom observation was compared to the literature-derived international criteria for INSET programmes. This information was used to answer the four research questions.

The findings indicated under which the programme was implemented successfully.

5.1 Objectives and issues relevant to INSET programmes for South African science educators

Any programme is required to address the assessment issues relevant to the guidelines for Physical Sciences and Life Sciences. Such aspects may include aid to the educators for the design activities to meet Learning Outcome 3 - regarding Science and Society - of the new FET curriculum for Life Sciences and Physical Sciences. At a 'swap and share' networking group created for science educators for Grade 9 Natural Science, Grade 12 Physical Science and, recently, the Grade 10 Physical Sciences, the educators with a Western Education background and perspective, commented on the challenge of including indigenous scientific knowledge of African, Asian and even Afrikaans cultures. (Joubert, 2005b). Some educators require training that includes process skills in their practical lessons. As mentioned previously, this is established in some of the provinces' INSET programmes for the Life Sciences and Physical Sciences. The Life Science INSET programmes organised by the Western Cape Education Department meet two of these needs; the one focused on process skills and the other includes indigenous knowledge. However, schools or educators have to pay for these programmes and financial assistance is available only for educators at under-resourced schools.

There is an urgent need for programmes that address concerns with regard to practical work in schools with more than 40 learners per class and the consequent assessment of practical work. There is an increased emphasis on group work. However, few science educators in South Africa are skilled in training learners to participate effectively in group work which requires using less equipment.

The effect of large classes on learner achievement is controversial. The reality remains that many educators are required to teach large classes (Onwu, 2000:130). The evidence shows that this impacts on the educator's ability to embark upon practical work in the classroom.

It could be that an effective form of INSET for science educators in the South African context of curriculum change is to combine the 'hands-on' workshop type programme of this INSET programme with sharing sessions where educators, who have devised ways of dealing with large classes, vandalism and lack of equipment, can share their ideas.

Cluster meetings - at which educators at schools in a particular area peer-assess the standard of activities used for continuous assessment - are already being held throughout the country. It is suggested that practical ideas be shared at these meetings. More educators, from a particular area, could attend INSET 'workshop-style' programmes endorsed and financed by the education departments. This occurred throughout the country for the implementation of the HIV/AIDS policy. These sessions were for passing on of information and this would not be sufficient for an INSET programme aimed at improving the quality of practical work in schools. The point is that the education department organised these.

As mentioned in section 2.2.7, the INSET workshops aimed at introducing the NCS were more thorough than the INSET sessions held to prepare educators for the implementation of the Curriculum 2005 at Grade 8 level in 2000. However, this investigation highlights a disparity in teaching conditions that educators require more practical assistance for practical work, especially where process skills are involved. Process skills and practical work are a focus of Learning Outcome 1 of Life Sciences, discussed on p. 28. Many educators are not experienced in such an approach. Unfortunately too often the method of the investigation is treated as a recipe and no problem-solving takes place (Drew, 2006 and Odendal, 2005).

International researchers (Caillods et al., 1995; Akeyeampong & Anamuah-Mensah, 1993 in Fabiona, 2000:137) question the importance of practical activities in science and technology teaching and learning. They claim that a laboratory can cost up to ten times more than that of a normal classroom and that the expense of maintenance and supplies are questionable (Caillods et al., 1995; Akeyeampong & Anamuah-Mensah, 1993 in Fabiono, 2000:137). They argue that practical activities are not cost-effective and should be kept to a minimum.

Their studies, however, measure achievement and pass rates in examinations where theoretical rather than practical work is assessed (Fabiona, 200:137).

Fabiona (2000:137), on the other hand, argues that curriculum goals require more practical work. This has been the case in South Africa since the mid 1990s. He suggests that to save costs, educators should utilize both their school environments and the community resources for science education (Fabiona, 2000:137-138). INSET programmes may need to highlight this type of relationship.

The African science educator, Jegede (1995 in Fabiona, 2000:140) believes that, if practical work is not included in science programmes and if the learner's local environment as a resource is ignored, it may lead to generations of learners who cannot apply what they have learnt. Fabiona (2000:140) concludes that when deciding on how best to use an investigative approach and to make the best use of the local environment, high levels of professionalism are demanded and it highlights the need to invest in teacher training.

Six out of the ten educators that were interviewed as well as Ms X, felt that attending this programme inspired them to do more practical work and that learners, in turn, became motivated by doing practical work. The value of practical work is recognised in the NCS. However, for the implementation of the new Life Sciences curriculum to be successful, effective and relevant INSET programmes for educators are essential.

5.2 Recommendations specific to this INSET programme

This INSET programme should retain its 'hands-on' nature and specific content. However, to remain relevant to current FET Biology educators, it should include activities which would train educators to design activities that meet Learning Outcomes 1-3 of Life Sciences. This was the feeling of Ms X in her concluding interview in 2006 and the opinion of the teacher trainer, Nomvuyo Mqui, who used the cell biology aspects of this INSET programme in the Advanced Certificate in Education (science stream) programme.

Further she maintains that this programme upgrades the skills of primary school educators and is valuable in its current context; and that she will be using many aspects of the programme, as well as the materials associated with it in the Advanced Certificate in Education for FET science educators in March 2006. Ms Mqui is attached to the Schools Development Unit of the University of Cape Town.

Both she and Ms X feel that this INSET programme should include more on assessment and should be adapted to the new curriculum. They also think that *The Practical Biology – A Classroom Resource for Teachers* (Abratt et al., 2002) was excellent. They both use the book extensively.

However, they feel that it requires revision to include more aspects of the new FET curriculum and rubrics for some of the practical investigations. They echo the Malawian science educator, Fabiano (2000:146) belief that curriculum goals call for problem-solving citizens and innovative teaching approaches. However, content and rote-style examinations leave educators with little option but to cram their students with facts. Fabiano (2000:146) points out that experience in Kenya indicates that items that test higher thinking skills encourage rather than discourage practical activity in schools. Ms X and Ms Mqui feel that the section, in the book and the workshop session on designing experiments, recording information and drawing graphs are excellent. They and other science educators use this section extensively. Process skills also need to be included in this programme. Educators need assistance to design activities that reach the requirements of Learning Outcome 3 – Science and Society. This would involve training educators to design case studies and offering opportunities to practice them in a workshop setting.

This INSET programme could also include a workshop on the training of educators to prepare learners' to participate in group work and to master the challenge of conducting successful practical lessons with large classes. Workshop participants should view and discuss videos of successful lessons.

Four of the eleven educators interviewed requested follow-up sessions and this possibility requires investigation.

The practical activities and skills covered in this programme have proved invaluable. It is suggested that the recommendations be taken into consideration. All stakeholders in the programme need to discuss the context in which it is best to continue its presentation. In the light of the report, *A National Framework for Teacher Education – Appendix I.*, the possibility of accrediting the programme with SAQA or SACE could be considered.

5.3 Limitations of this research

The subjective nature inherent in interviews limits the qualitative aspects of this investigation and the application of its results. An attempt was made to weight factors, This too has a subjective aspect. However, the statistical data was substantiated by the interviews and visual data which balances the other limitation. There was a time lapse between the attendance of the educators attending the programme and their being interviewed. This created an opportunity to assess the longterm sustainability of the programme. The small number of the educators interviewed impacted on application of the research findings.

Overall this research highlights that training educators for effective group work with their classes could be a way to cope with undertaking practical work with large classes.

The four research questions which were investigated and answered addressed issues surrounding the theoretical criteria for INSET courses for science educators and the transferability of the skills and activities of this programme to the classroom.

When it came to criteria for INSET courses, it was found that the first two Professional Standards were described in the National Science Standards(1996) document. The first standard requires that INSET programmes have an 'hands-on' approach for educators to implement the inquiry approach to their classrooms. This requirement of INSET courses for American science educators is just as relevant in South Africa. The second Professional Development Standard requires that learning experiences must include process skills in order to build understanding and also focuses on the needs of science educators as learners. Many of the 15 practical activities rehearsed with educators on this INSET initiative in Cape Town did cover these aspects. The third Professional Standard requires that INSET programmes encourage educators to collaborate and share resources (NRC, 1996, Chapter 4:1-2). Networking was one of the objectives of this course and 40% of the educators who were interviewed stated that this did take place on the programme.

The American educators, Dyasi & Dyasi (2000), with experience in organising INSET programmes in America and West Africa stressed that INSET programmes should be well organised and interesting. Ms X confirmed that the four times that she attended this programme it was indeed well organised. Tamir (1987), an Israeli INSET specialist emphasised the importance of the timing of the INSET programme and the fact that educator needs to find it rewarding. Ms X and most of the educators that were interviewed volunteered that this programme inspired them to do more practical work implying that they found it rewarding.

The extension of knowledge of educators and the need for INSET programmes to familiarise educators with curriculum developments were two of the well-known objectives of INSET that were met on this programme.

It was concluded that no formal set of descriptive criteria for INSET programmes for science educators in South Africa or any developing country exists. It is felt that current criteria are vague and not that practical in the South African context and that a set of criteria should be developed in line with current developments in the INSET field in South Africa.

When eleven educators and Mrs X, who attended the programme in 1999, were interviewed between 2002 and 2004, they reported that they each used more than four of the 15 activities rehearsed on this INSET programme. These four activities all had the following in common: the educators enjoyed them; they used inexpensive equipment and they were easy to reproduce.

The 68 educators who attended the programme in 1998 and 1999 reported that their level of confidence to embark upon practical work had increased. This was verified during the interviews with eleven educators and Ms X. Half the educators voluntarily reported that two of the greatest benefits of attending the programme were that it motivated them to do more practical work. They also stated that the programme improved their practical skills. Both these factors contributed to the individual educator's confidence to deal with practical work.

In the interviews and the visual data captured during classroom observations, the two most important factors that aided the implementation of this programme from the schools' perspective were established. These were: support for practical work in terms of financial assistance and/or the presence of a laboratory assistant; and classes with fewer than 35 learners. Educators who were: personally motivated to do practical work; had a classroom appropriate for practical work and who used effective teaching strategies, were more likely to implement this programme successfully. In three under-resourced schools, this programme was implemented as successfully as in four well-resourced schools. Ms X and these educators attributed this to the manner in which educators were motivated to do practical work on this INSET programme and the practical skills which they gained on this programme.

However, vandalism of science equipment and excessive workloads were cited as two most important factors within the control of school management, which hindered the implementation of this programme. If learners were not disciplined, this also hindered these educators from implementing this programme.

The educators in the three under-resourced schools managed to implement the course successfully. They used cheaper alternative equipment like straws instead of pipettes and corrugated cardboard instead of dissection boards. In all the lessons observed at these schools, educators had trained their learners to do group work effectively.

It was concluded that this INSET programme and the book *Practical Biology – A classroom resource for Biology teachers*, are valuable and useful. In order to improve the relevance of this INSET programme, more information regarding indigenous knowledge and case studies and assessment skills should be included in the future. Educators who have managed to do practicals with large classes could also share their solutions to challenges like these.

These changes will make the programme applicable to the new Life Sciences curriculum.

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APPENDIX A

Copies of the pre-course and two post-course questionnaires

University of Cape Town

Compiled by: Dr.V Abratt with the assistance of Prof. K Rochford

QUESTIONNAIRE 1 – PRE-COURSE EVALUATION

1. Name: _____

2. School: _____

3. Qualifications: BSc. Ed. Hons ST

4. How did you hear about this course? Please tick one of the following:

- Teaching and Learning and Resources Centre (TLRC) booklet 1
- Personal phone call
- School principal
- Other teacher
- Other (please specify) _____

5. What Grades have you taught this year? 8, 9, 10, 11 8/9/10/11/12

6. Number of pupils in each class: ± 40 40

7. Please describe your laboratory facilities. Circle or tick one of the following:

Well equipped / Poorly equipped / No facilities w

8. What do you hope to gain from this course? Please tick as many of the following as you wish:

- Practical skills 1
- Theoretical knowledge
- Teaching ideas 3
- Continuous assessment
- Other (please describe) _____

QUESTIONNAIRE 2 – POST-COURSE EVALUATION

1. Name: _____

2. School: _____

3. Do you think the course has met your expectations? Please explain your answer.

YES	
NO	
PARTLY	

4. In the table below please mark the activities you think you **will** / **will not** use with your class. Please explain your answers.

Activity	Will use	Will not use	Comment
Food groups	✓		
Enzymes	✓		ALL IDEAS
Microscopy	✓		
Epidemic	✓		
Osmosis	✓		USEFUL
Transpiration	✓		
Photosynthesis	✓		
Chicken wing dissection	✓		VERY PRACTICAL
Lung model	✓		
Reflexes	✓		VERY USEFUL
Taste tests	✓		
Respiration experiments	✓		FRIENDLY
Data response	✓		
AIDS activities	✓		

Handwritten notes:
 100
 100

Rate the success level in teaching the activities, on a scale of 1 to 5 (1 = not successful → 5 = very successful).

Activity	Success rating	Comments
1. Food groups	5	
2. Enzymes	—	
3. Microscopy	5	
4. Epidemic	—	
5. Osmosis	4	
6. Transpiration	4	
7. Photosynthesis	5	
8. Chicken wing dissection	5	
9. Lung model	—	
10. Reflexes	5	
11. Taste tests	5	
12. Respiration experiments	5	
13. Data response	4	
14. AIDS activities	5	

Rate the current level of interest of your pupils in studying Biology on a scale of one to five:

Not interested → Very interested
 1 2 3 ④ 5

Please answer this question only if you have been able to do practical activities with your classes this year.

In your opinion, has the use of practical work in your teaching affected any of the following, in what way?

	Yes / No	Comment
Interest in Biology	✓	More co-operative
Marks in Biology	✓	increased
Participation of Girls in class work	???	
Methods of doing Continuous assessment of work	✓	assignments and practical work.

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QUESTIONNAIRE 3 : FOLLOW-UP COURSE EVALUATION

Name: _____

School: _____

How often have you been able to do practical work with your classes this year:

Once a week / once a month / once a term / once a year / other

In the table below please mark the activities you have/ have not used with your class this year. If not, please explain your answers (eg. not in syllabus for particular grade, lack of space, equipment, other, etc).

Activity	Have used	Have not used	Comment
Food groups	✓		
Enzymes		x	time constraints
Microscopy	✓		
Epidemic		x	not in syllabus
Osmosis	✓✓		
Transpiration	✓		
Photosynthesis	✓✓		
Chicken wing dissection	✓✓		
Lung model	✓	x	lack of equipment
Reflexes	✓		
Taste tests	✓		
Respiration experiments	✓		
Data response	✓		
AIDS activities	✓		

5. Rate your enjoyment of the activities on a scale of 1 to 5:

(1 = did not enjoy it at all → 5 = enjoyed it very much).

Activity	Enjoyment rating (1 → 5)
Food groups	5
Enzymes	"
Microscopy	"
Epidemic	"
Osmosis	"
Transpiration	"
Photosynthesis	"
Chicken wing dissection	"
Lung model	"
Reflexes	"
Taste tests	"
Respiration experiments	"
Data response	"
AIDS activities	"

6. What else would you like to see included in this course?

OTHER PRACTICAL ACTIVITIES FOR OTHER

SECTIONS OF BIOLOGY EG. GENETICS,

REPRODUCTION ⇒ BIRTH CONTROL

7. Rate your ability to conduct practical sessions since attending this course, on a scale of one to five:

Very poor

→

Very good

1

2

3

4

5

5

8. Rate your level of interest in biology since attending the course, on a scale of one to five:

Not interested

→

Very interested

1

2

3

4

5

5

APPENDIX B

Statistical status study

University of Cape Town

Source: Abratt, V.R., Rochford, K and Abel, L (2003). How can concerned tertiary educators support laboratory practical work experiments with biology educators in deprived schools? SAARDHE Conference Paper: Stellenbosch, June 2003

SAARDHE CONFERENCE PAPER: STELLENBOSCH, JUNE 2003

SAARDHE MANUSCRIPT 2003 (b)

How can concerned tertiary educators effectively support laboratory practical work experiments with biology teachers in deprived schools?

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How can concerned tertiary educators effectively support laboratory practical work experiments with biology teachers in deprived schools?

ABSTRACT

In response to requests from experienced teachers in a range of deprived schools from 1997 to 2002, a limited but successful intervention programme of support in biology practical work was designed and implemented by UCT's Department of Microbiology. The compact programme of workshops centred on the practical provision of 14 school syllabus-based experiments for addressing the lack of biology practical work being carried out in these schools by teachers. The focus of the four-week programme was on the use of easily obtainable and inexpensive reagents, materials and equipment.

The workshop programme ran from 1998 to 2002 with an accumulating participant total of 143 experienced biology teachers from 27 mostly under-resourced schools. Response data were obtained by means of self-reporting multi-dimensional pre-course and post-course questionnaires, as well as from conversations and interviews with the teachers and in-depth follow-up reporting. Feedback from the teachers has been strongly positive in terms of perceived and actual benefits.

AIM

This study sought to determine how one socially concerned university academic department – with limited time available - might successfully respond to, engage with and support experienced biology teachers operating under deprived conditions in their communities, in 27 under-resourced schools in Cape Town.

The purpose of this article is to describe the extent to which a specially designed compact programme of INSET workshop interventions has been able to monitor and meet, over a period of six years, the expressed practical needs and requests of these teachers. Throughout this period they have remained at risk of becoming demotivated in an uncertain climate of education.

BACKGROUND AND INTRODUCTION

At the time of the initial requests from the biology teachers in schools in 1997, educationists were being confronted daily with the possibility of being relocated against their wishes to overcrowded and short-staffed schools in rural areas. They were also being asked to teach multi-lingual classes for the first time, yet with inadequate training to do so. They were being obliged to decide themselves when to teach biology and science using English textbooks, and when to use English as a second language. At the same time, the Third International Mathematics and Science Study Repeat (TIMMS-R) of 1998/1999 was advising that the science achievement

scores of South African school children were by far the lowest of the 39 countries that it surveyed. The RSA mean score for science was reported to be an unfavorable 243 points, compared with mean scores of more than 550 points achieved by school children in the higher performing countries such as Chinese Taipei, Singapore and Hungary (Howie 2001).

Edusource Data News, an educational quarterly, had just published a report in 1997 that found that most mathematics and science teachers were not qualified to teach these subjects. Only 42% of science teachers were qualified in science as a subject, although 84% of them were professionally qualified in other ways. Today in 2002-2003 there remains an estimated shortage of 12 000 science teachers. Van der Mecht adds that about 8 200 science teachers also still need to be targeted for in-service training to address their lack of subject knowledge, and more than 40% of science teachers currently have less than two years of experience (Groenewald 2002).

Thus, in the long term, the intention of the current study was to offer a modicum of help and hope for at least some teachers who were expressing a need for intervention and assistance with school practical lessons in science and biology.

IMPORTANCE OF THE STUDY

The demonstration and performance of practical work during the teaching of science at the school level are considered to be important requirements for a number of reasons. They aid the teaching of key concepts, develop skills in scientific methodology, and greatly add to the intellectual stimulation of learners (Ramsden 1994). It has been reported that the use of a wide range of learning activities, including general active learning strategies, problem-solving exercises and role-play can have both a motivational effect as well as encouraging learning (Brandes & Ginnis 1986; Bentley & Watts 1989). There is also greater participation of both boys and girls in classroom activities (Killermann 1996). Curriculum development for practical work is also an important aspect. The findings of a study by Ramsden (1994), strongly supported the use of everyday contexts as starting points from which to explore scientific concepts and as a means of stimulating interest in science.

Barenholz and Tamir (1997) examined the role of biology specifically as a bridge to teaching sciences in developing communities. Biology has been identified as being an accessible science, which can attract reluctant learners to the sciences by serving as a bridge to teaching other disciplines. It can also be used as a vehicle for teaching general life skills such as logic, observation and critical thinking.

Most recently, the Department of Education's South African Revised National Curriculum Statement (RCNS) of the Department of Education (DoE) for Grades R-9 (Schools) (2002:7) has a Learning Outcome 1: Scientific Investigations. This states, 'The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.' Thus, the timing and relevance of the study described in this paper appears to be both fortuitous and opportune.

ORIGIN OF THE PROBLEM: BIOLOGY TEACHING IN HISTORICALLY DISADVANTAGED SCHOOLS IN SOUTH AFRICA

Historically, many school children in South Africa were denied the opportunity to study science subjects at school. Apartheid policy ensured that many schools in the community were under-resourced, especially when it came to science laboratories and materials for practical work. Teachers who worked in these schools were also lacking in training, experience and confidence as to how to introduce practicals to their learners (Steyn 1999). Disadvantaged schools continued to be at the back end of the queue in mathematics and science education. For example, in the matriculation examinations of 2000 in Gauteng, only 5 136 out of 33 657 black candidates passed higher grade science (Groenewald 2002).

According to Schmidt (1986), cited in Ross and Lewin (*ibid.*: 7), the problem is not the availability of materials, which is often used as an excuse for not doing practical work, but concerns the use of materials by teachers. According to Schmidt there are psychological barriers that prevent teachers from implementing practical work - for example, fear of breaking expensive looking apparatus, and the fear of the experiment failing.

Today, it is widely accepted that scientific knowledge is vital both for emerging economies as well as those that compete in the global markets. Some of the stated aims of the transformation of the South African education system are to encourage the study of science subjects, to develop young scientists, especially girls, and to prepare them for admission to university. In addition, young people should be prepared to participate in, and use, the science-based technologies, which are increasingly becoming a part of daily life (White Paper on Education and Training, 1995; South African Schools Act, 1996 (Act 84 of 1996)). With regard to the content of practical work, however, curricula offered currently in South African schools continued to be irrelevant to the majority of learners because they did not reflect their life experiences (Jeevavatham 1999)

In initiating this study, several approaches and options were considered as ways to assist in stimulating learner interest in biology through practical work organised by their teachers.

1. School learners could be invited to participate in practical sessions at a university campus. The most positive aspect of this is that young learners would become familiar with the university environment and see it as an accessible and exciting place for further studies. Possible drawbacks of this approach are that it is expensive and difficult to sustain on a long-term basis. There are logistical problems in transporting large numbers of school learners to campus on a regular basis, and resources (both human and laboratory) are also not available during the university teaching term.
2. An alternative approach would be to have university academics visit schools and do practical work with learners on a regular basis. The main advantage of this approach is that a skilled scientist is involved in developing and training learners. The disadvantages are, however, that the academics could be viewed with hostility by some teachers who could feel threatened by not being able to do the teaching themselves. It is also very difficult to achieve sustained contact with learners.
3. The third approach is to offer In-service training (INSET) to biology teachers. The advantage of this model is that teachers are empowered to do the practical work themselves on a regular basis, and that a small number of teachers can have effective and sustained contact with large numbers of learners over a period of time. As a result,

effective use would be made of the limited time and resources available for enhancing educational delivery.

PURPOSE OF THIS INVESTIGATION

It was decided that the INSET approach (option 3) would be adopted in this study. The intention was to document its perceived impact on participant biology teachers' levels of interest, and on their self-perceptions of ability and confidence, and on their subsequent use of the practical work activities in their own classrooms (among other outcomes).

INSET TEACHER TRAINING

INSET is currently seen as an important intervention in improving the quality of education in developing countries (Harvey 1999). Most INSET courses have as a common aim, the assisting of the professional development of teachers through the acquisition of new concepts and skills in order to improve the quality and quantity of science taught (Dori & Barnea 1997). There are, however, few clear guidelines as to how such training should be constructed and implemented to ensure the greatest effect. There are also conflicting approaches as to the period of time over which INSET should be conducted. For example, Harvey (1999) proposed a phased-in two year model based on an evaluation of the Primary Science program in South Africa, while Clermont, Krajcik & Borko (1993) reported that short, intensive in-service programs can enhance the pedagogical content knowledge in chemistry of trainee science teachers. Other issues which need to be addressed in an INSET program are context-based curriculum content (Ramsden 1994), appropriate teaching aid support, and language support for second language users (Harvey 1999; Jeevavatham 1999)

SA INSET PRIOR TO 1995

In 1994, the Centre for Education Policy Development (CEPD) (1994:2-3) report stated, 'Hundreds of millions of rands are spent by the private sector and the foreign donor sector alone in attempting to improve the quality of teaching. Hundreds of NGOs run thousands of courses.....Yet, despite the plethora of evaluations which accompany these efforts, very few studies have demonstrated a positive correlation between these INSET activities and the rise of any index of educational quality such as better survival rates or exam results.'

Many reasons were ascribed to this (National Education Policy Initiative, NEPI 1992; Davidoff & Robinson 1992; CEPD1994) not the least of which were:

- The top down centred based courses offered by the departments of education
- The role of the donor community in funding interventions designed to have a quick impact and outcomes
- The way in which all institutions offering teacher education were operating, i.e. as if South Africa were a normal society, without any consideration for the crisis in education that South Africa was experiencing.
- NGOs who operated from a bottom up premise but who failed to provide for institutionalisation of the interventions and who were hampered by lack of infrastructure and capacity themselves.

As one of its major priorities, the new democratic Government recognised these deficits and set about radically revising the educational system. Its first publication – White Paper (Department of Education, 15 March 1995: 21-22) - emphasised the values and principals to be taken into account in setting out an education policy for the new South Africa.

These culminated in Curriculum 2005 which was revised in 2000.

INSET INTERNATIONALLY PRIOR TO 1995

The situation in South Africa was by no means unique – though certainly more complex. The disjuncture between teacher training and schooling was constantly being interrogated. How the changes that occurred should be measured was a matter for much debate (Burgess and Galloway 1993).

In the UK Ruddock (1991: 92) indicated that teachers and learners needed to feel control over what needed to be changed in schools and in Canada an entirely new curriculum was being introduced.

Abel (1997) has commented on a range of two reviews of sub-Saharan African education (Spector 1994; Stuart 1993) which indicated that most interventions were small-scale and unlikely to impact on the large problem of under-schooling being experienced. The numbers of students being prepared that were able to enter and participate in the global economy were few, commensurate with the size of the population.

In 1993, Fullan identified a new paradigm of dynamic change. This offered an alternative insight into the kinds of intervention that might change the way in which schools and departments of education could operate and, consequently, the nature and type of in-service training that might be offered. The literature on learning organisation emerged, and Senge (1996) offered a view of management that changed the way in which institutions were managed and operated. These learnings were extended to schools and to schooling world wide.

Dalin (1994) - as part of the World Bank-sponsored intervention in Bangladesh, Colombia and Ethiopia - offered the following insights which neatly intersect with those of Fullan and Senge. (Abel 1997) summarised them as follows:

- There should be devolution of decision-making to schools, principals and teachers on the question of what in-service training is to be done.
- Ownership of programmes should be clearly based with teachers.
- There should be provision of exemplary materials.
- Community and/or parents are to be involved to play a more significant role.
- Schools in a particular area should co-operate with one another.
- The government ultimately develops the capacity for delivery of resources and stays abreast of new developments.
- Donors become full partners in the developmental process, helping government, the schools and INSET providers to make possible strategic and co-ordinated approaches to change.

The concepts and ideas were powerful and heavily influenced the trajectory of INSET in South Africa. At the time it was grappling with the development of a completely transformed education system based on outcomes-based education. To this were added a collection of important issues and trends that were emerging nationally and internationally, viz: Gardner's (1983) theory of multiple intelligences, and the literature of collaborative learning (Slavin 1980, Sinclair 1977).

The reality in South African schools, however, mitigated against the implementation of this thinking. With the introduction of C2005 in 1996, INSET began in earnest; co-ordinated by the Department of Education and delivered by the NGO sector in collaboration with the Department. School management training was an important part of the process and Higher Education Institutions began to look at how they could become involved in the process of changing the way in which schools operated. In 2000, a process of curriculum revision was embarked upon which resulted in the Revised National Curriculum Statement.

Curriculum 2005 was the first major curriculum statement of a democratic South Africa. Deliberately intended to simultaneously overturn the legacy of apartheid education and catapult South Africa into the 21st century, it was an innovation both bold and revolutionary in its magnitude and conception. It signalled a dramatic break from the past. No longer would curriculum shape and be shaped by narrow visions, concerns and identities. No longer would it reproduce the limited interests of any one particular grouping at the expense of another. It would bridge all, and encompass all. It introduced new skills, knowledge, values and attitudes for all South Africans and stands as the most significant educational reform in South African education of the last century (RNCS Overview Document: Gazette 2002).

THE OBJECTIVES OF THE INSET PROGRAMME AS A WHOLE

The compact intervention programme had both short term and long term objectives:

1. To develop a short theoretical and practical in-service training course for secondary high school biology teachers aimed at teacher career development and biology awareness thus enhancing their confidence, interest in, and ability to teach biology. The focus of the training would be on enhancing self-perceptions of ability through inquiry-based active education. Teachers would be shown how to help learners recognise inter-relationships, solve problems and apply their learning experiences to their everyday lives.
2. To empower teachers to generate a greater interest in biology amongst their pupils. This would inspire more students to study it at the tertiary level and would assist in bridging the educational gulf between school and university. Students not wishing to pursue a scientific career after matriculating would also have received the grounding necessary to make them informed and environmentally aware citizens.
3. To develop appropriate teaching aids and techniques to address the needs of continuous assessment, outcomes-based educational requirements, and teaching large classes with limited facilities and from diverse language backgrounds. The teaching materials would provide teachers with practical and relevant applications and ideas of how to teach the content material through experiments, project work, model building, and discussions.

Easily obtainable, inexpensive materials would be used, and a high standard of scientific content maintained throughout.

4. To create regional networks of enthusiastic biology teachers who could assist each other with information and support. This would promote inter-school contact (e.g. science expos) on an ongoing basis after completion of the programme.

However, in this relatively long-term research investigation, during the initial years the more substantial data was gathered mainly in respect to objectives 1 and 3.

THE OVERALL RESEARCH PLAN

Phase 1 : Feasibility study (1997)

The target group

The members of the primary target group were senior high biology teachers (Grades 10-12) from previously disadvantaged schools in the greater metropolitan area of Cape Town.

Initially, a small sample of ten biology teachers were selected at random from the target group, and these were sent a detailed letter of enquiry aimed at identifying whether they supported the use of practical work as a teaching tool. They were also asked whether they were experiencing problems related to teaching practical work, what the greatest problems were, whether they supported an INSET initiative aimed at implementing practical work, and which areas of the syllabus they wanted covered in such a course. The teachers were asked for suggestions as to the timing of the course so that it would be of greatest use to them in their teaching schedule, and would also not disrupt their professional duties.

Their responses in 1997 guided the design and implementation of the INSET course in Phase 2, and it then ran twice during the period 1998 to 1999.

Phase 2: Formal implementation: 1998 - 1999

Early in 1998 schools were sent circulars advertising the INSET course, and this was followed up with personal phone calls to school principals and heads of biology departments to reinforce the nature and goals of the workshop.

The INSET workshop course was then formally scheduled, implemented and evaluated on the University of Cape Town campus with one group of biology teachers in 1998, and was repeated in a similar manner with a second group of teachers in 1999.

The workshops were run in the first month of the school year (early February) to enable teachers to use their newly-acquired skills during the current teaching year. They were held on four afternoons over a two week period during the school term, after teaching had been concluded. This was also a very suitable time from the university point of view as laboratory space and support staff were available before the start of the undergraduate teaching year.

Phase 3: Follow-up (1999-2002)

After the INSET workshops had concluded on campus in 1999, attention then turned to what might be happening subsequently in the biology teachers' classroom lessons in the reality of their schools. The phase 3 focus was the extent to which implementation of the INSET biology practicals might be impacting on the teachers and their learners on the ground in the following months and years from 1999 to 2002.

The research design for the workshop interventions during 1998 & 1999 (Phase 2)

(a) The samples

For carrying out the formal implementation and evaluation of the INSET course, the samples were drawn conveniently from a wide population of approximately 60 deprived high schools in the Western Cape metropole. A benchmark criterion for "social deprivation" is a situation in which the combined household monthly income is less than R3000 per month (Attwood 2001). For historical reasons, most deprived schools continue to have populations classified as "black".

A total of 68 teachers, self-selected but representing 27 schools, attended either the first or the second INSET workshop. The teachers came from diverse backgrounds and recorded varying degrees of experience and educational qualifications. Some of the teachers were formally trained to teach biology at the matriculation level but many were not. A number had obtained advanced degrees, but not necessarily BSc degrees.

They were also from different teaching situations and their class sizes ranged from 30 to about 64 learners per class. In preliminary, informal conversations and interviews, many teachers remarked they did not feel confident to teach practical work, both because of a lack of content knowledge as well as a lack of classroom and resource management skills. Ten teachers said that they had well equipped laboratories, but another ten reported having no laboratory facilities. 48 biology teachers described their science facilities as poorly equipped. Eleven teachers acknowledged that they had performed no biology practical work with their classes during the previous two years.

Sample 1 (in 1998) comprised 49 self-selected teachers representing 27 schools.

Sample 2 (in 1999) consisted of 25 self-selected teachers from the same set of schools.

Sub-sample 3 (2000-2002) consisted of 15 of the above 68 biology teachers conveniently available for follow-up reports and interviews more than a year later, after the INSET workshops they attended had ended.

For the purpose of the data analysis later, samples 1 and 2 were subsequently combined, since the teachers participating in 1998 and 1999 resembled each other in their spread of qualifications, race, gender, age, home language, needs, etc.

(b) The pre-course, post-course and follow-up questionnaires

The effectiveness of the INSET workshop with high school biology teachers was evaluated systematically by using both pre-course and post-course multi-dimensional self-report

questionnaires, together with a third follow-up questionnaire of a similar nature six months later. All evaluations made by the teachers were based on self-assessment criteria.

Copies of the lengthy three course evaluation instruments are available on request.

The Cronbach alpha reliability coefficients of the pre-course and post-course questionnaires yielded moderate to high values of 0.62 and 0.81 respectively (n = 67).

Questions and items were incorporated in the pre-course and/or the post-course questionnaire only after their inclusion had justified by a panel of three experienced biology teachers reaching consensus on their relevance, importance, content, wording and expression.

Some examples of reasons for including particular items may be mentioned:

Pre-course item 6: *“Number of pupils in each class”*.

This item was included because it was suspected that large sized classes would be associated with fewer practical experiments being conducted in school biology lessons.

Pre-course item 9b: *“How often have you done biology practical work in the last two years”*.

This item was include because it was intended that teachers would be inclined to perform more practical work sessions with their classes after attending the INSET workshop programme.

Post-course item 7: *“Rate your ability to conduct practical sessions since attending the course...”*

This item was included because of the recognised importance of teachers being able to exude **confidence** in the classroom. For example, national chemistry teaching award winner Hubbard (1995:3-4) wrote:

I think the number one criterion for a quality lesson is **confidence...and self esteem**. Quality criterion number two, but just as important, is great **enthusiasm** ... I think it is there in all good science teachers ... On a more basic level lessons must be well planned and must involve **practical work** ... However, these things will only happen if the teachers really **know the subject material** they are teaching ... a really outstanding lesson can only be taught by a teacher who is really in command of the material ... Top quality teaching comes with both knowledge and experience. Teachers must have opportunities to acquire these. [Emphases supplied]

Five items were repeated in at least two of the three course evaluation questionnaires. These were as follows:

- *“How often have you been able to do practical work with your classes?
Once a week / once a month / once a term / once a year / other.”*

This question appeared in the Pre-course evaluation (the first) as item 9b, and again in the Follow-up course evaluation (the third) as item 3.

It was anticipated that, after attending the INSET programme, more teachers would conduct practical work with their classes more frequently.

- *“Rate your level of interest in teaching biology on a scale of one to five:
Not interested 1 2 3 4 5 Very interested”*

This question appeared in the Pre-course evaluation (the first) as item 11, and again in the Post course evaluation (the second) as item 8.

It was anticipated that, after attending the INSET programme, more teachers might record increased levels of interest in teaching biology. However, since all teachers attending the INSET workshop course were already enthusiastic and self-selected, there was the possibility that no significant increase would occur in their expressed levels of interest as a result of the workshop.

- *“Rate the level of interest of your pupils on a scale of one to five:
Not interested 1 2 3 4 5 Very interested”*

This question appeared in the Pre-course evaluation (the first) as item 12, and again in the Follow-up course evaluation (the third) as item 6.

It was anticipated that, after attending the INSET programme, more teachers would report increased levels of interest among their classes of learners after six to nine months.

- *“Rate your ability to conduct practical sessions on a scale of one to five:
Very poor 1 2 3 4 5 Very good”*

This question appeared in the Pre-course evaluation (the first) as item 13, and again in the Post course evaluation (the second) as item 7.

It was anticipated that, after attending the INSET programme, teachers would be more confident, and so would perceive and rate their ability to conduct practical work more highly.

- *“Mark any of the 14 activities you will use [you have subsequently used] with your class.”*

This question appeared in the Post-course evaluation (the second) as item 4, and again in the Follow-up course evaluation (the third) as item 4.

This question sought to determine which, and how many, of the 14 practical experiments were considered important by an appreciable number of teachers who attended the INSET workshop; and which ones were not highly valued. Then, after the teachers had returned to their normal classrooms, this item sought follow-up data on the extent to which these teachers had been able to implement their expressed hopes and intentions later during the ensuing year.

(c) Data collection procedures

The questionnaires were administered to the participant teachers at the commencement and conclusion of each workshop intervention programme, and were returned completed by post. Late returns were pursued with reminder telephone calls to the participant teachers and their schools.

(d) Follow-up interviews, discussions, observations and member-checking

Using a triangulation-of-data research methodology, during 1998 the project was evaluated using additional semi-structured interviews and informal discussions with teachers during the workshops, and over the subsequent eight months in the school setting. The success of the initiative was gauged by the teachers' responses to the course itself, and by their self-reported ability to implement the ideas of the course in their own classroom situation. Conveniently accessible participants continued to be followed up on an individual basis from 1999 through to 2002, to establish whether their declared commitment to conducting the INSET biology practical experiments in schools was being sustained.

DEVELOPMENT OF THE INSET WORKSHOP CONTENT

The workshop programme was developed using input from the University of Cape Town (UCT) Departments of Microbiology, Botany and Zoology, and the Peninsula Technikon Science Education Department. The Teaching and Learning Resources Centre (TLRC), based at UCT, was the educational advisory body and certification authority. Participants attending at least 75% of the sessions were awarded a Course Attendance Certificate by the TLRC. Additional assistance at practical sessions was drawn from the post-graduate student body of each department. Teacher evaluation of these courses was used to develop the material further and run the courses in 1999.

Workshop course design

The course consisted of 4 x 3-hour sessions, each focusing on a different aspect of biology practical work, demonstrating different teaching strategies and materials which could be employed, and relating these activities to learners' own life experiences. The activities performed, as well as additional related experiments, were collated into a booklet for each participant, and all participants were given a Starter Kit of the reagents necessary for doing the practicals again as a demonstration in the classroom.

Emphasis was placed on how to perform experiments using materials which are easily obtainable (Pharmacy, Supermarkets) and inexpensive, and a list of suggestions supplied as to how to substitute equipment for formal apparatus, without compromising the scientific value of the experiments.

Examples of this are the use of

- kitchen measuring utensils instead of measuring cylinders and pipettes
- an average size teaspoon to measure approximately 5gm of solid material instead of using a balance
- drinking straws to add liquids in a drop-wise manner

- a pH indicator solution from the liquid in which a red cabbage has been boiled (the neutral liquid is purple, but turns red when acid and green when alkali).
- surgical spirits instead of ethanol
- kitchen starch ("Maizena") instead of chemical grade starch
- crushed glucose sweets instead of pure glucose powder
- tincture of iodine from a Pharmacy for doing tests for starch
- caustic soda from a supermarket instead of pure NaOH
- slaked lime from a supermarket or pharmacy instead of $\text{Ca}(\text{OH})_2$

Each session began with a short lecture to introduce the topics, and also included a tea break and end-of session discussion period to stimulate interaction and networking amongst the teachers.

The annexure contains a more detailed description of the 14 school-based practical experiments covered during the four sessions which ran over a period of a fortnight.

RESULTS

Formal implementation: 1998 + 1999 (Phase 2)

The response to the survey immediately after the course was overwhelmingly positive. The teachers indicated that they had personally benefited from the career development aspect of the course, and that they anticipated that the skills and teaching aids they had acquired, would be of use to them in the classroom situation.

Some teachers reported that they had already performed some of the experiments taught at the workshop with their school classes immediately after having learnt them themselves, and reported a high level of learner interest. On post-course follow-up informal contact, many indicated that they were being able to implement the activities in class and that learner interest had increased.

The main findings from the self-report questionnaires were as follows:

1. Fulfilment of teachers' expectations

53 teachers said that the programme had met their expectations fully; 14 partly; and one not at all.

2. Popularity of the practical activities

The 68 teachers reported that they intended to use an average of 12 of the 14 experimental activities with their classes in the future. They also explained their decisions and choices.

3. Practical experiments enjoyed by teachers

- (a) The 68 teachers rated the following experimental activities as the most enjoyable:
 (1) epidemic (ii) lung model (iii) foods groups (iv) transpiration.

- (b) The epidemic activity was given a significantly higher rating of enjoyment than 9 of the other 13 practicals.
- (c) The reflexes activity was scored significantly lower in terms of enjoyment than 9 of the other 13 practical activities.
- (d) Enjoyment ratings correlated highest for the two practicals “photosynthesis” and “transpiration” ($r = 0.80$), and for the two practical activities “food groups” and “enzymes” ($r = 0.78$).

4. **Teachers’ confidence levels**

Table 1 and Figure 1 record the changes that occurred in the 68 biology teachers’ ratings of their own self-perceived ability to conduct practical sessions before and after the inset intervention workshop of laboratory work.

The measured increases in self-rated ability, or perceived level of self-proficiency, are statistically highly significant.

5. **Teachers’ interest levels**

Measured on a scale of 1 to 5, the teachers’ mean pre- and post-levels of interest in their subject, biology, remained very high ($M_1 = 4.75 \pm 0.27$; $M_2 = 4.76 \pm 0.46$). The two weeks of four laboratory sessions had **maintained** their great levels of motivation and enthusiasm for teaching biology, and had not discouraged them.

6. **Teacher networking**

Teachers were unanimous in their appreciation of having the opportunity to meet with other teachers in an informal setting and to exchange teaching experiences and views. They discussed ways of supporting each other in future joint science initiatives.

The long-term effects of the INSET programme, on both teachers and their students (learners), are being monitored with respect to the numbers and types of practical experiments being favoured and carried out by them in their ordinary classrooms. These additional research findings are being prepared for publication.

Phase 3: Follow-up (1999-2002)

One or more years after the workshops had concluded, 15 of the original 68 participating biology teachers have remained conveniently available for regular follow-up reports and interviews.

The main findings may be summarised as follows:

1. **Number of experiments used in school classrooms**

The 15 teachers reported that, back in their normal classrooms, they had used an average of more than five of the original 14 practical activities tried by them in the INSET workshops during 1998 or 1999.

2. Classroom success ratings

The 15 teachers estimated and recorded the perceived levels of success of these practical experiments with their own school learners on a scale of 1 (not interested) to 5 (very interested). For the different practical activities, the recorded mean scores ranged from 4.1 (strongly interested) to 5.0 (maximally interested), which was a particularly gratifying response.

3. Increased interest of children in biology lessons

The 15 teachers reported that the perceived levels of interest of their school learners in biology, rated on a scale of 1 to 5, had increased from a pre-workshop mean of 3.31 to a post-workshop recorded mean of 3.37. However, this increase, obtained with just a small sample of reporting teachers, is not statistically significant.

4. Other long-term changes

In their individual post-workshop reports obtained from 1999 to 2002, some biology teachers explained how they had changed their methods of implementing continuous assessment in biology lessons using ideas and techniques they had acquired in the INSET workshops. Some teachers reported an increased participation in their biology lessons by girls. All reported on the workshop activities they had selected and implemented most often with their biology classes, and explained why they were successful. Some teachers suggested how they had modified or adapted the original practicals to their own local school conditions. Others mentioned obstacles they had encountered when trying to carry out practical work in their schools. Several commented on the effectiveness of the regional networks established since the workshops. Details of this considerable amount of qualitative data are to be presented, analysed and discussed in a sequel article.

DISCUSSION

This study has shown how it is possible for one small socially conscious university academic department – whose lecturers do not necessarily possess formal professional qualifications in education – to make a limited but relevant and successful contribution to upgrading the performance, support and motivation of science teachers. Educators who have been working for many years in deprived, under-resourced and disadvantaged communities have conveyed particularly forthright expressions of gratitude for this work. Beyond this compact programme of INSET intervention, however, it becomes important to follow through with more sustained and comprehensive programmes of action under the auspices of non-governmental organisations, or through long-term initiatives grounded in university-based centres such as the Schools Development Unit of the University of Cape Town.

Lock (1990) studied performances on a range of practical tasks in biology and chemistry. He found that performances on the *self-reliance* skills were generalisable, rather than being context-dependent. Thus the findings reported in this South African study in respect to appreciable increases in levels of expressed self-confidence might appear to be important and possibly persistent.

From 1997 to 1999, existing facilities were used at UCT at a time when they were not required for undergraduate teaching and when staff and support staff were available. Several interesting points emerged during the planning and running of this course which may be useful in the implementation of further courses. We found that it was useful to have at least two teachers from each school instead of limiting it to one. The reason for this is that a teacher who has attended a course of this kind may find it very difficult to implement the practicals in a school where the rest of the teachers are not as enthusiastic or well-trained. Two teachers can support each other and form the nucleus of a new initiative at a school. Tea breaks were an important aspect of the course. Teachers got to know each other, exchanged ideas and problems and phone numbers, and began to set up the beginnings of inter-school support and interactions. It is also essential that a valid certificate be awarded for course attendance. This gives legitimacy to the teacher's efforts, helps to build a teacher's CV, and gives status in the school setting.

The teaching approach and methodologies tested in the workshop and implementation phases of the project have been developed and are now published in the form of a teachers' handbook and classroom resource material (Abratt, Collett, Miller-Butterworth & Suiró-Steethman 2002). Important glossary terms are explained in the page margins, and study themes and lists of related topics will facilitate an approach to integrated study. Although the book does not cover all the material within the biology curriculum, teachers are shown how to adapt and apply activities to other areas of interest. The handbook aims to provide a versatile resource book for biology teachers. The focus is on the practical component of biology, and on providing activities that direct and assess the students' understanding of key concepts. It serves to guide teachers through the transition phase of the new education policy development, and provide criteria for the meaningful assessment of skills as part of the continuous evaluation programme.

Continuous assessment and a range of teaching and learning methodologies are addressed. The idea is to move away from traditional transmission and rote learning styles, and instead focus on inquiry-based education. Students are encouraged to experiment productively - to ask questions and find their own answers. Teachers are shown how to help students recognise inter-relationships, solve problems and apply their learning experiences to their everyday lives. The activities in the handbook provide ideas for assessment. Teachers are shown new ways of keeping records and of using the activities for diagnostic purposes.

The teaching aids arising from this project are sensitive to the fact that teachers and students may speak many languages. Learners need to reach understanding in their first languages and express these in the dominant classroom languages. Teachers are encouraged to get students to talk about new terms/concepts in their own languages. In addition, clear and extensive illustrations will support the text, so that instructions and concepts can be correctly interpreted.

INSET AFTER 1999 IN SOUTH AFRICA

It has been recognised that fundamental to curriculum change is the creation of genuine tools for teachers to improve their practice in ways that will transform, not just tinker with, pedagogy. This requires a common understanding of the requirements for effective pedagogic transformation as well as ways of instituting change efficiently and effectively. Schooling, per se, has undergone major shifts in the last few years. Attitudes and discourse, if not practice, have moved to a higher level in many schools. However, there remains a lasting attachment to old methodologies, attitudes, values and cultures of learning and teaching that were so prevalent in

all our schools. New approaches to INSET are required and the way in which INSET is managed has undergone several shifts to inculcate the new curriculum.

The kind of INSET that stands a chance of changing deeply ingrained attitudes, values and cultures is encapsulated in Fullan (2001). He records Elmore (2000:25) who says, 'People make these fundamental transitions by having many opportunities to be exposed to ideas, to argue them into their own normative belief system, to practice the behaviors that go with the values, to observe others practicing those behaviors and most importantly to be successful at practicing in the presence of others (to be seen to be successful).'

It is these kinds of interactions above all others that are vital to paradigmatic shifts for the delivery of the revised National Curriculum Statement.

One of the challenges to INSET providers has been the sloganisation of theory. In order not to burden teachers with learning theories, many of these were reduced to slogans. One example is the often repeated old Chinese proverb, 'I hear I forget; I see I remember; I do I understand.' This is endlessly advocated in an effort to get teachers to allow learners to be actively 'doing'. However, this is highly problematic!

Dewey is often quoted as saying "we learn by doing". However, this is not true – Dewey said that we learn by doing and by **thinking** about what we are doing!

So, by all means emphasise the doing, but **the reflection during and afterwards is essential!**

The new curriculum has emphasised constructivist theories as being the major thrust. However, the underlying logic appears to have disappeared from view. 'From a constructivist point of view, learners should be able to construct their own meaning of concepts. A predominant way of doing this is by hands-on activities. In other words, learners very often achieve a deeper understanding of concepts by exploring and constructing the concepts themselves than by just being told them and having to learn them off by heart.' This statement, often repeated in various ways, led to a number of misconstrued ideas, like the following: 'OK, if learners must construct their own knowledge, we as teachers can stand outside' – and many did just that.

Another statement, similarly misconstrued, was: 'Leave the learners to work things out for themselves; do not interfere while they are doing this.' This had several consequences.

Firstly, many INSET providers conveyed the misconception that telling means learning by absorption, and hands-on means learning through construction. The constructivist position is that we *always* construct our knowledge, no matter what the mode of teaching. Even when we listen, we must interpret it in terms of our own previous ideas, and mentally construct our thoughts and meaning.

Secondly, implied by the word 'activity' should not only mean physical activity, but also mental activity.

Thirdly, mere physical activity without mental activity does not lead to learning!

Fourthly, by presenting only a brief insight through one activity mindlessly carried out (no matter how engaging), one creates a condition of limited experience – that learners and their teachers are not able to move beyond.

One learns physical knowledge about the properties of objects through physical manipulation (hands-on).

One learns social knowledge about conventions, notations and terminology through social interaction and social transmission (by telling).

Finally one learns logico-mathematical knowledge, or conceptual knowledge through reflective abstraction! It is internal – it is not in the objects; one does not learn it with hands-on activity.

CONCLUSION

The results of this study have shown how it is possible for community-minded scientists to develop and implement a successful short biology practical INSET course for teachers. There is evidence that it has been both effective in terms of their personal career development as well as in introducing new and relevant curriculum ideas in under-resourced schools where classes are large. The approach has been highly cost effective and the training of approximately 73 teachers over a five year period extending from 1997 to 2002, and has resulted in sustained teaching contact with an estimated 4000 learners in schools.

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The generous financial assistance of the National Research Foundation and of the University Research Grants Committee of the University of Cape Town are hereby acknowledged with thanks. The initial inputs of the Peninsula Technikon Science Education Department, and the helpful comments of the referees on an earlier version of this manuscript, are also acknowledged with thanks.

ANNEXURE

Session 1: Microbiology Laboratory

- *Biochemical measurement of food groups*

Besides doing the tests themselves, teachers were shown how to make them more relevant to learners by extending them into a project "What I eat in a day". Here, learners would bring small samples of food saved from their previous day's diet and test them in class.

- *Starch degradation by salivary amylase.*

Saliva is a very accessible source of the starch-degrading enzyme, amylase.

In this set of experiments, the activity of the enzyme was demonstrated at different temperatures and pHs. Teachers were shown that bowls containing cold water, warm water and boiling water could be substituted for high-tech water baths in the temperature experiment, and that lemon juice or swimming pool acid could be used to make the pH of the saliva more acidic.

- *Introduction to microscope work*

Although schools may, in fact, have some basic form of microscope equipment, teachers are either not trained to use this, or are unsure of where to get suitable material to view.

In this activity, teachers are shown how to view a warm sugar solution of bakers' yeast, to make a hay infusion of pond water to view a range of microbial life, and to prepare and look at fungi growing on bread and fruit.

Ways were suggested of developing the activities into projects which learners could relate to, eg. looking at the factors which prevent food spoilage by monitoring fungal growth under different environmental conditions; examining the conditions under which milk sours and how this could be prevented by temperature control (cooling or boiling).

- *Demonstration of an "epidemic"*

The transfer of microbially transmitted disease is a very difficult concept to teach or demonstrate in the classroom setting. Yet it remains a crucial and relevant element in the teaching of biological interactions, particularly with respect to the current HIV/AIDS epidemic.

A simple demonstration of epidemic spread was performed in which participants were divided up into groups of 10, and were given paper cups containing a liquid. This represented their "body fluids" eg blood or saliva. All the cups contained water except for one, which contained a starch solution. This represented the "infected" person, but no participant knew which cup was "infected". Samples from each cup were set aside for testing at the beginning of the activity. Participants then chose partners and mixed their solutions. Test samples were again set aside and the mixing repeated with another partner. The procedure was repeated once more. At the end of 3 rounds of mixing, all the samples were tested with iodine to show the presence of starch. At the end of the activity, 8 of the participants in each group showed traces of starch in their solutions as opposed to only 1 at the beginning. This showed dramatically how infections can be spread.

Teachers were shown how to calculate the results as percentage people "infected at each contact, and to plot these results as a graph. They were also shown how this activity could be used together with the topic "Talking about AIDS" (see Session 4 below).

Session 2: Botany Laboratory

- *Photosynthesis*

The role of photosynthesis in the synthesis of carbohydrates was examined, by looking for the presence of starch in the green areas of geranium and variegated ivy leaves. Surgical spirits was used to extract the chlorophyll and iodine to test for the starch.

- *Transpiration*

The study of transpiration is an important core element of many Biology curricula. The practical demonstration of the phenomenon using a potometer is, however, often beyond the capability of the teacher because of 2 main factors: viz. Commercial potometers are expensive and they are often very difficult to use. For this course, a simple potometer was designed which makes use of a boiling tube, a thin capillary tube and a rubber stopper. A simple explanation for the use of the instrument and suggestions for trouble-shooting the technical difficulties were also offered.

- *Osmosis*

Text book experiments which demonstrate osmosis usually call for the use of a semi-permeable membrane, a component which is often difficult to obtain. In this course, the process of osmosis was demonstrated by immersing equally sized raw potato slices in containers filled with different concentrations of sugar solution for about 2 hours. The potato slices in the most concentrated solution became very soft showing that the water molecules had diffused from the potato cells into the sugar solution.

Session 3: Zoology Department.

- *Dissections of animal material*

In the pilot course, a dissection of the rat was offered as demonstrations to teachers. However, following feedback from teachers that this type of dissection could not be performed due to difficulty of obtaining material and difficult nature of the dissection, the approach was modified. The final course offered methods for dissection a chicken wing, which demonstrated many anatomical features, and investigations of internal organs were done by dissecting animal organs obtained from the butchery eg. lungs, kidneys, heart.

- *Human sense organs and reflexes*

Some quick, easy to perform activities were designed which investigated these processes. The activities were well-suited to being performed in large classes and required the minimum of equipment in the form of different flavoured solutions, mirrors, rulers and torches.

- *Making a model of the lung*

This model was designed to show the way in which the lung functions. It consisted of recycled waste materials yet accurately demonstrated the inflation of the lungs (balloons) within the chest cavity (a plastic cold drink bottle with the bottom cut off) when the diaphragm contracts (a piece of rubber glove over the bottom of the bottle is pulled down).

Session 4: Lecture Theatre

- *Practical organisation and continuous assessment.*

Suggestions were offered regarding group work, workstations and outdoor activities to deal with the problems of doing practical work with large classes. Continuous Assessment (CA) and the goals and criteria for Outcomes Based Education (OBE) were discussed in relation to practical work.

- *Alternative teaching approaches using "Talking about AIDS" as an example*

The theory of CA and skills-based activities was demonstrated through an activity designed to teach learners about the biological, social and economic impact of the AIDS epidemic. The "epidemic" activity from Session 1 was the starting point from which graphical data had been generated. This was linked to interpretation of actual graphs and data about the current numbers of HIV-infected people world-wide and in sub-Saharan Africa in particular. An HIV fact-file was presented which gave a flow diagram of the infectious cycle of the virus, an explanation of the test for HIV, and a clear table showing exactly how people can and cannot become infected. A fictional case study was offered, written from the point of view of an AIDS sufferer, who described how she became infected with the virus and what her concerns

were with regard to health care, employment and the care of her child (HIV negative) when she died. The activity was then developed into a set of comprehension questions on the topic, role-play around the questions raised in the case study, discussion of the issues, and presentation of a poster highlighting aspects of AIDS information and awareness. The teachers were then given the task of describing how all these different types of activities could be best assessed. Group discussions amongst them, together with the session facilitator, assisted in developing the most appropriate methods.

- *Teaching and interpretation of graphical data (Data response).*
Data Response was shown to be a natural and logical extension of experimental work. Simple but accurate guidelines were given to show how to plot graphs and what types of graphs should be used to plot different types of data.

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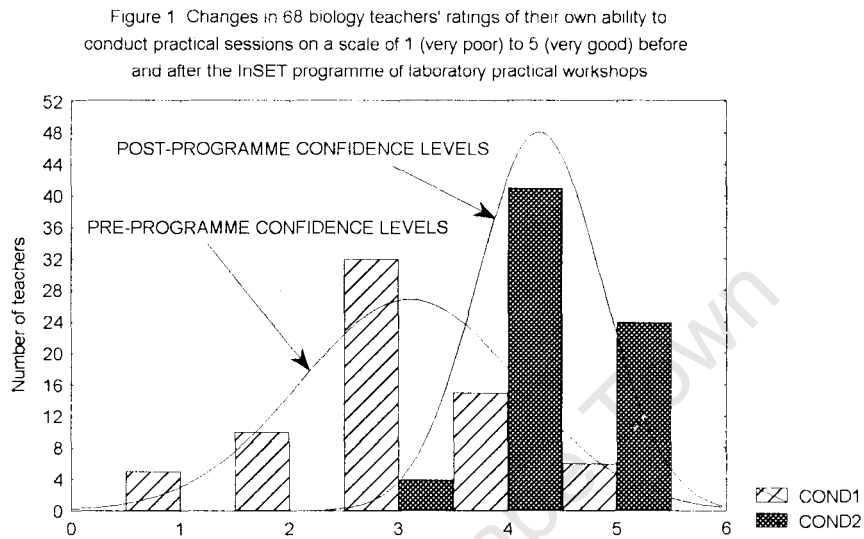
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Table 1. Teachers' self-perceptions of their ability to conduct classroom biology practical sessions, before and after the INSET programme, rated on a scale of 1 (very poor) to 5 (very good).

	N	Mean	SD	t	df	p
Pre-INSET	68	3.10	± 1.01			
Post In-SET	68	4.29	± 0.57	9.44	67	0.0000

Figure 1. Changes in 68 biology teachers' ratings of their own ability to conduct practical sessions on a scale of 1 (very poor) to 5 (very good) before and after the INSET programme of laboratory practical workshops.

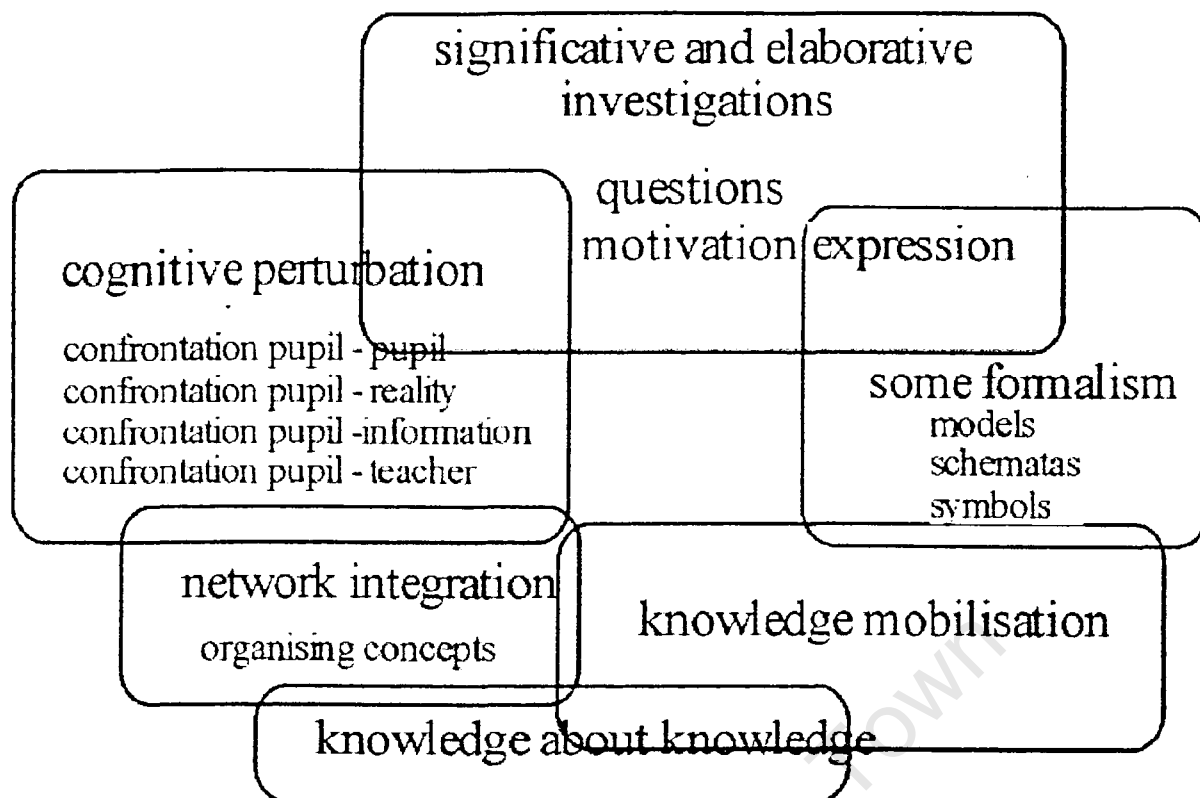


APPENDIX C

Giordan's allosteric learning model

University of Cape Town

Source: Giordan, A (2000). *BIOED2000: What is new about learning?* Paper presented at BIOED2000 conference in Paris in July 2000 organised by IUBS. [Online]. Available on http://www.iubs.org/cbe/papers/giordan_learning.html [2005, 3 January].



Main allosteric learning parameters

First, the teaching environment (classroom, museum, media) must provide learners with meaningful situations. We must trigger the desire to learn. To do so, the context must stimulate, motivate, concern or challenge learners, leading them to a questioning approach. Multiple confrontations are required: a single argument is not enough. We can either encourage pupil-reality confrontations, via surveys, observations, and experiments, or pupil-pupil confrontations, when learners work in groups and different ideas oppose each other. This can be completed by confrontations with (written or audiovisual) information. All these activities must be sufficiently pertinent to challenge current learner conceptions. They must convince learners that their conceptions are not adequate for dealing with the problem(s) at hand. Thus, the activities must lead learners to investigate, help them formulate their thoughts, and distance themselves from ideas which were previously taken for granted. Finally, they can help learners collect new data and broaden their experience.

It is important for learners to have access to an adequate level of formalism, as it encourages the elaboration of more adequate conceptions. This may take many guises (symbols, models, conceptual maps,...), and either provide food for thought, or assistance when thinking things through. In the latter case, formalism should encourage learners to rephrase problems, and/or consider additional links. In order to be operational, such formalism must be easy to access and manipulate. Finally, it must help organize diverse data, and can serve as an anchor when shedding light on reality.

Further, we need to provide situations in which learners can mobilize their new knowledge, and test its efficiency and limitations. Such situations must show that new data are more easily accessed or learned when using the new thought structures. Thus, learners learn to activate knowledge; in certain cases, they may also imagine individualized types of guidance.

everything with one single theory is attempting the impossible.

In order to go beyond the constructivist model, a number of micromodels have been created and gathered under the comprehensive term : *allosteric learning model*. They describe what is going on in the learner's head as well as the general conditions that make learning easier.

Allosteric learning model

A student learn simultaneously "thanks to" as says (Gagné 1965), "starting from" (Ausubel 1968), "with" (Piaget 1950, 1977), the functional knowledge inside his mind, but at the same time, he must learn "against" it (Bachelard 1934, 1938). Learning is a highly active mental process which works in a conflicting way and in an integrative mode between what the learner has in his mind and what he can find and understand through his conceptions on his environment.

When a learner elaborates a new model, all his mental model must be reelaborated in an interaction between the conception and the external information. And this, is not obvious. Student changes ideas with a lot of difficulties.

Mainly his questioning network must be completely reformulated, his framework of references, largely reorganised. And when a pupil changes his conception, it's not because he is convinced that it doesn't work, it's because he has elaborated another one which is more efficient to answer to the question he is confronted with. And this need conflict and interference periods and the elaboration of knowledge goes on with approximation, concernation, confrontation, decontextualisation, interconnexion, rupture, alternate, emergence and mobilisation periods.

On their own, learners clearly have a slim chance of discovering which set of elements can modify their questions, concepts or relationship to knowledge. Teachers can facilitate the production of meaning by filtering multiple items of information, by amplifying or by reducing the input of external stimuli.

Teaching biology and making it accessible to a wider public requires an increasingly complex alchemy. It is now possible to systematically classify the essential parameters which facilitate the learning process.

Since biology education is such a long and complex process, knowledge must be integrated into a network of 'organizing concepts'. We will not develop this idea any further in this section, because it is a topic in itself (see p. ...).

Finally, learners must be able to implement 'knowledge about knowledge'. The main obstacle in this case is often the representation learners have of biology or of their own approach. Learners have trouble grasping the scope or importance of certain knowledge, or of the 'logic' underlying a given approach, without alternating learning moments with moments of 'metacognition' (see appendix on germination).

Changes in the professions of teaching and promoting biology

To date people who taught biology in school and in the media simply distributed knowledge. They thought their work was over after having said or shown. Yet current ideas on the real meaning of 'learning' demonstrate how complex and demanding the professions of teacher or creator of exhibits have now become. Their primary role is to 'organize' learning conditions.

Therefore, such professionals must transform their own conceptions of 'teaching'. They must abandon the idea of a panacea. When teaching science or promoting a culture of biology, vaccines and ready-made pills do not exist. At best, we can provide multi-therapies... We must involve a whole cocktail of parameters when staging each learning situation and create an allosteric environment which is liable to transform learner conceptions. This should involve several elements (see figure), which interact with one another. The teacher must dose them in order to perturb without destabilizing. If successful, they must know how to accompany learners without completely taking them in charge.

In the end, all of this revolves around paradoxes which must be regulated. For example, teaching must be based on learners, while going against what learners think. Likewise, we must encourage self-teaching in museums, for example, yet simultaneously confront learners with challenging and meaningful situations.

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APPENDIX D

Assessment standards associated with Learning Outcomes 1 and 2

University of Cape Town

Source: Western Cape Education Department (2005b). *Life Sciences – Resource for Educators, Subject Orientation 2005*. Cape Town: Western Cape Education Department.

CHAPTER 3

LEARNING OUTCOMES, ASSESSMENT STANDARDS, CONTENT
AND CONTEXTS

INTRODUCTION

The three Learning Outcomes of the Life Sciences address the Critical and Developmental Outcomes. The Assessment Standards are vehicles of knowledge, skills and values through which the Learning Outcomes can be achieved.

The Assessment Standards per grade are the minimum requirements expected of a learner in order to progress to the next grade. Assessment Standards for each Learning Outcome specify more complex, deeper and broader knowledge, skills, values and understanding to be achieved in each grade. In each grade, learners are expected to demonstrate the knowledge, skills, values and attitudes achieved in the previous grade. The thrusts of the different Assessment Standards are stated under each Learning Outcome.

**Learning Outcome 1: Scientific Inquiry and Problem-solving Skills**

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.

- *Focus of Assessment Standard 1:* The learner identifies and questions phenomena and plans an investigation.
- *Focus of Assessment Standard 2:* The learner conducts an investigation by collecting and manipulating data.
- *Focus of Assessment Standard 3:* The learner analyses, synthesises and evaluates data and communicates findings.

**Learning Outcome 2: Construction and Application of Life Sciences Knowledge**

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

- *Focus of Assessment Standard 1:* The learner accesses knowledge.
- *Focus of Assessment Standard 2:* The learner interprets and makes meaning of knowledge in Life Sciences.
- *Focus of Assessment Standard 3:* The learner shows understanding of how Life Sciences knowledge is applied in everyday life.



Learning Outcomes 3: Life Sciences, Technology, Environment and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

- *Focus of Assessment Standard 1:* The learner explores and evaluates the scientific ideas of past and present cultures.
- *Focus of Assessment Standard 2:* The learner compares and evaluates the uses and development of resources and products and their impact on the environment and society.
- *Focus of Assessment Standard 3:* The learner compares the influence of different beliefs, attitudes and values on scientific knowledge.

University of Cape Town



Learning Outcome 1

Scientific Inquiry and Problem-solving Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.



Assessment Standards

Identifying and questioning phenomena and planning an investigation

We know this when the learner is able to:

- Identify and question phenomena.

Attainment is evident when the learner, for example:

- observes that some pot plants are growing poorly and questions whether they are lacking a mineral salt.

- Plan an investigation using instructions.

Attainment is evident when the learner, for example:

- plans an experiment to test the effect of a mineral salt (e.g. magnesium on plant growth) following given instructions.

- Consider implications of investigative procedures in a safe environment.

Grade 11



Assessment Standards

Identifying and questioning phenomena and planning an investigation

We know this when the learner is able to:

- Identify phenomena involving one variable to be tested.

Attainment is evident when the learner, for example:

- observes that fungi grow better on fish paste than on peanut butter; or
- observes that a number of people in the local community are suffering from diarrhoea.

- Design simple tests to measure the effects of this variable.

Attainment is evident when the learner, for example:

- designs an investigation to test the influence of substrate type on fungal growth (e.g. decides to spread a tablespoon each of fish paste, peanut butter, marmite and syrup on a slice of white bread and to use a slice of bread with no spread as a control); or
- plans ways of collecting information about the number of people infected (e.g. survey, information from the local clinic).

- Identify advantages and limitations of experimental design.

Attainment is evident when the learner, for example:

- considers how 'fair' the experiment is (amount of spread used, calculation of % spread covered by fungus);
- considers the limitations of survey methods in collecting accurate data about diarrhoea.

Grade 12



Assessment Standards

Identifying and questioning phenomena and planning an investigation

We know this when the learner is able to:

- Generate and question hypotheses based on identified phenomena for situations involving more than one variable.

Attainment is evident when the learner, for example:

- observes the high incidence of respiratory problems in the community;
- hypothesises that this could be linked to smoking or the local oil refinery.

- Design tests and/or surveys to investigate these variables.

Attainment is evident when the learner, for example:

- designs a survey to find the correlation between smokers/non-smokers and respiratory problems;
- designs tests to find out the amount of air pollutants in the community.

- Evaluate the experimental design.

Attainment is evident when the learner, for example:

- checks the accuracy of the air pollution test or survey.



Learning Outcome 1 Continued

Scientific Inquiry and Problem-solving Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.



Assessment Standards

Conducting an investigation by collecting and manipulating data

We know this when the learner is able to:

- Systematically and accurately collect data using selected instruments and/or techniques and following instructions.

Attainment is evident when the learner, for example:

- follows instructions on a worksheet;
- sets up an experiment in which five pot plants are given magnesium sulphate (Epsom salts) in solution and five pot plants are given water only;
- follows instructions to control all other variables (e.g. to use plants of the same type and size, to provide all plants with the same amount of sunlight and water, and to keep them at the same temperature);
- measures the height of each plant every three days.

- Display and summarise the data collected.

Attainment is evident when the learner, for example:

- records results in a table;
- calculates the average height of the five plants with or without magnesium every three days and plots the result on a line graph.

Grade 11



Assessment Standards

Conducting an investigation by collecting and manipulating data

We know this when the learner is able to:

- Systematically and accurately collect data using selected instruments and/or techniques.

Attainment is evident when the learner, for example:

- sets up the experiment;
- decides how to calculate, every two days the percent of the spread covered by fungi;
- records findings in a table;
- discusses, in a group, the limitations of the techniques and instruments used to measure fungal growth.

OR

- as a member of a team (class) carries out a survey in selected areas;
- recognises that people responding to the survey may not give accurate answers for a variety of reasons;
- investigates possible sources of the infection (e.g. sewage entering the stream running through the area);
- collects information on possible causes of diarrhoea from books, the Internet, pamphlets from a clinic, talk by the community health nurse.

Grade 12



Assessment Standards

Conducting an investigation by collecting and manipulating data

We know this when the learner is able to:

- Compare instruments and techniques to improve the accuracy and reliability of data collection.

Attainment is evident when the learner, for example:

- works co-operatively in a group;
- uses different instruments and techniques to collect data on the air pollutants;
- compares data collected using the different instruments.

- Manipulate data in the investigation to reveal patterns.

- Identify irregular observations and measurements.

- Allow for irregular observations and measurements when displaying data.

Attainment is evident when the learner, for example:

- draws graphs using the data collected;
- takes note of data that does not fit the graph;
- displays irregular observations on the graph but does not include them in the construction of the graph.



Learning Outcome 1
Continued

Scientific Inquiry and Problem-solving
Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.

University of Cape Town

Grade 11



Grade 12



Assessment Standards

Conducting an investigation by collecting and manipulating data

We know this when the learner is able to:

- Select a type of display that communicates the data effectively.

Attainment is evident when the learner, for example:

- displays the experimental design and group results in a 'paper';
- plots data on graphs.

OR

- combines all the results and plans to present the data in graphic form as part of a newspaper article.

University of Cape Town



Learning Outcome 1
Continued

Scientific Inquiry and Problem-solving
Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.



Assessment Standards

Analysing, synthesising, evaluating
data and communicating findings

We know this when the learner is able to:

- Analyse, synthesise, evaluate data and communicate findings.

Attainment is evident when the learner, for example:

- examines the graph and reaches a conclusion about the effect of magnesium on plant growth;
- displays results and conclusions on a poster.

Grade 11



Assessment Standards

Analysing, synthesising, evaluating data and communicating findings

We know this when the learner is able to:

- Compare data and construct meaning to explain findings.
- Draw conclusions and recognise inconsistencies in the data.
- Assess the value of the experimental process and communicate findings.

Attainment is evident when the learner, for example:

- draws meaning from graphs;
 - explains findings;
 - in a 'paper', discusses possible variables that could influence the results.
- OR
- prepares and submits an article for the school newspaper or newsletter describing the research and findings on diarrhoea in the community.

Grade 12



Assessment Standards

Analysing, synthesising, evaluating data and communicating findings

We know this when the learner is able to:

- Critically analyse, reflect on and evaluate the findings.
- Explain patterns in the data in terms of knowledge.
- Provide conclusions that show awareness of uncertainty in data.
- Suggest specific changes that would improve the techniques used.

Attainment is evident when the learner, for example:

- analyses and reflects on data represented in graphs and other data, looks for evidence of the causes of respiratory problems, and evaluates experimental findings;
- presents a report to the class in which they communicate their findings;
- demonstrates an awareness of weaknesses in their design and possible inaccuracy of results, and proposes how they could improve their experiments.



Learning Outcome 2

Construction and Application of Life Sciences Knowledge

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

Note: Progression in this Learning Outcome is reflected in the increase in the number of concepts as well as the depth of understanding of some concepts, together with the establishment of links between different concepts to develop a well-organised knowledge base.



Assessment Standards

Accessing knowledge

We know this when the learner is able to:

- Use a prescribed method to access information.

Attainment is evident when the learner, for example:

- uses books and magazines to collect information on human nutrition.

Interpreting and making meaning of knowledge in Life Sciences

- Identify concepts, principles, laws, theories and models of Life Sciences in the context of everyday life.

Attainment is evident when the learner, for example:

- identifies structures and processes as food passes through the digestive system.

- Describe and explain concepts, principles, laws, theories and models.

Attainment is evident when the learner, for example:

- describes causes of various digestive problems (e.g. heartburn, gastric ulcers, irritable bowel syndrome, colon cancer, piles);
- explains the causes of nutrition problems (e.g. bulimia, anorexia, obesity, kwashiorkor, rickets, gout).

Grade 11



Assessment Standards

Accessing knowledge

We know this when the learner is able to:

- Use various methods and sources to access information.

Attainment is evident when the learner, for example:

- researches causes, effects and incidence of HIV/AIDS by making use of libraries, clinics, medical personnel, magazines and/or the Internet.

Interpreting and making meaning of knowledge in Life Sciences

- Identify, describe and explain concepts, principles, laws, theories and models by illustrating relationships.

Attainment is evident when the learner, for example:

- uses information or sources collected to describe and explain meaningfully causes and effects of HIV/AIDS;
- traces the source and incidence of the HIV/AIDS pandemic and its impact on society.

- Evaluate concepts, principles, laws, theories and models.

Attainment is evident when the learner, for example:

- evaluates different ideas on the cause of HIV/AIDS from information collected.

Grade 12



Assessment Standards

Accessing knowledge

We know this when the learner is able to:

- Use various methods and sources to access relevant information from a variety of contexts.

Attainment is evident when the learner, for example:

- searches for information on theories about the origin of life and about South Africa as the cradle of mankind by making use of various sources of information such as libraries, local people, the Internet and magazines.

Interpreting and making meaning of knowledge in Life Sciences

- Interpret, organise, analyse, compare and evaluate concepts, principles, laws, theories and models and their application in a variety of contexts.

Attainment is evident when the learner, for example:

- engages in debates regarding the origin of life;
- compares different theories regarding the origin of life and identifies their shortcomings;
- analyses and evaluates theories on changes in different species over time.



Learning Outcome 2 Continued

Construction and Application of Life Sciences Knowledge

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

Note: Progression in this Learning Outcome is reflected in the increase in the number of concepts as well as the depth of understanding of some concepts, together with the establishment of links between different concepts to develop a well-organised knowledge base.



Assessment Standards

Showing an understanding of the application of Life Sciences knowledge in everyday life

We know this when the learner is able to:

- Organise, analyse and interpret concepts, principles, laws, theories and models of Life Sciences in the context of everyday life.

Attainment is evident when the learner; for example:

- uses information or sources collected to describe and explain meaningfully the problems associated with health (e.g. heartburn).

Grade 11



Assessment Standards

Showing an understanding of the application of Life Sciences knowledge in everyday life

We know this when the learner is able to:

- Analyse and evaluate the costs and benefits of applied Life Sciences knowledge.

Attainment is evident when the learner, for example:

- writes a report on the impact of HIV/AIDS on the health and lifestyle of peers;
- makes suggestions and comes up with solutions for the HIV/AIDS problem.

Grade 12



Assessment Standards

Showing an understanding of the application of Life Sciences knowledge in everyday life

We know this when the learner is able to:

- Evaluate and present an application of Life Sciences knowledge.

Attainment is evident when the learner, for example:

- writes a report on how DNA can be used to identify the parents of a lost child.



Learning Outcome 3

Life Sciences, Technology, Environment and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.



Assessment Standards

Exploring and evaluating scientific ideas of past and present cultures

We know this when the learner is able to:

- Identify and investigate scientific ideas and indigenous knowledge of past and present cultures.

Attainment is evident when the learner, for example:

- investigates various home remedies for nutritional disorders.

Comparing and evaluating the uses and development of resources and products, and their impact on the environment and society

- Describe different ways in which resources are used and applied to the development of products, and report on their impact on the environment and society.

Attainment is evident when the learner, for example:

- describes the use and abuse of fossil fuels.



Learning Outcome 3
Continued

Life Sciences, Technology, Environment
and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.



Assessment Standards

Comparing the influence of different beliefs, attitudes and values on scientific knowledge

We know this when the learner is able to:

- Analyse and describes the influence of different beliefs, attitudes and values on scientific knowledge and its application to society.

Attainment is evident when the learner, for example:

- discusses the views of peers on cloning.

Grade 11



Assessment Standards

Exploring and evaluating scientific ideas of past and present cultures

We know this when the learner is able to:

- Compare scientific ideas and indigenous knowledge of past and present cultures.

Attainment is evident when the learner, for example:

- compares industrial production of fermented beer and/or food preservation in South Africa to the traditional method.

Comparing and evaluating the uses and development of resources and products, and their impact on the environment and society

- Compare different ways in which resources are used in the development of biotechnological products, and analyse the impacts on the environment and society.

Attainment is evident when the learner, for example:

- investigates the history of heart transplants;
- compares the new approaches to organ transplants.

Grade 12



Assessment Standards

Exploring and evaluating scientific ideas of past and present cultures

We know this when the learner is able to:

- Critically evaluate scientific ideas and indigenous knowledge of past and present cultures.

Attainment is evident when the learner, for example:

- critically evaluates ideas on parental care during early childhood in various communities (e.g. quarantine of mother and newborn baby immediately after birth).

Comparing and evaluating the uses and development of resources and products, and their impact on the environment and society

- Analyse and evaluate different ways in which resources are used in the development of biotechnological products, and make informed decisions about their use and management in society for a healthy, sustainable environment.

Attainment is evident when the learner, for example:

- differentiates, analyses and evaluates the impact of non-indigenous plants on the environment.



CONTENT AND CONTEXTS FOR THE ATTAINMENT OF ASSESSMENT STANDARDS

In this section content and contexts are provided to support the attainment of the Assessment Standards. The content indicated needs to be dealt with in such a way as to assist learners to progress towards the achievement of the Learning Outcomes. Content must serve the Learning Outcomes and not be an end in itself. The contexts suggested will enable the content to be embedded in situations which are meaningful to learners and so assist learning and teaching. The teacher should be aware of and use local contexts, not necessarily indicated here, which could be more suited to the experiences of the learners. Content and context, when aligned to the attainment of the Assessment Standards, provide a framework for the development of Learning Programmes. The Learning Programme Guidelines for the Life Sciences give more details in this respect.

Knowledge areas for the Life Sciences

In section on 'Scope' in Chapter 2, it was mentioned that knowledge in the Life Sciences is organised around the following four knowledge areas:

- tissues, cells and molecular studies;
- structures and control of processes in basic life systems;
- environmental studies; and
- diversity, change and continuity.

The section on Assessment Standards (above) provides levels of attainment as well as examples of how content and contexts could be used to attain the specified Assessment Standards. This section provides core knowledge and concepts to be used to attain the Assessment Standards of all three Learning Outcomes. This core knowledge covers 80% of the policy statement. The other 20% must be used by provinces and schools to adapt specified knowledge to local conditions or to incorporate local knowledge into the curriculum.

Certain factors must be kept in mind when the knowledge areas are used to attain the Assessment Standards. These are:

- The knowledge areas are neither Learning Outcomes nor Assessment Standards, but are vehicles to attain the Assessment Standards.
- The knowledge areas are applicable when dealing with all three Learning Outcomes. In each grade, every learner should be able to interpret and apply some of these knowledge areas in both familiar and unfamiliar contexts specified for that grade.
- The order in which the knowledge areas may be arranged is not fixed. However, care should be taken to ensure that, among others, the principles of progression and integration are adhered to. For example, knowledge, which is foundational to others, should be dealt with first.
- The knowledge areas have the same weighting.
- The Assessment Standards and not the knowledge areas determine the depth or level.

Grade 11



Assessment Standards

Comparing the influence of different beliefs, attitudes and values on scientific knowledge

We know this when the learner is able to:

- Compare scientific ideas and indigenous knowledge of past and present cultures.

Attainment is evident when the learner, for example:

- compares traditional and modern medicines in healing various diseases.

Grade 12



Assessment Standards

Comparing the influence of different beliefs, attitudes and values on scientific knowledge

We know this when the learner is able to:

- Critically evaluate and take a justifiable position on beliefs, attitudes and values that influence developed scientific and technological knowledge and their application in society.

Attainment is evident when the learner, for example:

- debates and takes a justifiable position on deforestation and its impact on certain communities and the environment.

Selecting core knowledge and concepts

It is impossible to study all knowledge and concepts in the Life Sciences. The criteria used to select core knowledge and concepts were derived from the Learning Outcomes and Assessment Standards, as well as the principles underpinning the National Curriculum Statement Grades 10-12 (General) (discussed in Chapter 1). In addition, the following factors were taken into consideration when selecting core knowledge and concepts:

- Foundational knowledge that builds on the General Education and Training band should be dealt with first. This will provide the basis for further knowledge to be dealt with in this band. For example, cell structure should be dealt with before genetic engineering.
- It should be possible to link the core knowledge areas to all known knowledge in the Life Sciences.
- Progression should be from simple to more complex knowledge with higher cognitive demands.
- Knowledge and concepts have been selected that have vast practical significance and relevance (e.g. natural products with possible indigenous knowledge system links to industry, nutrition, health and other sciences), and that build a foundation for future science careers and further learning.

Using core knowledge and concepts to attain Assessment Standards

The following steps are used to decide which knowledge and concepts to use to attain Assessment Standards:

- Identify the Learning Outcome(s) to be achieved.
- Identify the Assessment Standards to be attained.
- Decide on the knowledge areas to attain the Assessment Standards.
- Select or decide on the concepts to attain Assessment Standards.
- Decide on appropriate contexts and local knowledge to achieve Learning Outcomes.

This approach will ensure that teachers do not focus only on topics in their teaching, but will make the effort to achieve the Life Sciences Learning Outcomes.

The concepts for the four core knowledge areas are used to attain Assessment Standards in the Further Education and Training band. The core content builds on the knowledge, skills, attitudes and values developed in the General Education and Training band. The table below indicates concepts and skills for these core knowledge areas.

All concepts can be treated at varying levels of complexity; this is discussed in the Learning Programme Guidelines. The material below gives suggestions on how content may be linked to grade. Developers of Learning Programmes must use Assessment Standards to guide them in the way they use the content table in each grade.

Progressive deepening and broadening of integrated thinking patterns must be part and parcel of the gradual progression of Assessment Standards from Grades 10 to 12. These should be the driving tools for the

progression of the content demarcated for the different grades. The content is used to develop competences in all three Learning Outcomes of the Life Sciences. The skills related to Learning Outcome 1, as well as the issues related to technology, environment and society in Learning Outcome 3, are not directly linked or limited to any particular grade. They are interrelated and their usage depends on the Assessment Standards visited.

Content areas within Grades 10 -12

TISSUES, CELLS AND MOLECULAR STUDIES



Learning Outcome 1: Scientific Inquiry and Problem-solving Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.

Grades 10 - 12

- Research in a field of biotechnology (e.g. chemotherapy).
- Microscopic skills or other comparative methods and resources.
- Investigation of (community) diseases: conduct surveys, collect data (e.g. on fungal, viral, animal and plant diseases, genetic diseases).
- Collection of latest research information on diseases (e.g. malaria resistance, TB incidence in South Africa).



Learning Outcome 2: Construction and Application of Life Sciences Knowledge

The learner is able to access, interpret construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences

Grade 10

- Cell structure.
- Cell division (mitosis).
- Tissues.
- Related diseases (e.g. cancer).

Grade 11

- Micro-organisms (viruses, bacteria, protists and fungi):
 - diseases (e.g. rust, blight, rabies, HIV/AIDS, cholera, tuberculosis, malaria, thrush);
 - immunity.

Grade 12

- DNA, protein synthesis.
- Chromosomes, meiosis, production of sex cells, diseases (e.g. Down syndrome).
- Genes, inheritance, genetic diseases.

**Learning Outcome 3: Life Sciences, Technology, Environment and Society**

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

Grades 10 - 12

- Historical developments (e.g. discovery of genes and DNA).
- Ethics and legislation:
 - tissue culture;
 - cloning;
 - genetic engineering;
 - ethics.
- Indigenous knowledge systems and biotechnology:
 - micro-organisms and biotechnology in the food industry (e.g. cheese, beer);
 - traditional technology (e.g. traditional medicines and healers);
 - medical biotechnology (e.g. immunity, antibiotics, hormones like insulin);
 - genetic engineering and its use in medicine and agriculture (e.g. genetically-modified crops);
 - cloning;
 - DNA, fingerprinting and forensics.
- Beliefs, attitudes and values:
 - beliefs and attitudes concerning diseases;
 - genetic counselling.

STRUCTURE, CONTROL AND PROCESSES IN BASIC LIFE SYSTEMS OF PLANTS AND HUMANS



Learning Outcome 1: Scientific Inquiry and Problem-solving Skills

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

Grades 10 - 12

- Structure of systems:
 - investigation of kidneys, hearts and eyes through dissections;
 - other comparative techniques using models and charts.
- Experimental investigation (e.g. photosynthesis).
- Designing a model (e.g. anatomy of a system such as the digestive system).
- Microscope work (e.g. alveoli or stomata).
- Conducting research on any of the latest medical practices concerning life processes (e.g. heart transplants, laser surgery).



Learning Outcome 2: Construction and Application of Life Sciences Knowledge

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

Grade 10

- Energy release.
- Food production.
- Human nutrition and related diseases and allergies.
- Gaseous exchange and related diseases and allergies.

Grade 11

- Support (structural).
- Transport.

- Excretion.
- Nervous and endocrine systems.
- Related diseases of the above.
- Medical conditions (e.g. stroke, diabetes, hyperthyroidism).

Grade 12

- Reproduction and related diseases.



Learning Outcome 3: Life Sciences, Technology, Environment and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

Grade 10 - 12

- Historical developments: indigenous knowledge systems, biotechnology, environment, legislation, social behaviour, ethics and beliefs.
- Food manufacturing and preservation (indigenous knowledge systems and industry).
- Blood transfusion.
- Life support systems (e.g. dialysis, and organ transplant) and ethics.
- Sperm banks, surrogate motherhood, test tube babies, abortion and ethics.
- Sexuality, ethics and beliefs.

ENVIRONMENTAL STUDIES



Learning Outcome 1: Scientific Inquiry and Problem-solving Skills

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

- Investigation of human influences on the environment (e.g. introduction of exotic species).
- Management and maintenance of natural resources.
- Investigation of a local environmental issue, problem solving and decision making (e.g. managing rubbish dumps).

APPENDIX E

An example of Subject Framework for Life Sciences

University of Cape Town

Source: Western Cape Education Department (2005b). *Life Sciences – Resource for Educators, Subject Orientation 2005*. Cape Town: Western Cape Education Department.

CLASSROOM PRACTICE

Subject Framework

Subject Framework					
Main knowledge areas	Number of weeks (per year/grade)	Learning Outcome 1: Scientific inquiry & problem-solving skills All AS's covered All grades	Learning Outcome 2: Constructs and applies life sciences knowledge Possible knowledge concepts All AS's covered		Learning Outcome 3: Life Sciences, technology, environment & society All AS's covered All grades
Tissues, Cell and molecular study (24½ weeks for the FET phase)	8 weeks	o Microscopic skills or other comparative methods or resources	10	o Cell structure o Cell division (mitosis)	Historical developments: IKS, biotechnology, environment, legislation, social behaviour and ethics o Historical developments - History of microscopy applicable to discovery of cell, genes and DNA - Ethics and legislation: - Tissue sampling, tissue culture, cloning, genetic engineering & ethics o IKS and biotechnology: - Micro-organisms and biotechnology in the food industry e.g. cheese, beer. - Traditional technology e.g. traditional medicines & healers - Medical biotechnology e.g. immunity, antibiotics, blood transfusion - Genetic engineering and its use in medicine, agriculture e.g. genetically modified crops - Cloning - DNA, fingerprinting and forensics. o Beliefs attitudes and values - concerning diseases. - Genetic counseling
	6 weeks	o Research in a field of biotechnology eg <i>cell structure, tissue growth, chemotherapy</i>	11	o Tissues Related diseases e.g. cancer o Micro-organisms (viruses, bacteria, protists and fungi) - diseases e.g. rusts, blight, rabies, HIV/AIDS, cholera, tuberculosis, malaria, thrush - immunity	
	8 weeks	o Investigates (community) diseases: conducts surveys , collects data on eg. fungal, viral, animal and plant diseases; genetic diseases o Collects latest research information on diseases eg. malaria resistance, TB incidence in South Africa	12	o DNA, protein synthesis, o Chromosomes, meiosis, production of sex cells, diseases e.g. Down's syndrome Genes, inheritance, genetic diseases	

Structure and control of processes in basic Life systems (24½ weeks for the FET phase)	10 weeks	Structure of systems: - Investigate kidneys, hearts, eyes through dissections and/or other comparative techniques using models, charts - Experimental investigation eg. photosynthesis - Design a model : eg. Anatomy of a system such as the digestive system. - Microscope work e.g. alveoli or stomata - Conduct research on any of the latest medical practices concerning life processes eg. heart transplants laser surgery	10	o Energy release o Food production o Human nutrition & related diseases/ allergies Gaseous exchange & related diseases/ allergies	Historical developments: IKS, biotechnology, environment, legislation, social behaviour ,ethics and beliefs o Food manufacturing & preservation (IKS & industry) o Drug Influence o Hormones like insulin o Blood transfusion o Life support systems e.g. dialysis, and organ transplant and ethics o Sperm banks, surrogate motherhood, test tube babies, abortion & ethics o ultrasound for determining sex of the child, amniocentesis. o Sexuality, child-parental responsibility (parent as protector, provider and potential threat), ethics and beliefs
	11 weeks		11	o Support (structural) o Transport o Excretion o Nervous & endocrine systems o Related diseases of the above	
	4 weeks		12	o Reproduction & related diseases	
Environmental Studies (24½ weeks for the FET phase)	4 weeks	Investigate the human influences on the environment eg. Introduction of exotic Species Manage and maintain natural resources Investigate a local environmental issue, problem solving and decision making eg	10	o Biospheres, biomes and ecosystems o Living and non-living resources, nutrient cycles and energy flow within an environment	Historical developments: IKS, biotechnology, environment, legislation, social behaviour and ethics Exploitation vs. sustainability: Exploring issues o Industrialisation and impact of Industry & management. Management of resources, use and abuse of resources eg. Fossil fuel
	5 weeks		11	o Human influences on the environment - air, land and water issues o Sustaining our Environment o Air, land & water borne diseases	
	4 weeks		12	o Local environmental issues o Effect of pollutants on human physiology and health e.g. allergies	

Diversity, Change, and continuity (24½ weeks for the FET phase)	6 weeks	investigation on plants and animals-comparison Analyse given data & findings to evaluate growth and behavioural issues among population Measure population growth using different techniques	10	o Biodiversity of plants and animals and their conservation o Significance and value of biodiversity to ecosystem function and human survival o Threats to biodiversity Parasitism, diseases. E.g. Bilharzia	Historical developments: IKS, biotechnology, environment, legislation, social behavior and ethics Adaptation & Survival Sustainable development History and nature of science Extinction of species, red data listing and endangered species Fossils records, museum, zoo's Population changes over time Belief about creation and evolution Changes of knowledge through contested nature and diverse perception of evolution
	6 weeks	Collect and analyse data on specific community diseases that will impact on population vigour dynamic) Analyse and evaluate any specific human behaviour that will influence population growth Collect and analyse data on evolutionary trends in a population e.g. Human beings	11	o Population studies - characteristics of populations, population growth, fluctuations, limiting factors o Social behaviour - predation, competition, o Managing populations	
	5 weeks		12	o Origin of Species o Evolution theories, mutation, natural selection, macro evolution and speciation o Fundamental aspects of fossil studies o Cradle of mankind - South Africa? o Biological evidence of evolution of populations □ Popular theories of mass extinction	

APPENDIX F

An example of a Work Schedule for Life Sciences

University of Cape Town

Source: Western Cape Education Department (2005b). *Life Sciences – Resource for Educators, Subject Orientation 2005*. Cape Town: Western Cape Education Department.

EXEMPLAR WORK SCHEDULE PER GRADE

Grade 10 Work schedule

Learning outcomes & assessment standards	Number of weeks	Main knowledge areas	Knowledge concepts	Concepts, attitudes and values on interrelationships of life sciences, environment and society	Teaching strategies	Resources	Assessment Strategies
LO1 LO2 LO3 All assessment standards	8 weeks	Tissues, cell and molecular study	<ul style="list-style-type: none"> ➤ ✓ cell structure <i>LO1 A1, 2</i> ➤ ✓ cell division (mitosis) <i>LO2 A1, 2</i> ➤ tissues related <i>LO2 A2</i> ➤ ✗ diseases e.g. Cancer 	Historical developments: IKS, biotechnology, environment, legislation, social behaviour and ethics <i>LO3 A1</i>	Microscopy work, research, excursions, group work, experimental work, case studies, problem solving, interviews, questionnaires, guests talks, career opportunities	Charts, brochures, videos, microscopes, textbooks, reference books, recycled materials, food labels and containers, computer software, internet programmes, ohp, transparencies, life sciences kits, micrographs	Rubrics, tests, portfolio work, class work, homework, practical work, projects, data and oral presentations, reports, posters, interviews, peer assessment, self assessment, <i>Microscope study Project on</i>
LO1 LO2 LO3 All assessment standards	10 weeks	Structure and control of processes in basic life systems	<ul style="list-style-type: none"> ➤ energy release food production <i>LO1 A1, 2, 3</i> ➤ human nutrition & related diseases/ allergies gaseous exchange & related diseases/ allergies <i>LO2 A1, 2</i> 	• drawing of the membrane • drawing of cells			
LO1 LO2 LO3 All assessment standards	6 Weeks	Environmental studies	<ul style="list-style-type: none"> ➤ biospheres, biomes and ecosystems ➤ living and non-living resources, nutrient cycles and energy flow within an environment 				

RESOURCES: FET LIFE SCIENCES

Historical cultural graph

Research project on one of the domains - ACP lung cancer substrate abuse

APPENDIX G

An example of a Lesson Plan for Grade 10 Life Sciences

University of Cape Town

Source: Western Cape Education Department (2005b). *Life Sciences – Resource for Educators, Subject Orientation 2005*. Cape Town: Western Cape Education Department.

Check-list of principles for creating a work schedule / learning activity

Component	Yes	No
Outcomes driven		
Assessment standards driven		
GET linkage indicated		
Indigenous Knowledge Systems		
Prior Beliefs/Knowledge		
Human Rights Inclusivity		
Attainment of assessment standards: Formative *		
Attainment of assessment standards: Summative*		

CLASSROOM PRACTICE: LESSON PLANS

Exemplar Lesson Plans

Teacher :	Grade:	School:			
Focus learning outcome	Commit to outcome(s) LO 1				
Integrated Life Science learning outcomes					
Learning outcomes and Assessment standards	LO 1	AS1	AS2	AS3	
	LO 2	AS1	AS2	AS3	
	LO 3	AS1	AS2	AS3	
Integrated learning outcomes from other subjects					
Knowledge area					
Prior Beliefs					
TEACHER ACTIVITIES	LEARNER ACTIVITIES	RESOURCES	ASSESSMENT METHODS	TIME	

Expanded opportunities	Enrichment
Special needs	Homework

LESSON PLAN: IS EUGLENA A PLANT OR AN ANIMAL, BOTH OR NEITHER?

Educators: Quinton Terhoven & Tommy Botha	Grade: Grade 10	School: Cape Academy for Science, Mathematics and Technology (WCED)		
Learning outcomes	LO 1: Scientific inquiry and problem-solving skills LO 2: Construction and application of Life Sciences knowledge			
Focus assessment standards	AS 3: Analysing, synthesising, evaluating data and communicating findings AS 2: Interpreting and making meaning of knowledge of Life Sciences AS 3: Showing an understanding of the application of Life Sciences knowledge			
Learning outcomes and assessment standards	LO 1	AS1	AS2	AS3
	LO 2	AS1	AS2	AS3
Integrated learning outcomes from other subjects	Languages: LO 3 Writing and Presenting (an essay and/or letter) AS 3: Reflects on, analyses and evaluates own work, considering the opinion of others, and presents final draft			
Knowledge area	Tissues, Cells and Molecular Studies			
Prior learning	<ul style="list-style-type: none"> ➤ Cell Theory, Plant and animal cells ➤ Concepts such as analysis, evaluating, inference, elements of argumentation, such as, claims, counter-claims, warrants, backing, rebuttals, consensus ➤ PowerPoint Slides explaining the elements of an argument 			
Where the lesson fits in	This lesson could be part of the work schedule for Grade 10 in the first term: <ul style="list-style-type: none"> ➤ Knowledge Area: Tissues, Cells and Molecular Studies ➤ Addressing LO 1 Scientific inquiry and problem-solving skills, and ➤ LO 2: Construction and application of Life Sciences knowledge 			
TEACHER ACTIVITIES	LEARNER ACTIVITIES	RESOURCES	ASSESSMENT METHODS	

<p>Overview Create the opportunity for learners to explore and evaluate evidence presented by teachers to argue whether the organism is a plant, an animal, both or neither.</p>	<p>Learners able to construct claims and counter-claims for Euglena being either a plant or an animal, construct warrants and backings to support claims, construct rebuttals, and communicate findings.</p>	<p>Video clip/ electron microphotograph of Euglenas Worksheets with instructions and data about Euglena PowerPoint Slides</p>	<p>Assessment for learning – interventions by teacher during groups' discussions and feedback Assessment of learning – Individual summary of findings to classify Euglena with claims, counter-claims, warrants and backings</p>	
TEACHER ACTIVITIES	LEARNER ACTIVITIES	RESOURCES	ASSESSMENT METHODS	TIME
<p>Setting the scene/Context Explain the outcomes of the activities Clarify instructions. Show video clip/ transparency to provide a visual stimulus to motivate learners to engage in the argument.</p>	<p>Study the worksheets, which include text, instructions, drawings, electron micrographs.</p>	<p>Worksheet that includes drawings and electron micrographs Video clip: http://bio-101-104.biocornell.edu/BioG101_104/tutorialsprotista/movies/Euglena.MOV</p>	<p>Assessment for learning – using leading questions</p>	<p>10 min</p>
<p>Main activity Stress the importance of making claims with warrants / backings. Divide into groups (max. 4). Explain the role of each member of the group. Interventions: Keep learners focussed. Summary on writing board by teacher during feedback by learners – encourage the groups to rebut each other's argument by providing evidence that would counter their position. The teacher can use</p>	<p>Learners are asked to work individually and then in groups. Each group has to study and use the worksheets and evidence cards to synthesise claims and counter-claims with warrants and backings. Their findings should be summarised on the worksheet. Feedback: Each group must give feedback during the plenary. Follow-up/Homework Each individual writes an article giving a detailed account of their claims and counter-claims with warrants</p>	<p>Worksheets that include text, drawings, and instructions and electron micrographs Cards with evidence</p>	<p>Assessment for learning: Informal - during small group interventions – verbal feedback to improve learning and to keep learners focussed Assessment of learning by teacher: Criteria: ➤ Claims ➤ Counterclaims ➤ Data linked to claims</p>	<p>30 - 40</p>

<p>leading questions such as "What information would you use to prove that this argument is not true?"</p>	<p>and backings. The learner must place the detailed account in his/her Life Sciences' portfolio.</p>		<ul style="list-style-type: none"> ➤ Warrants ➤ Backings ➤ Rebuttal <p>Use a rubric to assess the summary.</p>	
<p>Expanded opportunities / Special needs</p> <p>Provide learners with worksheets with data about other single cell organisms. Learners must make a summary of their claims and counter-claims with warrants and backings.</p>				
<p>Reflection by teachers and learners</p> <p>Feedback on the lesson by teachers. Consolidate the elements of argumentation skills and discuss the protists group briefly by referring to algae, protozoans, etc., classification before the advent of modern biochemistry and electron microscopy. Learners complete their journal – metacognition (thinking about their own thinking).</p>				

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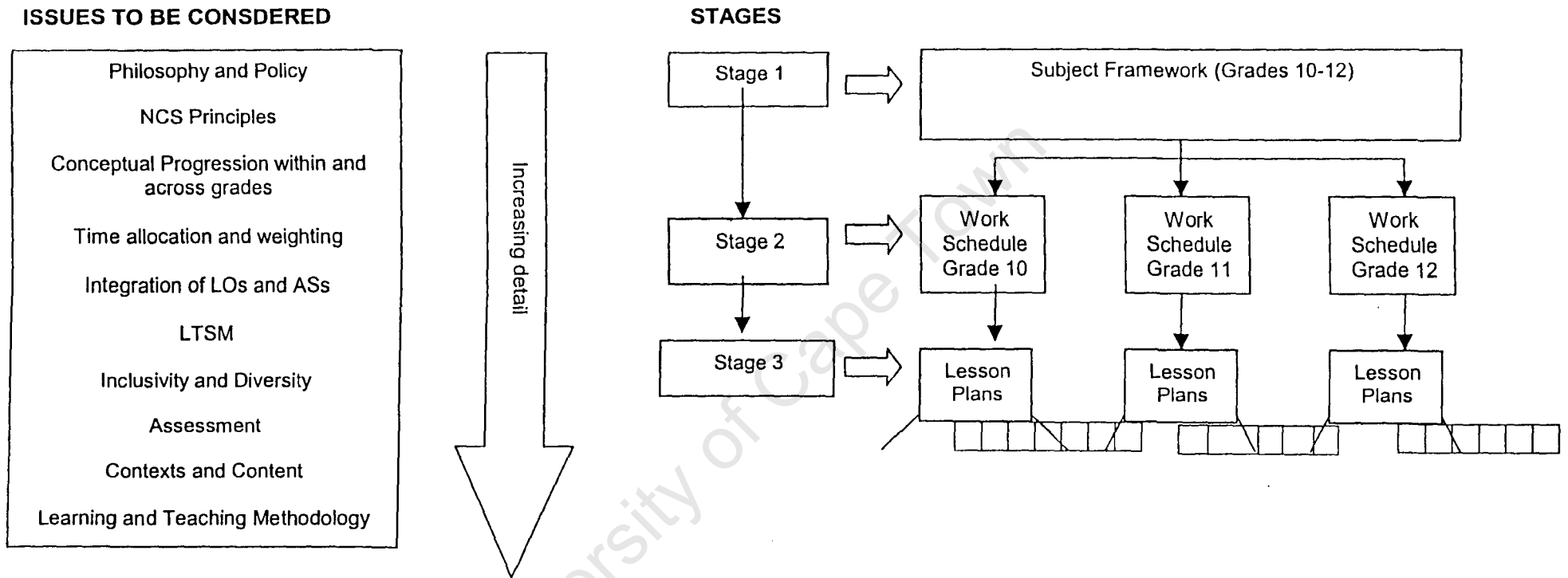
APPENDIX H

A flow-chart indicating the relationship between the three stages of planning when developing a learning programme

University of Cape Town

Source: Western Cape Education Department (2005a). *Physical Sciences – Resources Pack, Subject Orientation 2005*. Cape Town: Western Cape Education Department.

FIGURE 1: RELATIONSHIP BETWEEN THE 3 STAGES OF PLANNING WHEN DEVELOPING A LEARNING PROGRAMME



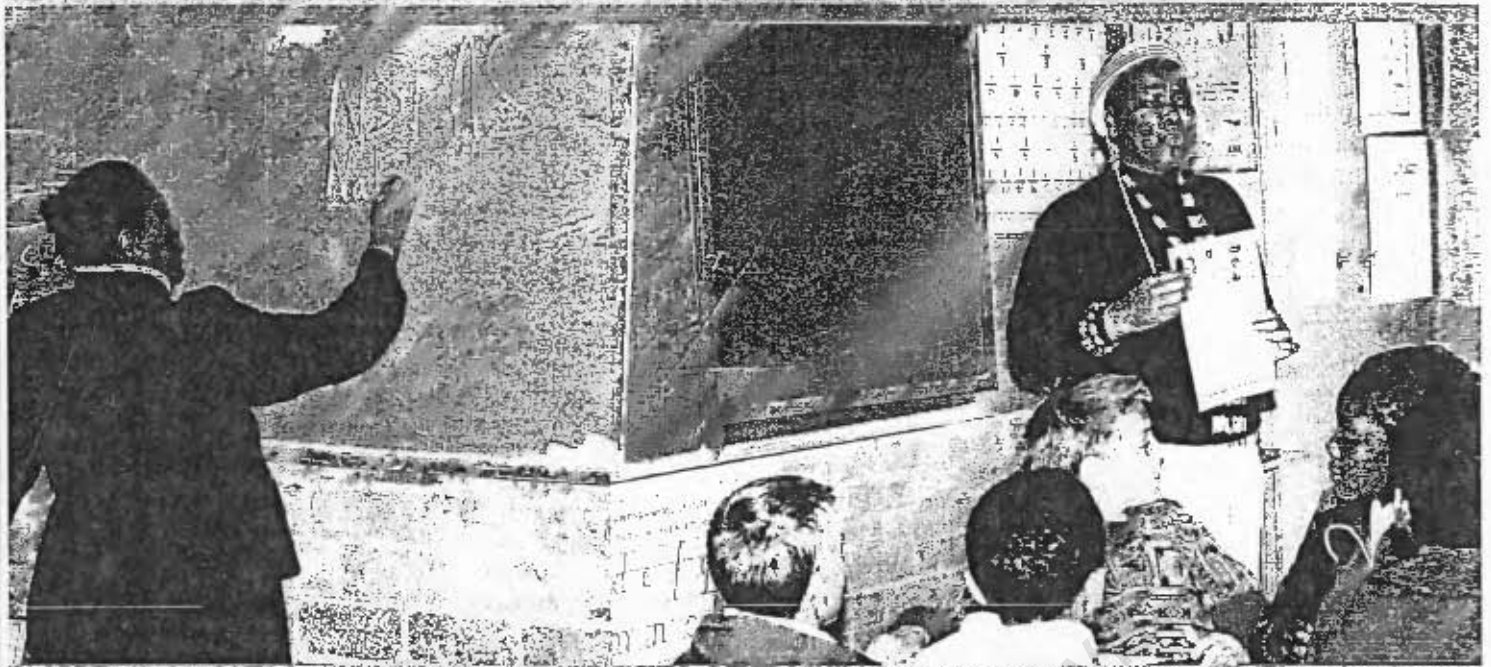
APPENDIX I

Relevant Extracts from the National Education Framework

University of Cape Town

Source: Department of Education (2005). *A National Framework for Teacher Education – Report of the Ministerial Committee on Teacher Education*. [Online]. Available on <http://education.gov.za> [2005, 16 December].

Report of the Ministerial Committee on Teacher Education



A National Framework for Teacher Education in South Africa

16th June 2005



education

Department
Education
REPUBLIC OF SOUTH AFRICA

SECTION A

Terminology and conceptual orientation

Some of the key problems we face can be traced back to terminological and conceptual confusions in the way we think about, plan and organise the education system, and consequently teacher education. Such problems are exacerbated in a multilingual context. The Framework is based on a definite understanding of teaching, a professional teacher, teacher education, the difference between career paths and development tracks, distinctions between NQF Credits and Professional Development Points, and the Registration and Licensing of teachers.

Teaching

Teaching is the practice of organising systematic learning, and it is at the core of any educational system.

Apartheid schooling and resistance against it, coupled with a (romantic) 'progressivist' theory (with its replacement of 'teaching' by 'facilitation') have served to undermine the key rôle of teaching in schooling and education.

To replace the word 'teacher' with the word 'educator' - used to cover a range of rôle players in the education system - is to risk losing sight of the very practice that is the *raison d'être* of the whole system. The term 'educator' homogenises the distinctive rôles of the range of staff within the education system, and, thus, leads to a lack of a clear focus on the defining purpose of education - purposefully to foster systematic learning. Such homogenising might have served political purposes related to levelling hierarchies between different post levels, but what it has done is to distract attention from the core function of any schooling or education.

The defining purpose of all other posts within an education system is to support the central purpose of the system, namely, teaching and learning. Managers need to manage; administrators need to administer; and teachers need to teach. The rôle of managers and administrators is to sustain enabling conditions for teaching and learning to flourish.

Recommendation A1

Retrieve the word 'teaching', understand it as the practice of organizing systematic learning, and relocate it at the heart of how we think about, plan and organize the education system.

Professional Teacher

A professional teacher is a person with the educated competences and abiding commitments needed to engage successfully in the professional practice of teaching. A professional teacher is characterised more by a commitment to the ideals of the profession, and flexible competences to pursue those ideals in a variety of circumstances, than by mere obedience to the legitimate requirements of an employer.

The practice of teaching is a situated and interpretative contextual practice. Although this practice does involve skills and routines, it cannot be reduced to skills and routines. Variations in what the exercise of this practice involves are dependent on variable contextual realities that include the level of the learners and the socio-historical, political contexts of practice. Expert teaching involves making situated, interpretive judgments, and this is one reason for saying that it is a professional practice.

SECTION A

Despite the undisputed differences between teaching different classes of learners in different learning sites and different circumstances, the use of different labels to differentiate between 'educators', 'practitioners', and 'lecturers' disrupts the coherence of the system, marginalizes some parts of the system, and reinforces hierarchies of status. Professional teachers in the ECD, ABET, GET, FET and HE phases and bands are all, by definition, engaged in the practice of organising systematic learning. To lose sight of this fact in our labelling system is in conflict with the goal of achieving an integrated national education and training system.

Recommendation A2

Accept that professional teachers are the essential resource of the education system, and configure our programmes of teacher education (IPET & CPTD) and support systems to reinforce the professional competences and commitments of teachers.

Teacher Education

Teacher education is a form of professional education that has as its defining purpose to improve the professional practice of teachers.

Teacher education should be conceived of as a continuum without sharp breaks. However, there are important differences between the Initial Professional Education of Teachers (IPET) and Continuing Professional Teacher Development (CPTD). The conventional distinction between 'pre-service' and 'in-service' teacher education does not serve our purposes well. There are many currently serving teachers who have not yet reached minimum qualification levels; and, given the history of teacher education in our country and goals for the transformation of our education system, CPTD needs to be given much higher prominence in our conception of teacher education.

The defining purpose of IPET is to prepare a person to reach the threshold of competent participation in the teaching profession - it involves the initial development of the basic competences and commitments characteristic of this profession. The defining purpose of CPTD is to enable teachers continually to revitalize and improve their professional practices. In our teacher education system at present IPET is the responsibility of public HEIs, but their rôle is contested. And CPTD is left to the haphazard and un-coordinated interventions of a variety of providers.

Recommendation A3

Conceive of teacher education as a continuing process with two main parts (IPET and CPTD) each of which needs to be conceived of as a coherent system with overlapping but different main purposes.

Career Paths and Development Tracks

A failure to distinguish between career paths (in a system of employment) and personal development tracks leads to confusion about the purposes and nature of both CPTD and postgraduate study in the field of education.

Career paths conceive of teachers as employees in an education system, and provide promotion routes within that system. It is unfortunate that traditionally the main promotion routes in the education system are promotion out of teaching, and into management, administration or 'special services'.

SECTION A

Career pathing is an important way of shaping the career trajectories and aspirations of teachers employed in the public education system. Furthermore, clearly conceptualised and operationalised career paths can make an important contribution to the morale of teachers⁶. ELRC Resolution 8 (of April 2003) recommended four career paths, including a new career path: **Teaching & Learning**. This resolution is to be welcomed as a way of providing material rewards for good teachers to remain in teaching, rather than to aspire to move out of teaching into some other rôle in the education system. The **Teaching & Learning** career path should be exploited by employers as a way of emphasizing the essential rôle of teaching in the whole system, rewarding teachers who remain in this rôle, and of developing a core of expert teachers who can begin to serve as on-site mentors for novice teachers.

Development tracks conceive of teachers as members of an educated profession. They are forms of personal enrichment rather than being linked to promotion routes within an education system. Development tracks are lines of development for individuals, and they may or may not be parallel to their career paths.

In the field of education there are two formal development tracks - a professional track and an academic track, and to fail to distinguish clearly between them is bad for both professional education and the academic study of education. These tracks are not entirely distinct from each other, but they differ in relation to their defining goal. The professional track is concerned with improving professional practice and it leads towards the goal of excellence in that practice; the academic track is concerned with the rigorous study of education and it leads towards the goal of engaging in higher level research and study in the field of education. The distinction between these two tracks is of major significance in relation to formal qualifications and programmes in the field of education⁷.

Recommendation A4

Emphasize the teaching & learning career path, and distinguish between career paths for educators, and the two personal development tracks (namely, the **professional** and **academic** development tracks), while acknowledging that there is some relationship between them.

NQF Credits and PD Points

NQF Credits are 'permanent'; they are recorded on the SAQA National Learners Record Database. By contrast, PD Points have a limited shelf-life, and they are based on the idea of life-long learning as a continuing process of renewal. The proposed PD Points system⁸ **complements** the NQF Credit system - it does not replace it.

The National Qualifications Framework is a system for registering qualifications (and unit standards), and recording the learning achievements of learners in terms of those qualifications (and unit standards). It was conceived of as a comprehensive system to encompass all learning achievements in any contexts for any purposes. Such a purpose has proved to be over-ambitious (there are forms of learning not capturable on an NQF) - and this is especially important in relation to Continuing Professional Teacher Development (which encompasses more than formally registered kinds of learning.)

⁶It is notable that one reason provided by teachers for considering leaving the profession is lack of career advancement and recognition. (See ELRC Report *Potential Attrition in Education* (2005))

⁷See Appendix 4.

⁸See Section C below.

SECTION A

Contributions to the professional development of teachers can be of a wide variety of kinds, from a range of different sources. Some are once-off interventions, many are short training programmes, some are linked to further formal qualifications, some are specifically designed to introduce teachers to new policies, etc. Currently there is no system to recognise this range of activities or to reward teachers for engaging in them.

This Report argues that many activities that are legitimately understood as contributing to the professional development of teachers are not suitable or appropriate to be registered on the NQF, and awarded NQF Credits. It, thus, recommends the development of a **CPTD system** centred around the idea of a register of endorsed professional development activities allocated Professional Development Points. An endorsed PD activity will be allocated PD Points, and it may or may not also earn the learner NQF Credits. A prime example of this could be an ACE⁹ programme which could earn a teacher **both** PD Points and NQF Credits.

Recommendation A5

Distinguish between NQF Credits and PD Points, while acknowledging that there are some learning activities that can earn both.

*Registration and Licensing*¹⁰

No educator is permitted to be employed as an educator unless they are registered with the South African Council for Educators (SACE). A professional qualification at at least the level of M+3¹¹ (REQV 13) is a requirement for Registration. Registration is relatively permanent; an educator can be deregistered only if they commit a criminal act or contravene some part of the *SACE Code of Professional Ethics*. This Report recommends that the SACE establish a special form of Registration to be called a 'Licence'. A minimum qualification for being Licensed is the possession of an Advanced Diploma in Education¹².

Unlike ordinary Registration a Licence will not be 'permanent', its retention would depend on regulations established by the SACE, and particularly the earning of a specified number of PD Points in cycles of three years. The suspension of an educator's Licence would not affect their employment status, but the possession of a current Licence is expected to provide benefits, such as better prospects for promotion. In addition the existence of a category of Licensed Educator would establish a benchmark (at REQV 14) for full status as a professional teacher.

Recommendation A6

Request the SACE to recognise a distinction between Registered and Licensed Educators, and establish a category of Licensed Educator within the broader category of Registered Educator.

⁹ See Appendix 4b. It is proposed that the ACE be renamed an Advanced Diploma in Education (Specialisation).

¹⁰ See Section E2 below. The introduction of sanctions related to maintaining a Licence has been a contentious issue with the teacher unions, and a concern of the DoE. However, this concern reflects more the concern with the consequences of teachers' losing their Registration, which has the negative sanction of rendering them legally unemployable in schools. The Framework does not recommend that teachers will be debarred from employment if they lose their Licence. Teachers may have their Licence suspended or revoked, but continue to be employed as registered teachers. Positive sanctions for retaining one's Licence are that it constitutes evidence of one's engagement with continuing professional growth, and it improves one's eligibility for promotion within the system. This encourages all teachers to engage in CPTD as a form of lifelong learning. A clear distinction between the consequences of de-registration and de-licensing needs to be made.

¹¹ See *Criteria for the Recognition and Evaluation of Qualifications for Employment in Education Based on the Norms and Standards for Educators*, 2000. Explanatory Notes, Point 2 (second bullet)

¹² See Appendix 4b for a description of the proposed Advanced Diplomas in Education.

SECTION B

Initial Professional Education of Teachers (IPET)

The education system requires a steady flow of newly qualified teachers. Normal attrition out of the system runs at between 5 and 5.5%¹³ per annum, and in our case this implies that we need about 20 000 newly qualified teachers per annum¹⁴. We do not know how the HIV and AIDS pandemic will affect this figure. Currently we are producing, at best, between 5000 and 7000 new teachers per annum¹⁵, and this indicates that we will face severe shortages in the medium to longer term.

Over the past several years Faculties of Education have had some difficulty in recruiting students for their initial teacher education programmes and this has had a severe impact on the maintenance of their capacity to continue to provide quality initial teacher education programmes. In many Faculties as many as 50% of staff are employed on temporary contracts. The low subsidy level of initial teacher education programmes does not provide a sufficient incentive for HEIs to give more weight to their responsibilities for teacher education.

Moving initial teacher education from Colleges of Education to Higher Education Institutions has impacted particularly negatively on the capacity of the system to train Grade R and Foundation Phase teachers, including the teaching of basic literacy and numeracy, and the rôle of mother tongue teaching at the early stages of schooling. In general, the institutional capacity of the system to train Foundation and Intermediate Phase teachers has deteriorated.

Traditional full-cost loans for initial professional education of teachers (IPET) are no longer readily available; the costs to individuals (and their families) - in terms of both direct costs and lost income - are a serious barrier to potential teacher education students. One consequence of the incorporation of Colleges of Education into HEIs is that teacher education provisioning has become more centralised, predominantly in urban settings, and less accessible to rural students. This has increased the costs to individuals to study to become teachers¹⁶, in terms of the need to factor in travel, living expenses and accommodation costs. The majority of students in Foundation Phase teacher education programmes are female and white. In short, IPET programmes have become too expensive for the majority of traditional teacher education students, and, as an additional disincentive, prospects of employment for newly qualified teachers have decreased. There is no system of service contracts, which traditionally provided some security of employment after initial training.

Recommendation B7

Reinforce and consolidate the rôle of public HEIs as the principal providers of Initial Professional Teacher Education programmes, provide adequate funding, and nurture their capacity to fulfil this responsibility.

Important as it is (especially in our context in which many students have less than satisfactory schooling backgrounds) the initial professional education of teachers involves more than gaining a formal qualification. The practice of launching novice teachers into employment without explicit on-site induction is unsatisfactory, and we need to conceptualise IPET as having two closely linked phases: formal qualification and site-based induction.

¹³ See Crouch and Perry "Educators", Chapter 21 in HSRC (2003) *Human Resources Development Review 2003*.

¹⁴ The ELRC study: *Factors Determining Educator Supply and Demand in South African Public Schools* (2005), found that the HIV positive prevalence rate for currently serving educators is 12.7%, and that, on average at this time, 21 000 educators leave the system annually.

¹⁵ These figures are drawn from self-reports from the Deans of Education. One of the difficulties in achieving accuracy here is that it is unknown how many students in initial teacher education programmes are already-serving teachers.

¹⁶ This is particularly important in the light of the social classes from which teachers are traditionally drawn.

SECTION B

IPET should be understood as including formal intellectual development (including the consolidation of the basic tools for learning, and challenging embedded assumptions about teaching), nurturing a commitment to the ideals of the profession, and training for specific tasks as a teacher in particular institutional contexts. But it should also be understood as including on-site induction into the situated contexts of practice. During induction novice teachers should be employed as registered teachers, and this employment should also be regarded as probation. IPET should, thus, be understood as consisting of two phases leading to registration as a Licensed Professional Teacher.

Recommendation B8

Conceptualise the IPET system as having two phases:

Initial formal **qualification**, including practical internship - leading to Registration with the SACE;
Formal school-based **induction** - leading to Licensing by the SACE.

The policy¹⁷ of replacing the previous range of Certificates and Diplomas with Degrees for initial teacher education had as its central intention to improve the quality of professional teacher education. This is an improvement that we still need to accomplish.

But a four-year full-time (480 NQF Credit) BEd is too costly for a high proportion of teacher education students and their families and communities. A three-year degree programme, followed by a year of formal induction during which the novice teacher would be employed and paid a salary, would reduce the costs to individuals and their supporters. As teacher shortages - especially in particular Phases and Learning Areas or particular locations - increase, there is a tendency to employ un- or under-qualified teachers¹⁸, and to find non-HEI based forms of initial teacher education. But these tendencies should not be welcomed if we support the ideal of improving the quality of education for all.

De facto many HEIs currently design the fourth year of their BEd programme as school-based. This is, indeed, an acknowledgement of the key contribution of site-based training in an IPET programme. However there are two problems. One is that whether or not the fourth year is linked to a 'learnership', there are many cases in which novice teachers become simply exploited labour, with little time or energy to engage well with the expectations of the HEI. Another is that because it is not a formally specified part of the IPET programmes both schools and HEIs find it difficult to conceptualise their joint rôle and shared responsibilities, and many novice teachers are simply left to their own devices. The building of capacity, and its link to defined responsibilities of mentor teachers during the induction phase of IPET are acknowledged as important elements in the viability of the following recommendation.

Recommendation B9

Establish the BEd (360 NQF Credits) and an Advanced Diploma (Education: Induction) (120 NQF Credits) or another appropriate degree and an Advanced Diploma (Education: Postgraduate) as the basic IPET qualifications¹⁹.

¹⁷ As recommended in the *Norms and Standards for Educators* (DoE 2000)

¹⁸ Which is a way in which Provincial Departments of Education can reduce the percentage of their budgets for personnel costs!

¹⁹ See Section E2 and Appendix 4 - which spell out the details of this recommendation.

SECTION B

Provincial Departments of Education (PDEs) persistently complain that HEIs do not prepare teachers well for the tasks of school teaching; and there are very few examples of genuine partnerships between schools (the world of schooling) and HEIs (the world of formal teacher education). Part of the explanation is the persistence of a traditional conception of 'pre-set' as producing a 'qualified' teacher needing little more than a bit of unsupported experience to become an expert teacher.

The success of the on-site phases of initial teacher education rests on the quality of the supervision of novice teachers during 'practical internship' and the quality of the mentoring they receive during induction. But in our context - partly because of the chronic overloading of teachers (including the lecturers in Faculties of Education) - there is, in general, a lack of a tradition of effective supervision and mentoring of novice teachers.

In addition, the success of an induction year will depend on HEIs continuing to be allocated a normal subsidy for the fourth year of training, and PDEs supporting this phase of IPET, and, in particular, agreeing to the formal employment of novice teachers during their induction.

Recommendation B10

Develop effective partnerships²⁰ between HEIs, schools and PDEs as a condition for the success of the initial professional education of teachers.

The delivery of initial teacher education programmes should be expanded beyond an exclusive focus on face-to-face teaching modes²¹. Such a teaching mode is labour-intensive, and, thus, expensive. This is not to cast doubt on the importance of face-to-face teaching, especially where the lecturers are themselves good teachers. But it is to say that face-to-face teaching should be seen as only one element in the design of quality IPET programmes.

Developments in 'distance education'²² contain many lessons for more conventional modes of delivery, and the expertise in Faculties of Education should be well-placed to think more imaginatively about their modes of delivery in IPET programmes²³. This is especially crucial in the light of the high (institutional) costs of IPET programmes, and the considerable distance, in many cases, between the campus of the HEI, and the schools and other sites of learning in which novice teachers will be located for the Induction phase of their programmes²⁴.

It has to be acknowledged that as part of a survival strategy, some Faculties of Education have become embroiled in 'distance' or 'semi-distance' modes of delivery based on poorly-designed and inappropriate learning material, and inadequate attention to the quality of support provided for novice teachers by the school and the HEI. But these unsatisfactory developments are not sufficient reason for Faculties of Education not to pioneer responsible alternative modes of delivery for IPET programmes.

Recommendation B11

Encourage HEIs to explore less costly and less labour intensive but higher quality modes of offering teacher education programmes.

²⁰ A partnership is a relationship between equals in which no partner is dominant.

²¹ A project such as MINDSET needs to be much more firmly integrated into the regular teaching in schools, and incorporated into teacher education programmes. The OLSET project is a radio-based learner support programme that is simultaneously a form of in-service teacher training. It provides a model that could be considered for mainstreaming in the schooling system.

²² See the CHE Report: *Enhancing the Contribution of Distance Higher Education in South Africa* (September 2004)

²³ Reluctance of Faculties to move in this direction is partly an outcome of the way in which if their programmes get reclassified as 'distance' programmes they would earn only 50% of the subsidy.

²⁴ About half of current IPET students are registered with Unisa.

SECTION B

Perhaps as a reaction to the excessive prescription of teacher education in the past there has been an excessive concentration on the personal development of teachers. But this swing of the pendulum can have the effect of prioritising 'teacher performance' without due attention to teachers' contribution to learner achievement. The constitutive goal of teacher education is the development of teachers with the capacity and commitment to enhance the quality of students' learning. Teacher education programmes do indeed need to acknowledge students' personal embedded images of what teaching and learning entails, their biographical histories and their levels of subject matter expertise, but this is only the starting point for the development of their competence in the practice of organising systematic learning.

It has to be acknowledged that many students in initial teacher education programmes have very poor levels of (print) literacy and numeracy. IPET programmes need to focus sharply on this issue, and emphasize the development of student teachers' levels of literacy and numeracy across the whole curriculum, if for no other reasons than to enable teachers to continue to learn from reading.

Few teachers are well prepared to cope with HIV and AIDS in learning sites, or have a clear appreciation of the growing impact of the pandemic on education and the schooling system. But teachers are at the sharp edge of the pandemic, increasingly having to cope on a daily basis with its impacts on school organisation, colleagues, learners and communities. As a matter of urgent priority IPET programmes need to equip future teachers with the emotional, social and practical competences to cope with the effects of the pandemic in learning sites.

Newly qualified teachers are frequently criticised²⁵ for being under-prepared in the knowledge content of the subjects / learning areas they teach. Perhaps some interpretations of OBE and the valorisation of 'learner-centred education' have contributed to the under-emphasis on content knowledge, and the ability to make it accessible to learners. But whatever the reason, it is clear that no-one can teach something they themselves do not know, and a re-emphasis on the key importance of content knowledge, especially in the formal qualification phase of the IPET programme, is needed at this time.

Initial teacher education materials tend to over-emphasise theoretical rather than practical strategic actions that novice teachers require. Learning material (print, electronic, etc.) that targets the kinds of challenges and practical interventions possible for novice/newly qualifying teachers in resource-scarce institutional settings is not widely available.

There are many policies with which one might ideally expect beginning teachers to be familiar, but it would be an error to expect IPET programmes to have as one of their goals the development of policy experts. IPET students should, as a matter of course, become familiar with the broad constitutive goals of relevant education and other policies such as the Inclusive Education Policy, the Language in Education Policy and *The Constitution*. However, National Curriculum policies²⁶ have a different status in IPET programmes, and such programmes should include teaching student teachers how to be responsive to such policies in various contexts.

Finally, IPET programmes need to promote critical engagement with the SACE *Code of Professional Ethics*, and develop an understanding of how that Code will frame their membership of the teaching profession.

²⁵ See Taylor & Vinjevold (eds) (1999) *Getting Learning Right: Report of the President's Education Initiative Research Project (JET)*

²⁶ In the case of GET the *Revised National Curriculum Statement* is the ruling policy, but in other phases and bands there are other curriculum policies.

SECTION B

Recommendation B12

Encourage HEIs to prioritise the following in their teacher education programmes:

- o The development of students' literacy and numeracy.
- o A definite focus on HIV and AIDS - including the development of an informed understanding of the pandemic and its impacts on schooling and community life, and the competences to cope responsibly with the effects of the pandemic in learning sites.
- o Pedagogical content knowledge.
- o Responsiveness to National Curriculum policies.
- o A thorough understanding of the SACE *Code of Professional Ethics*.
- o How to find and use locally accessible learning resources²⁷.

Responsiveness to National Curriculum policies is sometimes understood as requiring the IPET curriculum to mirror the school curriculum²⁸. But this view is based on a superficial understanding of knowledge, confusions about the theoretical underpinnings of professional practice, and a failure to appreciate the ways in which traditional academic disciplines provide the epistemological basis for any elements of the school curriculum. HEIs should be encouraged to think about IPET programmes as being generic and developing a deeper understanding of teaching and education, with only a proportion devoted to Phase and Learning Area specialisation.

The IPET curriculum needs to include 'public knowledge' - what teachers need to know and to be able to do to become teachers in contemporary institutions - but it usually fails to take account of embedded and unarticulated assumptions about teaching and learning that the students bring from their own twelve years of experience as learners at school. The teacher education curriculum needs to disrupt these embedded assumptions of what it means to teach and to be a teacher.

The Norms and Standards for Educators (DoE February 2000) raises elaborate and utopian expectations of the scope of IPET - in particular the 'seven rôles' of a teacher are highly unlikely to be achievable by a novice teacher. In addition the *Norms and Standards for Educators* is sometimes interpreted as implying that teacher education should be phase-specific. This presupposes a stable schooling system with dedicated teachers for each phase. Except in the case of more privileged schools in our current context this is unrealistic.

Recommendation B13

Encourage HEIs to focus their IPET programmes on the generic development of professional understanding, and to avoid cluttered and overloaded curricula that attempt to cover all seven of the rôles specified in the NSE and to mirror school curricula.

The definition of a 'qualified teacher' has been a source of resentment and controversy. The *Norms and Standards for Educators* recommended that a qualification at M+4 (REQV 14) should be the benchmark for a 'qualified teacher', but the current practice of the SACE is to use a qualification at M+3 (REQV 13)²⁹. The definition of a 'qualified teacher' leads to definitions of 'unqualified' (REQV 10) and 'underqualified' (REQV 11 or 12) teachers, which many long-serving teachers find demeaning.

²⁷ The point of this recommendation is that teacher education programmes should work towards teachers being less dependent and more resourceful in the actual situations in which they find themselves.

²⁸ There is a tradition in South Africa of conceiving of the school curriculum as providing the template for the construction of the Teacher Education curriculum.

²⁹ EMIS data (March 2005) indicates that currently 11% of teachers are below REQV 13, 39% are at REQV 13, and 50% are above REQV 13.

SECTION B

It is widely agreed that in the longer term an M+4 qualification (REQV 14) should be regarded as the minimum qualification for a professional teacher. And this Report agrees with this, and proposes a way of retaining this ideal as a benchmark we aspire to without disadvantaging current teachers and their employment status³⁰.

Disputes about the definition of a 'qualified teacher' run together two separable issues: the administrative need to peg teachers on salary scales, and the aspiration to improve the quality of schooling by 'upgrading' the formal qualifications of teachers. But the need to peg teachers on salary scales can be served without the use of the word 'qualified' and its relatives (the REQV system is enough); and the need to improve the quality of teaching can be better served by establishing a category of Licensed Teacher and developing a substantial CPTD system.

Recommendation B14

Retire the word 'qualified' (and its cognates) from use, and request the SACE to establish a new category of Registration: 'Licensed Teacher'.

Once a teacher is Registered with the SACE they can begin to earn PD points, and some of those points might be earned for completing qualifications that entitle them to achieve Licensed Teacher status. Registration by the SACE is a legal requirement for employment in the schooling system. While Registration is relatively permanent (an educator can be de-registered for, for example, contravening the requirements for the *Code of Ethics*), the retention of a professional License will depend on earning a required number of PD points in each three-year cycle.

Recommendation B15

Treat Registration (by the SACE) as the threshold between IPET and CPTD.

³⁰See Recommendation B8, and the distinction between Registration and Licensing as in Recommendation A6 above.

SECTION C

Continuing Professional Teacher Development (CPTD)

The National Qualifications Framework (NQF) is acknowledged as an important mechanism for the transformation of education and training in South Africa. It is a system for recording and rewarding learning achievements. However it lacks the focus and flexibility needed in the case of well-targeted Continuing Professional Teacher Development (CPTD). This Report recommends a **complementary** valuing system for CPTD.

It is widely acknowledged that CPTD is of increasing importance in teacher education - and especially in our context with the legacies of Apartheid-inspired forms of teacher education, our transformation goals, and an evolving school curriculum. There is a great deal of activity in this field, and considerable resources are devoted to these activities. However, such interventions tend to be *ad hoc* and driven by immediate needs, and, overall, the field is haphazard, not clearly focussed, and directionless. Each activity is likely to be driven by good intentions³¹, but there is no regulatory system to steer CPTD activities, focus them on effective professional development, and provide a well-constructed reward system for teachers, especially those on the **Teaching & Learning** career path.

A dedicated CPTD system will try to ensure that the substantial resources currently devoted to the professional development of teachers have a better prospect of contributing to the lasting improvement of the quality of teaching³², it will emphasize and reinforce the professional status of teaching, provide teachers with clear guidance about which PD activities³³ will contribute to their professional growth, and protect teachers from fraudulent providers. In addition such a dedicated system would expand the conception of the variety of kinds of activities that can contribute to the professional development of teachers, and break the hold of the idea that all worthwhile PD activities should be either NQF credit bearing, or required by the employing authorities. The recommended system expands the conception of activities that contribute to professional development beyond those linked to formal qualifications and official Departmental training workshops and courses.

Formal qualifications play a seminal rôle in teacher education if the deep transformation of education is our goal, but CPTD is not synonymous with attaining formal qualifications. Not all activities endorsed by the SACE need to be NQF credit bearing and not all PD activities need to be endorsed and allocated PD Points.

The CPTD **System** recommended is that the SACE, as the statutory body for professional educators, endorse³⁴ PD activities and allocate PD points to them, and maintain a readily accessible register of such activities. The endorsement of PD activities (and the allocation of points to them) requires dedicated and expert focus on the specific issues of professional development of teachers. It is further recommended that although all Registered educators would be entitled to earn PD points, Licensed teachers would be required to earn a specified number of PD points in cycles of three years, as a condition for maintaining their Licensed status.

It is recommended that in order to foster a more inclusive conception of the range of activities that contribute to CPTD, PD activities be classified into five types: School driven, Teacher Union driven, Employer driven, Qualification driven, and 'other' (which will include activities offered by NGOs, NPOs, FBOs, CBOs, for-profit providers, etc.) The boundaries between these five main types of activities are not clear-cut, but they serve to broaden and enrich the conception of professional development³⁵.

³¹ Although we need to acknowledge that it is a field ripe for picking by educational entrepreneurs with profits in mind.

³² Funding for the maintenance of the CPTD system should be conceived of as an investment rather than an additional cost to the education system.

³³ The word 'activity' is used as a generic label for 'courses', 'programmes', 'workshops', 'conferences' or any other learning activity.

³⁴ See Appendix 5 for a note on the use of the word 'endorse' in this context.

³⁵ A rule might be adopted, for example, that no more than 60% of individual's PD Points in any cycle can be earned from any one of the types of activity.

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But there are risks we need to avoid. One is that we need to avoid teachers' neglecting their main responsibilities in order to earn PD points; and another is that we need to avoid increasing the administrative burden on already overloaded teachers. The system recommended can avoid the former risk by trying to ensure that PD activities bear directly on the classroom responsibilities of teachers. Since professional development is considered to be a 'continuing' lifelong learning process, there might be a limit on the number of PD points that a teacher can earn in any one year. The latter risk can be avoided by requiring providers to undertake the administrative tasks involved in recording the PD points earned by individuals. Providers will apply to the SACE to get their PD activities endorsed and allocated PD Points, and it would be their responsibility to claim the PD Points for those individuals who participate satisfactorily (successfully) in an endorsed PD activity.

The CPTD system, Integrated Quality Management System (IQMS) and Workplace Skills Plan (WSP) are integrated with each other³⁶. IQMS provides a way of identifying the needs of teachers and schools, and providers of CPTD activities could be guided by those needs. The Developmental Appraisal component of IQMS requires teachers to construct a 'personal growth plan' based on self and peer reflections on each teacher's practice. The growth plans of all teachers in a school should be integrated into the 'school improvement plan' as part of the Whole School Evaluation component of IQMS. Earning PD points could become one element in the assessment of 'satisfactory performance' for salary progression, linked to the Performance Achievement Measures component of the IQMS.

The guiding purpose of all these systems should be to enable teachers to become less dependent on outside agencies for their professional development and more able to become responsible for their own development. In some contexts, where internal capacity is lacking, there will clearly be a greater need for 'outside-in' strategies of development, but always with the purpose of growing the professional agency of teachers. Teachers need to be conceived of as members of a profession, and the CPTD system recommended has as one of its guiding principles that teachers need to be prompted increasingly to draw on their own capacities to promote their own professional growth.

Concerns have been raised about the capacity of the SACE to manage the proposed CPTD system. While it is acknowledged that sufficient capacity does not at present exist in the SACE, it is clear from the SACE Act³⁷ that it is the appropriate body to manage such a system. This Report proposes that an interim steering committee (reporting to the SACE Council, but with membership from a range of bodies, including DoE, ETDP-SETA, CHE, SAQA, Teacher Unions, HEIs, MCTE) be established to set up the CPTD system³⁸, and recommend the resources and structures the SACE would need for the maintenance of the system.

Recommendation C16

Support the development of a Continuing Professional Teacher Development system by encouraging, resourcing and empowering the SACE to manage such a system.

Recommendation C17

Authorize the SACE to fulfil its mandate for the professional development of educators by establishing a CPTD system, which will endorse professional development activities and allocate Professional Development Points to them, keep a register of endorsed PD activities, and maintain a record of PD Points earned by Registered Educators.

Recommendation C18

Require all Licensed Teachers to earn a specified number of PD points, in three-year cycles, as a condition for maintaining their License.

³⁶ The CPTD system is conceived of as underpinning the IQMS, and providing teachers with a menu of endorsed CP activities in terms of which to construct their personal growth plan.

³⁷ *South African Council for Educators Act* (31 of 2000) Section 5(b), and particularly sub-sections (iii) and (iv) provide the legal mandate. There has been a tendency for the SACE to attempt to fulfil this mandate by providing courses and workshops for teachers; but this is for it to misconstrue how to satisfy that mandate.

³⁸ A very efficient turn-around time for applications would have to be established, as the envisaged register of endorsed PD activities would have to be sufficiently flexible to be able to add or remove items from the register at short notice.

SECTION D

Support Systems to enable IPET & CPTD

D1 Supply and Demand

The supply of teachers is a **national** responsibility and 'demand' is **provincial**. The distinction between these two concurrent responsibilities is still not adequately acknowledged in on-going debates about 'supply and demand', or in data gathering or funding procedures. It needs to be accepted that precise matching of supply and demand of teachers for the schooling system is an unattainable ideal, but the current unmanaged systems are a serious gap in planning. Expensive and labour intensive research into supply and demand is unlikely to be of much of value to the system. Fundamentally, for adequate planning, what we lack is up-to-date and accurate data about both supply and demand.

Some PDEs seem to have a tendency to want to recover control over initial teacher education. But this tendency is in serious conflict with the intentions of one of the major policies that had as one of its central purposes to transform the quality of teacher education.

There are currently about 350 000³⁹ state-employed teachers in South African public schools, and about 100 000 employed by school governing bodies or in independent schools. Annual attrition from the teaching force is between 5 and 5.5%. This implies that the IPET system needs to produce between 17 500 and 22 500 newly qualified teachers per annum to replace teachers leaving the system⁴⁰. Currently the IPET system is producing, at best, a third of this number. The imminence of a major crisis in the supply of teachers is being obscured by the (perceived) availability of a large pool of qualified teachers no longer employed as teachers. But we do not have reliable data about the size of this 'pool', nor about what the Phase or Learning Area qualifications are of teachers in this pool, nor about how many in this pool are ready and available to take up teaching posts. What we can say with certainty is that it is a shrinking pool and it cannot be counted on as a substitute for the production of new teachers.

Under ongoing fiscal restraints Faculties of Education are rapidly losing the institutional capacity to offer quality IPET programmes. Faculties of Education have found it more and more difficult to recruit students into IPET programmes. And the demographic profile of students in such programmes is a cause for serious concern with implications for the provision of new teachers in traditionally disadvantaged reaches of the schooling system and on our attempts to promote mother-tongue instruction in the early years of schooling.

A national system of tracking teacher supply - such as those currently in operation in Gauteng and the Western Cape - to gather (supply) data from HEIs should be implemented, and needs to become a key planning tool for the recommended National Teacher Career and Recruitment Centre⁴¹.

Demand is provincial. Information about demand is either not available, or is incomplete, unreliable and out-of date. In some cases PDEs do not even have accurate data about the number of teachers who are presently employed in the system, their specialisation, and their attrition from the system. A lack of capacity to forecast demand is a major shortcoming for reasonable planning, and it has a dramatic effect on the recruitment of students for IPET programmes and the provision of targeted student loans.

³⁹ This number drops to about 300 000 during the first months of each year.

⁴⁰ If there are 22 HEIs offering IPET programmes they would each, on average, need to graduate 1000 newly qualified teachers per annum. If one thinks in terms of a 4-year programme, and adds an attrition rate of say 10% during this programme, these institutions would on average each need to have 4400 students in their IPET programmes, and would each have to recruit some 1250 additional students into those programmes on an annual basis!

⁴¹ See Recommendation D27. Additional fields can be added to HEMIS to provide the (supply) data needed.

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Current management information systems - specifically EMIS - are, at best, an historical record; they do not provide an effective tool for planning and management. Projections of future demand - on which the establishment of a system of loans linked to service contracts will depend - are currently not available. This Report recommends a concerted national effort to improve the quality of data input⁴² and to use management information systems to manage and plan the supply and demand for teachers.

The integrated report of the comprehensive study, co-ordinated by the ELRC, on teacher supply and demand in relation to the impacts of the HIV and AIDS pandemic, is due to be published in August 2005. It will provide us with reliable data about the extent to which teacher HIV and AIDS related mortality and malaise is affecting the attrition rate of teachers. The disaggregated data by district, phase and learning areas in this report is useful.

The proposed National Teacher Career and Recruitment Centre will have the task of co-ordinating (national) supply data from HEIs and (provincial) demand data from PDEs.

Recommendation D19

Set up a system to keep updated data about registrations and expected graduations in IPET programmes in public HEIs. (National supply data)

Recommendation D20

Dramatically improve the operation and use of EMIS at provincial level so that PDEs can provide reliable four-year projections of their need for teachers. (Provincial demand data.)

Recommendation D21

Assign the function of monitoring teacher supply and demand to the proposed National Teacher Career and Recruitment Centre

D2 Funding for teacher education

The failure to acknowledge the division of responsibilities between national and provincial departments of education in relation to teacher education has had a severe impact on funding arrangements for teacher education. And issues of the distribution of funding are a major problem in teacher education at present.

The funding of Initial Professional Teacher Education programmes (BEd and PGCE) needs to be reconceived, and plans need to be made for the funding of the proposed Continuing Professional Teacher Development system.

Subsidy to HEIs

The subsidy level for IPET (BEd and PGCE) programmes offered by public HEIs, who have been assigned with this responsibility needs to be improved as a matter of great urgency. Their institutional capacity to provide quality IPET programmes is deteriorating rapidly.

⁴² One part of this project could be a workshop for all EMIS managers to consider the current systems and whether it might be logistically feasible to supplement them with some version of the District Education Monitoring and Management Information System (DEMMIS) currently being piloted in some districts in KZN. The DEMMIS system, which works in collaboration with EMIS, provides a possible model of a lean and dynamic system which can provide the kind of rapid information we need in the context of HIV and AIDS. In addition the DEMMIS system captures detailed data at the school and district level, and monitors teacher mobility, utilisation and demand on a monthly basis.

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Many HEIs are now organized in terms of 'cost centres' required to justify their continued existence in terms of income and expenditure. In this climate HEIs and Faculties of Education have a tendency to prioritise higher subsidy earning programmes, and IPET programmes tend to get sidelined. The level of subsidy for IPET programmes needs to be used as a lever to enable HEIs to fulfil their responsibilities for initial teacher education.

The truth of the matter is that many Faculties of Education are facing financial meltdown, and if we do not provide them with the financial backing to offer quality initial teacher education, it is likely that they will stop doing so, and other 'providers' will step into the gap, or that we will face a situation in which the employment of unqualified teachers will become the norm. The current subsidy allocation for IPET fails to recognise the labour intensive nature of professional teacher education with its costly human, travel and time resource requirements for supervision of novice teachers in on-site schooling contexts. Initial teacher education is unreasonably pegged in a lower funding category than, for instance, management sciences, communication, computer science, languages, philosophy and social sciences.

Recommendation D22

Improve the level of subsidy for initial teacher education (BEd and PGCE) programmes at public HEIs.

Student loans for initial teacher education

The maintenance of the schooling system requires a steady flow of newly qualified teachers. We can add that newly qualified teachers have the potential to bring new energy and innovation into the system. The re-imaging of the teaching profession to enhance its public reputation and status (which might be outsourced to a professional marketing agency) is generally important, but it should not be understood as an effective strategy for expanded recruitment. If we treat recruitment into teaching programmes as market driven we are pursuing a fantasy. No expensive 'advocacy campaigns' or 'recruitment drives' will solve the problem of a need for a steady flow of recruits into initial professional teacher education programmes unless they are accompanied by a dedicated loan scheme for IPET students, and reasonable prospects of employment on completion of the qualification.

The traditional system of full-cost loans for initial teacher education - linked to service contracts - has broken down, and in the mid- to longer-term this will lead to a major crisis in the supply of newly-qualified teachers into the system. It might have been expected that the National Student Financial Aid Scheme (NSFAS) would replace the traditional system but it has become increasingly obvious that NSFAS, given its current mandate, is unable to do this. The 'bursaries' offered by some PDEs are, by and large, poorly administered⁴³ and their allocation is driven more by the perceived needs of the provincial schooling system than by the national demand situation. And not only are there very few posts advertised by PDEs, but many students in IPET programmes face the prospect of not being employed as teachers, or using their qualification to seek greener pastures in other countries.

The cost to individuals and their supporters of a four-year BEd programme is between R84 000 and R120 000, and this is unaffordable for most students who aspire to become teachers. This Report argues that there is no substitute for a restoration of full-cost loans for initial professional teacher education, tied to service contracts. In a climate of serious unemployment, a service contract, linked to guaranteed employment (for the length of the contract) would be a

⁴³ For instance, 'bursaries' are provided without any liaison with HEIs, the availability of the bursary is not co-ordinated with the financial timetables of the HEIs, and many bursaries are at levels that do not meet the real costs of students from poorer communities.

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major incentive - and likely to be a necessary supplement to an effective 'advocacy campaign'. But the possibility of service contracts depends, crucially, on more accurate projections of demand than we have at present.

Recommendation D23

Establish a National IPET Student Loan Scheme and provide full-cost loans to initial teacher education students (BEEd and PGCE) who sign (Provincial) service contracts.

The funding of such a national IPET loan scheme should not be understood as a question of having to find a whole bank of additional funding. Careful consideration needs to be given to the extent to which currently under-used funding elsewhere in the system could provide the funding for such a loan scheme⁴⁴.

It is further recommended that although the service contracts would be with Provincial Departments of Education, the loan scheme itself needs to be managed nationally. One reason for this is that the supply of teachers is a national responsibility, but another is that it would be too costly for each Province to set up and maintain such a system⁴⁵.

Funding the proposed CPTD system

There are strong reasons in our context to devote at least as much attention to CPTD as is traditionally devoted to IPET. Some of these reasons arise out of the history of teacher education in our country, but others have to do with the profound implications of attempting to transform a whole education system, and to provide quality education for all.

Currently the SACE, which is the proposed manager of the CPTD system, draws its resources primarily from registered teachers. Requiring professional teachers themselves to maintain the CPTD system financially is untenable in the context of teachers' salary levels.

Funding for the start up of the proposed system might be found from other sources, but longer-term maintenance of the system will require a regular source of funding. It can be noted that the maintenance costs of a well-managed CPTD system can be understood as a profitable investment. For a relatively small outlay, to fund the capacity of the SACE to manage and administer the system, considerable resources will be brought into the teacher education system for CPTD. The costs of resourcing the sustainability of a CPTD management system are likely to pale into insignificance in terms of the funding that will flow into CPTD.

Recommendation D24

Find ways of funding the maintenance of the proposed CPTD system that will be managed by the SACE.

D3 Structures and Co-ordination

Some of the central problems in the teacher education system at this time revolve around lack of operational clarity about the rôles and spheres of authority of statutory and other bodies responsible for teacher education, and the prevalence of competitive (in some cases even hostile), rather than participatory, relationships between them. One particularly debilitating instance

⁴⁴ Parts of PDE budgets earmarked for teacher development, NSFAS and ETDP-SETA?

⁴⁵ See Recommendation D27.

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of this tendency is the lack of productive relationships between the ultimate employers of teachers (the PDEs) and the legislated public providers of teacher education (the HEIs). But there are many other examples.

The work of the various bodies involved in teacher education⁶ needs to be harmonised, in terms of a shared vision of the transformation of education, and an acknowledgement of the key rôle of teacher education in that project.

National Consultative Forum

A model of 'co-operative governance' should promote dialogue across the distinctive but complementary responsibilities of the various rôle-players engaged in the development of a coherent and comprehensive system for quality teaching and learning for all. There is a need to develop systems which ensure critical engagement with the operations, management and regulatory frameworks of the State, the government bureaucracy at national and provincial level, the statutory bodies, the public and private higher education institutions, the NGO sector, and the teacher union movement. The intention of the proposed forum is not to detract from the legislated authority vested in each of the separate bodies, but to contribute to the development of a coherent national system of teacher education. The complementary responsibilities of the various rôle players need to be mutually agreed in collaborative dialogue. Such dialogue will clarify rôles which have become blurred in the absence of co-operative and sustained partnerships across the full range of partners in teacher education. Bilateral negotiations between only some of these bodies have proved to be inadequate to achieve a sustainable system of teacher education. Whilst 'co-operative governance' initially could be perceived of as a 'loss of authority' for some sector(s), the broader agenda of an efficient and effective teacher education system could result.

A National Consultative Forum for Teacher Education should be established in terms of Para 11 of the *National Education Policy Act 27 of 1997*. Its function would be to bring together statutory and other bodies involved in teacher education broadly conceived (HEIs, PDEs, DoE, SAQA, SACE, ETDP-SETA, CHE, ELRC, and Teacher Unions) for the purposes of coordinating their complementary responsibilities for teacher education so as to avoid duplication, waste of resources and lack of common effort. This Forum should be conceived of not as a National Institute to replace public higher education institutions, or as an additional bureaucratic structure, but it should have stable membership and meet on a regular basis. It should be conceived of as a way of overcoming the tendency for such bodies to operate on their own agendas independently of each other, while also ameliorating the tendency for any one body to try to dominate the debate about the essentially contested areas of the conception, quality, planning and promotion of teacher education

Recommendation D25

Establish a National Teacher Education Consultative Forum (outside of the line functions of the DoE) to coordinate the functions of the various bodies responsible for teacher education.

The internal organization of Departments of Education

Teacher development is variously located within the DoE and PDE structures, making the co-ordination of their teacher development programmes and activities across provinces and between national and provincial departments an administrative bureaucratic difficulty. Budgetary allocation to teacher development becomes subsumed under the other initiatives of the embedded directorates.

⁶ See Appendix 3 for a list of these bodies.

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The following recommendation is not that DoEs need to need to be "restructured" - yet again - with different configurations of Directorates or Branches, but that, given the seminal rôle of teacher education, DoEs need to have a coherent focus on their functions in this regard. In some provinces there is a "matrix management" system to take account of this responsibility short of restructuring the departments.

Recommendation D26

Organize both the National and Provincial DoEs to give proper weight to teacher development.

National Teacher Career and Recruitment Centre

A National Teacher Career and Recruitment Centre needs to be established in the national DoE⁴⁷. The main functions of this unit would be to monitor (national) teacher supply and (provincial) teacher demand, and to manage the National IPET Student Loan Scheme.

Subsidiary functions might be the monitoring and management of teacher migration into and out of the country and across provincial boundaries, the career mobility of teachers within the system and the development of targeted teacher recruitment drives.

Recommendation D27

Establish a National Teacher Career and Recruitment Centre to monitor teacher supply and demand, to facilitate and promote teacher recruitment, and to manage the National IPET Student Loan Scheme.

Provincial Teacher Education Liaison Committee

The central purpose of the Provincial Teacher Education Liaison Committees would be to forge a partnership between the main employers of teachers, and the legislated public providers of teacher education. One of the recommendations of this Report is that the fourth year of Initial Professional Education of Teachers, called Induction⁴⁸, should be site-based, with mentorship from senior teachers. This will require close co-operation between higher education institutions, schools and Provincial Departments of Education, and the Provincial Teacher Education Liaison Committees are seen as a crucial structure in the management of such a system. Another of the recommendations of this Report is that Provincial Teacher Education Liaison Committees should also pay attention to ECD and ABET provision in the Province⁴⁹.

Conceptions of the mode of governance of former colleges of education dominate the views of PDEs in their relationship to HEIs; they tend to see HEIs not as willing partners but as recalcitrant parts of the system or (more commonly in the current climate) as 'service providers'. The growing tendency for Provincial Departments of Education to treat Higher Education Institutions as 'service providers', as opposed to as 'partners', in teacher education should be vigorously resisted; it has the potential to subvert our transformation goals. Planning regarding the provision of teachers by HEIs tends to be *ad hoc* because it is not done in consultative dialoguing between the DoE and the HEIs, and because adequate data about system needs is not available.

⁴⁷ Located in the Human Resources Planning Directorate?

⁴⁸ See Recommendations B9 & B10.

⁴⁹ See Recommendation A2.

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If we do not retrieve an understanding of teaching as a profession, as opposed to a 'service', we will renege on one of the key dimensions of the transformation of education in South Africa. An impoverished conception of teaching would be a retrograde step in the light of our ideal to provide quality education for all⁵⁰. The establishment of provincial teacher education 'institutes' or 'corporate universities' diverts resources and responsibilities away from the legislated public providers of teacher education and further destabilizes the capacity of public higher education institutions to deliver on their mandate to provide quality professional teacher education.

Recommendation D28

Establish Provincial Teacher Education Liaison Committees. The core membership of these committees should be the PDE and the HEIs that offer teacher education in that province⁵¹. The main functions of these committees would be to create a climate of trust between the (main) employers of schoolteachers and the main providers, to consider system needs on an on-going basis, and to ameliorate rival conceptions of teacher education.

Districts

As has been frequently argued⁵², districts have an indispensable rôle to play as the link between PDEs and schools, but they need consolidation and development. And this is going to become particularly important in relation to the implementation of IQMS and the recommended CPTD system.

Across the nine provinces there are different conceptions of "Districts", their size and functions. The recommendation below is to the effect that there need to be some effective structures that are closer to schools than the PDEs

Recommendation D29

Prioritise the development of Districts as the key management nodes in the delivery of quality education for all.

D4 Quality and Quality Assurance

At this time there is increasing concern about the quality of teacher education in our country. Provided we avoid the trap of ascribing poor performances of the schooling system simply to deficient teachers, a focus on the quality of teacher education can be beneficial to the whole education system. But the contemporary assumption that quality can be measured in some simple and mechanical way fails to fit what is involved in judging the quality of teaching.

An undisputed principle of quality assurance is that while there is an important rôle for self-assessment of quality, the judgement of quality is an interpersonal judgement and depends on criteria agreed in the relevant community of practice. In the current case the MCTE holds that the quality assurance of teacher education programmes or courses depends on maintaining a distinction between the provider of the programme or course, and the quality assessor. If a Department of Education delivers training workshops, or if an HEI delivers programmes, they cannot be the quality assessors of those workshops or programmes.

⁵⁰ See Recommendation B7

⁵¹ The teacher unions have argued that they should also be represented on these committees, especially in the context of CPTD decision-making at provincial level. Such a committee could explore further the rôle of teacher unions in IPET considerations. The composition of this committee should avoid it becoming too large and cumbersome and to lose its focus on its core functions. In addition, as national institutions, HEIs (and the Faculties of Education they contain) work across provincial boundaries, and this is why Recommendation D28 uses the phrase 'the HEIs that offer teacher education in that province'.

⁵² For example: Department of Education (August 2000) *Report of the National & Provincial District Development Conferences, 1999/2000*; Brahm Fleisch (2002) *Managing Educational Change*; Department of Education (January 2003) *District Development Support Programme: Improving the Quality of Primary Education*; Taylor, Muller & Vinjevoid (2003) *Getting Schools Working*.

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We already have in place a range of ways of trying to assure the quality of teacher education. Institutions need to be accredited, qualifications need to be registered, programmes need to be approved, etc. Formally registered Education and Training Quality Assurance Bodies (ETQAs) have been the focus of our 'quality assurance' attention, but registration, approval, accreditation and endorsement can all be understood as being complementary elements of the quality assurance system.

But there is widespread confusion about these different processes and which bodies are responsible for them. In addition, this complex system has generated a considerable increase in the administrative load on Faculties of Education. Appendix 5 clarifies this situation.

There is unclarity in the field of teacher education about ETQAs and which bodies carry the responsibilities for this formal dimension of quality assurance. The MCTE knows that there are currently negotiations between the CHE and the ETDP-SETA in this regard and it does not think it helpful to intervene in those negotiations. Thus Recommendations D31 and D32 below are nothing more than an attempt to reflect the current situation.

It is argued in Section C above that the CPTD system needs a different kind of valuing system from that embodied in SAQA and the NQF - and that NQF Credits and PD Points need to be distinguished from each other⁵³. One main reason for this is that the criteria for assessing the value of an activity as a worthwhile professional development activity revolve centrally around whether that activity promises to contribute to the teachers' skills in the practice of teaching - defined as the practice of organising systematic learning. Ultimately the value of a professional development activity rests on the extent to which it enables the teacher to become better at enhancing the achievements of learners. But, unlike the case of an industrial production process (in which the idea of 'quality assurance' had its origins) there is no direct way of measuring professional development activities in these terms. This is the main reason for the MCTE preferring the word 'endorse' to refer to the rôle of the SACE in the realm of assuring the quality of professional development activities. Ultimately the endorsement of PD activities, and the allocation of PD Point to them will depend on professional judgement. And this is outside of the sphere of 'Quality Assurance' understood as an, in principle, straightforward assessment of the quality of a product.

The following recommendations are made in order to clarify issues of quality assurance in the field of teacher education:

Recommendation D30

The SACE, through the process of endorsing Professional Development activities, should endorse the quality of such activities.

Recommendation D31

The CHE should remain the ETQA for all formal education qualifications offered by HEIs.

Recommendation D32

The ETDP-SETA should remain the ETQA for teacher education short courses.

⁵³ See recommendation A5.

SECTION E

Careers and qualifications

E1 The Career of a Professional Teacher

Presently there is no clear career development system for teachers. The series of the stages of development from a student teacher, to a novice teacher, to an experienced teacher are uncoordinated. Little deliberate planning around the specific needs of teachers at these different stages is evident. This is reflected in inadequate planning about how many teachers are needed in the system, about the career expectations of student teachers and promotion mobility of practising teachers as they move along their career trajectory. This is also evident in the lack of clear planning and data management around the teachers who leave the system. The process of becoming a professional teacher is characterised by different stages of growth, and different needs and expectations should be a feature of the regulatory system. A 'one-size fits all' approach to professional development does not take the above into consideration. The following concerns highlight some of the difficulties.

Initial Professional Education of Teachers

A systematic recruitment of teachers linked to career possibilities is not evident. This is exacerbated by the lack of adequate data to signal the projected shortages of teachers in specialist focus areas and potential patterns of employment within the schooling systems.

There is a strong tendency to understand an initial teacher education qualification as the terminal qualification for professional competence⁵⁴. However, an initial qualification provides, at best, a good beginning to becoming a professional teacher, and continued professional growth is reliant on teachers' engagement within the specific contexts in which they develop their expertise in organising systematic learning.

Follow through tracking of graduates of the HEIs is not evident, providing little understanding of the quality of teachers they have developed during initial teacher education. Linkages between schools and HEIs are tenuous.

Limited support of a structured nature is given to new recruits into the teaching force. Practising school-based mentors who do not share views about practice from the HEI training institutions promote a 'wash out effect' of initial teacher education. Newly qualified teachers are not supported through a **critical** induction into the world of schooling, and may become easily disillusioned, and /or develop practices of replicating poor quality teaching and learning.

Early attrition from the teaching career is a loss of State investment in teachers' initial teacher education and such attrition can be partly explained in terms of lack of formal support for novice teachers.

The need to build CPTD into the career of a teacher

The SACE has limited influence on the hallmarks of 'good practice' in professional teaching. Mere description of a code of practice without a system to operationalise, monitor, regulate and quality assure the code undervalues the setting of such professional codes.

⁵⁴ This tendency underlies the over-ambition of many IPET programmes, and also the disappointment of the employing authorities about the graduates of such programmes.

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Many practising (and experienced) teachers do not focus explicitly on further professional growth during their careers. This is reinforced by the conception that their initial teacher education qualification constitutes adequate requirement for being a teacher. This undermines the conception of lifelong learning and does not acknowledge the need for teachers to be responsive to the changing expectations of both the educational policy terrain and wider social and technological innovations impacting on teaching and learning.

Many practising teachers enrol for academic qualifications (eg BEdHons, Masters and DEd) under the misconception that these qualifications will improve their professional practice. This undermines both the professional aspirations of the teachers, and the academic quality of postgraduate qualifications in the field of education.

Limited opportunities are perceived to be available for teachers within the career of teaching. A consequence is that teaching is seen as an unattractive career. Uninspired teachers resort to rituals and routines which seldom engender job satisfaction and this contributes to their own low morale.

Many teachers aspire to become managers, but there will always be a limited number of management posts available. Alternative career paths within the rôle of being teacher are not readily available. Mistakenly, 'promotion' is understood to be limited to an 'escape out of the classroom'.

The proliferation of programmes and short courses in the field of educational management tends to create false expectations about career progression, and teachers become frustrated when they are not promoted into management. In addition, such an emphasis serves to undermine and undervalue the essential rôle of teaching in the whole system. Many competent classroom teachers are removed from the classroom into serving administrative, management and leadership rôles, depleting the schooling system of quality teachers for the classroom.

We need to prioritise teaching as the core function of the whole schooling system. The justification for any other functions in the system (for instance, funding, management and administration) rests on the extent to which they support or contribute to that core function. The quality of the system as a whole depends crucially on the quality of teaching, and the **Teaching & Learning** career path should be exploited as the opportunity to reward quality teaching, and to provide competent and committed teachers with a strong incentive to remain in teaching rather than to aspire to move into 'management'.

Teacher education and training of the past was geared towards serving particular educational policy goals, but policy goals shift and teachers need to engage with these changes. All professional teachers should be able to engage critically with innovation, changing policy environments, and changing social, technological and historical contexts. And teachers' expressed needs for career development need to be taken into account.

Recommendation E33

Give much better formal shape to the career of a professional teacher by building the following into our thinking and practices:

- o While acknowledging the continuity of the professional development of a teacher, replace the traditional inset-pretet distinction with an IPET-CPTD distinction.
- o In employment practices emphasize the distinction between the career path: **Teaching & Learning** and the other career paths, and give particular emphasis to establishing the former.
- o Avoid confusing career paths with development tracks, particularly in relation to salary levels.

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E2 Qualifications Framework

The current qualifications framework for education is as specified in the *Norms and Standards for Educators* (4 February 2000)⁵⁵. In July 2004 a (Draft) *Higher Education Qualifications Framework* was published for public comment. Although there are good reasons to avoid disrupting in a well-populated field such as education, the HEQF provides an opportunity to revise the NSE qualifications framework - with a view to eliminating some of the anomalies which have emerged, and reconfigure the qualifications framework in the light of a clearer conception of the differences between IPET and CPTD, and differences and relationships between professional and academic qualifications.

General comments about the current situation

Despite the negative feedback about the current National Professional Diploma in Education (NPDE), it has played an important rôle in enabling currently serving un- and under-qualified teachers to access the qualifications framework. The NPDE has been revised (SAQA 11 August 2004) to enable new categories of students to access it. The NPDE is **not** an alternative IPET qualification, and should not be treated as such, but in the medium term it will continue to have a rôle to play in the qualifications framework.

The BEd degree has become established as one of the two basic professional qualifications. Its central purposes are to contribute to the intellectual development of students in the context of preparing them as members of the teaching profession. However the current BEd (480 NQF Credits) is proving to be unaffordable for many individuals and their supporters. It is recommended that it become a 360 NQF Credit qualification, if only to reduce the cost to individuals and their supporters by 25%.

The ACE, as a quintessentially **professional** qualification, has played an important rôle in improving the competences of teachers, and qualifying them to take up new career paths⁵⁶ but it is now widely used as a 'bridge' between an NPDE and a BEdHons. But this use of the ACE is a symptom of a failure to distinguish adequately between professional and academic qualifications. The large number⁵⁷ of ACE programmes approved by the DoE and the very large number of students registered for ACE programmes are a product, in large measure, of the ACE being used as an alternative route into a BEdHons programme. The proliferation of ACE and BEdHons programmes, and the rapid increase in numbers of students registering for these programmes are symptoms of (a) survival strategies of HEIs, and (b) the perception that formal qualifications are the only route to advancement in the teaching profession⁵⁸.

There is little evidence that improving the higher-level academic qualifications of teachers improves the quality of their professional practices. The large numbers of teachers registered for postgraduate programmes are likely to be symptoms of:

- (a) the fact that credits on the NQF have become the only valuing and reward system for further study,
- (b) the difficulties Faculties of Education have had, over the past years, in surviving by recruiting students into their IPET programmes, and

⁵⁵ But with the addition of a National Professional Diploma in Education, introduced as a temporary 'upgrading' qualification to enable teachers with qualifications from previous dispensations to reach REQV 13 and to access the (new) qualifications registered on the NQF.

⁵⁶ Many ACE programmes qualify teachers to teach in new learning areas (the ACE in Maths Literacy is a good example here), or for new rôles in management and administration.

⁵⁷ More than 180!

⁵⁸ This Report recommends an alternative valuing and reward system - which focuses sharply on professional growth and development and the real improvement of professional practices in education. (See Section C (above) for an outline of the proposed CPTD system.) Formal qualifications are only one type of endorsed professional development activity.

SECTION E

(c) a climate of financial stringencies in HEIs, in which Faculties of Education have been expected to prioritise programmes which draw a higher state subsidy. This has led to many Faculties of Education recruiting an increasing number of students for higher degrees, and fast-tracking them through such programmes. However, over time, Masters and Doctoral Degrees in education continue to lose their academic status because of growing doubts about their value and credibility, and the poor level of research training developed in such programmes.

There is a growing proliferation of teachers registering for Masters degrees without adequate preparation for quality academic and educational research training. A significant proportion of teachers registering for MEd programmes do not complete the 'dissertation component' of independent inquiry. The definitive goals of pursuing educational research (in higher degree study) are poorly appreciated by many teachers engaged in honours, masters and even doctoral level study.

Proposals for reconfiguring the qualification framework⁵⁹ in the field of education

There is a key distinction between **academic** and **professional** qualifications; and this parallels the distinction between the academic development track (which takes a student towards scholarship and research in the field of education) and the professional development track (which takes a student towards improved professional practice.). These two 'development tracks' should not be confused with each other or with 'career paths' (referred to in Recommendation A4 and Section E1 above.)

Secondly the qualifications framework should reinforce a broad distinction between **generic** and **specialised** qualifications in the field of education. The BEd and BEdHons should be understood, and designed, as generic qualifications; the Advanced Diplomas in Education, and the Masters Degrees should be designed as specialised qualifications.

One of the unintended consequences of the introduction of the NQF, and this is especially debilitating in the field of education, is that it has reinforced the idea that all learning should be reflected in advancement **up** the qualifications levels on the NQF. Only vertical progression up NQF levels is seen as real progress⁶⁰. Lip service is paid to horizontal progression⁶¹, which has a key contribution to make to deepening the quality of professional practice. The use of horizontal (as opposed to vertical) progression on the NQF is especially important in the field of teacher education.

This Report recommends that one of the two basic Initial Professional Education of Teachers qualifications be a 360 NQF Credit BEd and an Advanced Diploma in Education (Induction); the other would be another appropriate first degree and an Advanced Diploma in Education (Postgraduate). The BEd would be (the equivalent of) a three-year full-time programme of study at a higher education institution - which would, of course, include some school-based teaching practice. But although the completion of a BEd would be sufficient for Registration with the SACE, it would need to be complemented by a 120 NQF Credit Advanced Diploma in Education (Induction) in order to qualify for Licensed Teacher status.

⁵⁹ See Appendix 4 for an elaboration of these proposals.

⁶⁰ Such a conception might have been driven by confusions about the relationships between REQV and NQF levels. The REQV is not a qualification, it is a particular level on the salary scales.

⁶¹ 'Horizontal progression' is something of a misnomer. Even if I have a doctoral degree (Level 10), I might need to register for a programme in IT at Level 4 if I am an IT illiterate. This principle underlies the recommendation that even if you already have a postgraduate degree (at Level 8 or above) you would be required to complete an Advanced Diploma (at Level 7) to qualify as a Licensed Teacher.

SECTION E

An Advanced Diploma in Education is recommended as the qualification required for registration as a Licensed Teacher; but **not** as an admission qualification for a BEdHons or further academic study in the field of education. This Report proposes that there be three kinds of Advanced Diploma in Education, distinguished in terms of their special purposes: (a) Postgraduate - which would replace the current PGCE, (b) Specialisation - which would replace the current ACE, and (c) Induction - which would be a new qualification for an on-site programme of training⁶⁷.

The proposed Advanced Diploma in Education (Induction) qualification would be an on-site programme of training, offered in partnership between a school and an HEI, but with the qualification (AdvDip) awarded by the HEI. The viability of the proposed AdvDip in Education (Induction) depends on the availability of good school-based mentors, and this Report recommends that Advanced Diplomas in Education (Specialisation) for mentor training be developed.

The proposed Advanced Diploma in Education (Specialisation) is a key **professional** qualification that provides for the responsiveness of the qualifications framework to changing system and individual professional needs, and it should be designed and conceptualised as such.

Recommendation E34

Reinforce the key distinction between professional and academic qualifications (and, thus, development tracks) in the qualifications framework.

Recommendation E35

Reinforce the distinction between generic and specialised qualifications in the field of education.

Recommendation E36

Make better use of 'horizontal' progression on the National Qualifications Framework.

Recommendation E37

Establish three kinds of Advanced Diplomas in Education (Postgraduate, Induction and Specialisation) and recommend that the SACE consider the Advanced Diploma in Education (any of the three kinds) as a necessary qualification for Licensing as a Teacher.

Recommendation E38

Require an appropriate Bachelor degree for formal admission to a BEdHons programme.

Recommendation E39

Require students wishing to proceed to a structured Masters degree to register in the first place for a Postgraduate Diploma in Education, which should be treated as the 'course work' part of that degree.

⁶⁷ See Appendix 4b

SECTION F

Can we deliver on the right to quality education *for all*?

Conceptions of teacher education presuppose particular models of schooling (or other institutional arrangements) with their associated conceptions of the rôles of professional teachers and other employees in those institutions. But we may rapidly reach a stage at which an accumulation of problems will force us radically to reconceptualize schooling, and the utilization of professional schoolteachers⁶³. The chronic difficulties of schooling systems and their failure to deliver on their promise are an international problem. Symptoms of the stress on conventional schooling systems attempting to provide quality education to a whole population can be found even in affluent countries. But in our situation we face even more severe problems⁶⁴ which are likely in the relatively near future to need radical solutions.

The recommendations in the body of this Report are rooted, by and large, in a traditional and conventional view of schools, and this must be a reasonable stance to adopt in relation to the size of our education system, the range of policies that have impacted on it over the past decade, and the manifest difficulties in accomplishing a radical change in a huge system.

However, we need to try to ensure that we do not establish policies that will make it even more difficult to cope with the problems that are bound to increase in the coming decades. The following recommendation has a different status from the previous recommendations in this Report. In effect, although there are some examples of changes already taking place⁶⁵, it is to recommend a particular mindset, rather than a definite decision or course of action.

Recommendation F40

Retain on the national agenda for education and teacher education that we might need to consider radical alternatives to traditional ways of conceiving of schooling and the rôle of schoolteachers.

⁶³ A few notes about this issue are provided as Appendix 6

⁶⁴ An increasing gap between the well-off and the poverty stricken, not to mention HIV and AIDS.

⁶⁵ Two examples are some cases of qualified teachers teaching across a number of schools, and the tentative moves towards conceiving of schools as centres of care, which would become the sites for the delivery of a range of social services. See also the WCED *Education 2020: a Human Capital Development Strategy for the Western Cape* - Section on Transversal Initiatives - pp 22-25.

APPENDIX 3

List of Partners in Teacher Education

Department of Education (National and Provincial)

Key Branches, Chief Directorates and Directorates:

(Nomenclature and structural location may differ from province to province.)

Branch C: **General Education & Training**

Education Human Resources Development

Teacher Development Directorate (TDD)

Educator Qualifications & Programmes

Education Management & Governance Development (EMGD)

Curriculum, Assessment and Learner Achievement

School Education

General Education and Training (GET)

Inclusive Education

Adult Basic Education & Training (ABET)

Early Childhood Development (ECD)

Branch P: **Systems Planning**

Educator Human Resources Planning (EHRP)

Financial & Physical Planning, Information & Policy Support

Education Management Information Systems (EMIS)

Integrated Quality Management Systems (IQMS)

Educator Labour Relations Management

Educator Provisioning & Employment Conditions

Branch H: **Higher Education**

Higher Education Planning & Management

Higher Education Policy

Higher Education Planning

Branch Q: **Quality Promotions**

Quality Promotion & Assurance

HIV/AIDS & Nutrition

Whole School Evaluation (WSE)

Branch FET: **Further Education & Training (FET)**

- 1 Higher Education Institutions (HEIs)
- 2 South African Council for Educators (SACE)
- 3 Education Labour Relations Council (ELRC)
- 4 South African Qualifications Authority (SAQA)
- 5 Council on Higher Education (CHE)
- 6 Education, Training & Development Practices: Sector Education & Training Authority (ETDP-SETA)
- 7 Teacher Unions
- 8 Non-governmental Organisations
- 9 School governing bodies

APPENDIX 2

Relevant Education Policies and an ELRC Resolution encompassed by this Report

(In chronological order)

- 1. Department of Education. (1995). **South African Qualifications Authority Act No. 58 of 1995**. Government Gazette 1521. Cape Town.
- 2. **The Constitution of the Republic of South Africa**. (1996). Act No. 108 of 1996. Cape Town.
Department of Education. (1996). **National Education Policy Act No. 27 of 1996**. Cape Town.
- 3. Department of Education. (1997). **Higher Education Act No.101 of 1997**. Government Gazette 18515. Cape Town.
- 4. Department of Education. (1998). **Employment of Educators Act No.76 of 1998**. Cape Town.
Skills Development Act. (1998). Act No. 97 of 1998. Cape Town.
- 5. Department of Education. (2000). **South Africa Council for Educators Act No. 31 of 2000**. Cape Town.
- 6. Department of Education (2000). **Norms and Standards for Educators**. Government Gazette No. 20844. Dated 04 February 2000. Cape Town.
- 7. Department of Education (2000). **Criteria for the Recognition and Evaluation for Employment in Education based on the Norms and Standards for Educators, 2000**. Government Gazette No. 21565. Dated 22 September 2000. Cape Town.
- 8. Education Labour Relations Council Resolution. (2003). "**Career Pathing**". ERLC Resolution 8 of 2003. Dated 01 April 2003. Pretoria.

APPENDIX 1

Abbreviations

ABET	Adult Basic Education and Training
ACE	Advanced Certificate in Education
AdvDip	Advanced Diploma
AIDS	Acquired Immune Deficiency Syndrome
BEEd	Bachelor of Education (undergraduate)
BEdHons	Bachelor of Education Honours
CBO	Community Based Organisation
CHE	Council on Higher Education
CPTD	Continuing Professional Teacher Development
DEMMS	District Education Monitoring and Management Information System
DoE	Department of Education
ECD	Early Childhood Development
ELRC	Education Labour Relations Council
EMIS	Education Management Information System
ETDP-SETA	Education Training Development Practitioners - Sector Education and Training Authority
ETQA	Education and Training Quality Assurance (Bodies)
FBO	Faith Based Organisation
FET	Further Education and Training
GET	General Education and Training
HE	Higher Education
HEI	Higher Education Institution
HEQF	Higher Education Qualifications Framework (Draft, July 2004)
HIV	Human Immunodeficiency Virus
HSRC	Human Sciences Research Council
IPET	Initial Professional Education of Teachers
IQMS	Integrated Quality Management System
KZN	KwaZulu-Natal
M+4	Matric plus four years of additional training
MCTE	Ministerial Committee on Teacher Education
NFTE	National Framework for Teacher Education
NGO	Non-Governmental Organisation
NPO	Non Profit Organisation
NQF	National Qualifications Framework
NSE	Norms and Standards for Educators (4 February 2000)
OBE	Outcomes Based Education
OLSET	Open Learning System Education Trust www.olset.org.za
PD	Professional Development (Points or Activities)
PDE	Provincial Department of Education
PGCE	Postgraduate Certificate in Education
PQM	Programme and Qualification Mix
REQV	Relative Educational Qualification Value
SACE	South African Council for Educators
SAQA	South African Qualifications Authority
WSP	Workplace Skills Plan

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APPENDIX 5

Registration, Approval, Accreditation and Endorsement in the field of Education

Authority	Regulation	Key terminology	Notes
South African Qualifications Authority	All qualifications must be registered by SAQA on the NQF at a particular NQF Level with a specific number of NQF Credits	Registration of Qualification	
(National) Department of Education	The DoE must approve programmes and the qualifications to which they lead. Such approval signals that (a) the programme is noted in the HEI's Programme and Qualification Mix, (b) the qualification will be recognized for employment in education at a particular REQV level, and (c) the programme will be state-subsidized in a public HEI	Approval that the programme is part of the HEI's PQM Approval of qualification for employment in education Approval of programme for subsidy purposes	There needs to be a single application form for these purposes - perhaps with a common section, and particular sections for each purpose.
Council on Higher Education	All HEIs must be accredited by the CHE, to offer particular programmes	Accreditation of HEI to offer particular programmes	
South African Council for Educators	All educators are obliged to register as professional educators with the SACE Continuing Professional Teacher Development activities must be endorsed by the SACE, and allocated a particular number of PD points	Registration as professional educator PD activities Endorsed and allocated PD points	After becoming Licensed as an educator, earning PD points would become a condition for retaining the License Some PD activities would be qualifications, others would not

HEQF July 2004			Existing NQF Level	Norms and Standards for Educators (4 Feb 2000)	Standards Generating Body for Educators in Schooling (10 October 2001)	New NQF Level	Proposed qualification types in education (MCTE 8 Aug 2004)		
New NQF Level	Minimum credits	Qualification Types and minimum credits at exit level		Names of qualifications with minimum credits					
Higher Education band	Postgraduate	10	360	Doctoral Degree (360)	8	DEd (360) MEd (240)	PhD (360) MEd (180)	10	Doctoral Degree (PhD or DEd) (360)
		9	180	Master's Degree (120)	9	Postgraduate Diploma in Education (120)	Master's Certificate in Education (120)	9	Master's Degree (MEd) (180, at least 120 at Level 9)
		8	120	Honours Degree (120) Postgraduate Diploma (120)	7	BEdHons (120)	BEdHons (120)	8	Postgraduate Diploma in Education (120, at least 60 at level 9) BEdHons (120)
	Undergraduate	7	360/480 + 120	Bachelor's Degree (120) Advanced Diploma (120)	6	BEd (480) PGCE (120) ACE (120) [First degrees – 360 or 480]	BEd (480) Graduate Certificate in Education (120) ACE (120)	7	BEd (360) *Advanced Diploma in Education (120)
		6	360	Diploma (120)	5	Diploma in Education (240)	NPDE (240)	6	NPDE (360)
		5	120	Advanced Certificate (120)		Certificate in Education (120)	Professional Diploma in Education (360)	5	Higher Certificate in Education (120)?
5	120	Higher Certificate (120)			Certificate in Education (120)				

* See Appendix 4b for the proposal about the use of the Advanced Diploma in Education

Notes

- * See: The Higher Education Qualifications Framework (Ministry of Education - July 2004), esp page 23
- * The Advanced Diploma is a 120-credit qualification at Level 7 (all credits at Level 7)
- * The Advanced Diploma is a professional qualification, and it does not provide formal access to a BEdHons programme.
- * The Advanced Diploma qualifies a teacher to be classified as at REQV 14
- * An Advanced Diploma will be a requirement for Licensing by the SACE

	Qualifiers	Abbreviation	Minimum admission requirement	Articulation	Purpose	current qualification	Notes
A	Education: Postgraduate	Adv Dip (Educ: PG)	Approved 360 credit academic qualification at Level 7 (eg BA, BCom, BSc)		A 'capping' professional qualification, following an academic degree.	PGCE	First degree plus Adv Dip (Educ: PG) will be a requirement for Licensing by the SACE
B	Education: Specialisation	Adv Dip (Educ: Specialisation)	Any recognised 360 credit professional qualification at Level 6+	The Adv Dip does not provide formal access to the BEdHons. Such access is only via a degree at NQF level 7+	This is an additional professional qualification. Its purpose is to enrich current phase or learning area specialisation or a change of career path. Provides for responsiveness to new developments	ACE	For those candidates qualifying through the normal route (ie BEd or other first degree + Adv Dip) this Adv Dip will be a horizontal move on the NQF, but it will earn an additional REQV rating.
C	Education: Induction	Adv Dip (Educ: Induction)	BEd (360 credits at least 120 at Level 7)		Site-based induction year. Basic professional qualification	None	Will need to be registered on the NQF as a 120 credit Level 7 qualification. The BEd plus Adv Dip (Educ: Teaching) will be a requirement for Licensing by the SACE

APPENDIX J

Summary of Minister Naledi Pandor's article regarding factors associate with the underachievement of Grade 6's in Mathematics and Science

University of Cape Town

Source: Pandor, N (2005) *Rural schooling fails our learners*. Cape Times, 14 December 2005, page 11

Article was summarised by Associate Professor Kevin Rochford. School of Education, UCT

Factors associated with underachievement in Grade 6 mathematics, science and language

Newspaper report

Pandor (2005) reported that factors associated with underachievement among 34 000 learners in Grade 6 mathematics, language and science, in 1000 mainstream primary schools across South Africa, in late 2004 were:

(1) Out-of-school issues:

- (a) The geographical location of the school (Town schools performed best, followed by township schools, farm schools, rural schools, and remote schools least of all).
- (b) Social and economic conditions at home correlated most strongly with achievement performance. Poor households were unable to afford books, radios and television. Children who had access to these media of information and their stimulation at home generally performed better on the assessment tasks.
- (c) Some children stayed at home from time to time when their parents were unable to afford school fees. Such intermittently absent children scored significantly lower on three assessment tasks.
- (d) Learners performed better when their parents or guardians
 - were themselves educated
 - took an interest in their children's school work
 - participated in school activities.

(2) In-school issues and conditions:

- (a) "Learner participation" was most strongly associated with better performance in language, maths and science, i.e.:
 - the learners had frequent interaction with their teachers
 - they worked together
 - they used educational materials.
- (b) Home language
 - The language in which the learners were taught and learnt best was the mother tongue.
- (c) Resources
 - The richer the learning environment in schools, the better the children performed on the assessment tasks.
 - Teachers need adequate resources (delivered on time) to aid them: a library or book collection, an internet connection or a teaching resources centre - these are crucial threshold factors; where these were absent, learners fared significantly poorly.

Her recommendations for action from 2006 onwards:

1. Teachers
 - Recruit people who will make teaching a vital and respected career.
 - Provide high quality initial teacher education.
 - Supply continuing professional development for teachers.
2. Support staff
 - Significantly improve professional and administrative support from provincial, district and circuit education offices.
3. Efficiency
 - All pre-school children should receive an early childhood development programme that lays a firm foundation for further learning.

Reference

Pandor, N. 2005. Rural schooling fails our learners. Cape Times 14 December, page 11.

APPENDIX K

Contents pages of Practical Biology – A classroom resource for teachers

Source: Abratt, V.R., Collett, H., Miller-Butterworth, C. and Suiro-Steethman, V.(2002)
Practical Biology – A classroom recourse of Teachers. Cape Town: Francolin
Publishers on behalf of African Forum for Chidren’s Literacy in Science and
Technology

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APPENDIX L

Newspaper articles regarding violence at one of the under-resourced school

University of Cape Town

Source: Joseph, N (2006) Robber target pupils. Front page of *The Cape Argus* of 26

January 2006 [Online] Available on [http:// www.capeargus.co.za](http://www.capeargus.co.za) [2006,5 February]

Schronen, J (2006) Dead boy's pal has to flee school. *The Cape Argus* of April 2005
[Online] Available on [http:// www.capeargus.co.za](http://www.capeargus.co.za) [2006,5 February]



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FRONT PAGE

Robbers target pupils

Four armed muggings rock M Plain school

January 24, 2006

By Norman Joseph

Four armed robberies within three days - that's how pupils at Portland High School in Mitchell's Plain started their new school year.

It is understood members of the Schoolboys gang are targeting the pupils, entering the school grounds through a broken fence after crossing the railway line along the bridge in Morgenster Road.

It started last Wednesday, when a teenage girl's earrings were ripped from her ears at gunpoint by two men.

Fellow pupils had to help her home as she clutched her bleeding ears. She did not lay a charge for fear of being attacked again.

Last Friday, two girls were held up and robbed of cellphones and a wristwatch by two men, one with a gun.

They were attacked as they walked along the school fence near the bridge. Other pupils ran to safety.

Bystanders helped one of the girls, who had fallen. Again the pupils did not lay charges.

But on Thursday, Grade 12 pupil Victor Oliver, 16, decided to fight back. He was attacked by two men, one with a gun, on the school premises. Horrified, screaming children scattered and ran for cover.

The gunman snatched his cellphone from his hand, while the other man punched him repeatedly in the face.

But Victor fought back, and when the attacker shouted to the gunman to shoot him, Victor used him as a human shield.

By this time the school security guard, Wesley Adams, who was about 100 metres away, heard the commotion, left the entrance gate and ran to help Victor.

Seeing the gunman pointing the gun at Victor, he fired two warning shots in the air.

The two attackers fled, but Victor pounced on the unarmed man and grabbed his cellphone back.

Principal Winston Fielies said "numerous robberies" had hit the school last year.

Victor's mother, Zelda Oliver, told the Cape Argus yesterday that her son's face was swollen and bleeding and his shirt torn when he arrived home.

"He looked a mess and was in pain when he arrived home, so we took him to our doctor," she said shaking her head.

After he was treated by the family doctor, he laid charges of armed robbery, serious assault and pointing a firearm, at the Mitchell's Plain police station.



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Oliver said her son had also gone for counselling on Friday and yesterday.

Asked whether he has any plan to help safeguard pupils, Fielies said he would meet the Education Department's Safer Schools committee and inform it of the damaged fence and robberies.

Western Cape police spokesman Superintendent Billy Jones said: "The Mitchell's Plain police could only confirm one reported robbery incident that occurred at Portland High School since that school opened last week.

"The reported incident occurred on Thursday at about 9.30am, where the complainant was allegedly robbed at gunpoint of his cellphone by two unknown men. He was assisted by the security officer at the school.

"The investigation of the case is ongoing."



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University of Cape Town

Dead boy's pal has to flee school

By Johan Schronen

The friend of a Bosmansdam High School boy killed in a fight was sent home today after the principal said he could not guarantee the boy's safety.

Many parents have contacted the Cape Argus after yesterday's report to paint a picture of a school where a violent gang is terrorising and preying on other pupils.

And it has emerged that the boy who died, Chadh Rowley, had been sent home for his own safety for several days before the holidays.

Now the Education Department has ordered an urgent investigation into the situation at the school.

Yesterday the Cape Argus published an interview with a friend of Chadh who described watching the fight in a Bothasig park that ended in his death last Thursday.

The boy, who is not being identified for his own safety, reported that a gang at the school had been threatening Chadh for some months.

Today the boy, 14, went to school for the first day of his Grade 7 year, only to be told it would be better if he went home until the matter had been resolved.

The boy's father told the Cape Argus: "My wife went with our son to school today, and said to the staff in the office that, for his safety, could they keep an eye on him.

"The principal said to her, 'We can't promise anything, he should rather go home until this matter has been sorted out'."

The father added: "Now I don't know what to do. Should we send him to another school, or should we leave the area?"

Principal Danie Human said he would issue a statement on the matter, but it had not been received by the time of going to press.

Gert Witbooi, spokesman for Education MEC Cameron Dugmore, said the safety of pupils was an "absolute priority", but Dugmore was concerned about the impact violence could have on the boy's education.

Dugmore had instructed officials in his department to investigate the matter and report back to him.

The Cape Argus has received a barrage of phone calls from concerned parents, who say a violent gang operating among pupils at the school has been robbing children of money, valuables and even their lunch.

Schoolgirls were sexually harassed, according to several mothers who called in to complain about the school.

Chadh himself had been sent home several days before the school closed for the December holidays "for his own protection", according to his mother, Jessie Rowley.

Rowley said earlier that shortly before his death, Chadh, a burly "six-foot rugby player" told her: "I'm scared mom, you don't know how bad it is at school."

"Chadh was told that they were going to kill him," Rowley said. "And he took them seriously. As big as he was he had fear in his eyes when he told me about it," she said.

Even before this conversation, she and her husband Peter were planning to send Chadh to another school this year. He should have started today.

Chadh collapsed and died in a Richwood park last week after he was allegedly attacked by a classmate who belongs to the gang.

A witness at the scene told the Cape Argus that Chadh and the other boy "really climbed into each other, hitting each other on the head, in the face and the ribs".

Police said the cause of Chadh's death had not been determined and the autopsy report was still to be finalised.

Earlier this week principal Human denied there was a gang or drug problem at the school.

But he admitted there was friction between some boys, and several parents, including Chadh's mother, had complained about this.

APPENDIX M

Science Practical Work

University of Cape Town

Source: Photocopy of summary by Joubert (2003)

Background literature

The contested value of practical work internationally

The development of practical science since the 1950s has been vast.

Before the Second World War Harvard University was the one of the important institutions from where practical techniques spread into the schools in the United States. Harvard's descriptive list of key experiments remained dominant well into the late 1950s. (Khan 1990).

As the Cold War followed the Second World War, there was a growing realization that industries based on scientific findings was the key to maintaining and gaining global power. At the same time extensive research in the field of behaviourist and cognitive psychology was taking place. This meant that the reappraisal of the western science education, was influenced by the work of Bloom, Piaget and Brunner. The basis of these new curricula was the 'hands-on, pupil-centred, discovery learning method'. (Khan 1990:128)

This emphasis on discovery learning became the norm in industrialized countries and this method was spread globally by organizations like UNESCO. The Physical Science Study Committee (PSSC), Biological Sciences Curriculum Study (BSCS), Chemical Bond Approach Project and in particular the Nuffield Foundation Science programme, became known throughout the English speaking world.

These developments coincided with African decolonization. At the Addis Ababa Conference of African States on the Development of Education it was stated that:

.... 'economic and social progress is indissolubly linked with the development of education... the content of education should be related to economic needs, greater weight being give to science and its applications.'

(UNESCO, 1961:12 cited in Khan, 1990:129)

The 'hands-on, pupil-centred' approach which was being implemented in industrialised countries in the 1950s and 1960s, was only beginning to impact some African countries in the late 1970s. This approach was not necessarily implemented in African and other developing countries with a great deal of success.

In Kenya Nuffield Science was transferred as the School Science Project. One of the main reasons that it failed to have an impact is the way in which the syllabus was expected to be spread downwards from the elite schools into the less well-resourced schools. (Lowe 1986) The manner in which science programmes developed in industrialised countries were transferred and implemented in developing countries was often inappropriate for the needs of these countries. (Allsop 1991:31).

Towards early 1970s, the 'hands-on, pupil-centre or self discovery' approach was being questioned in industrialized countries. Kempa, an European science educator, gave a detailed criticism of this approach in his paper entitled 'Functions of and approaches to the practical work in science. He concluded that:

"There is ample evidence to suggest that practical work done in science classrooms at school levels and beyond often lacks direction and educational effectiveness"

(Kempa 1988:147 cited in Khan 1990:130)

Kempa supported this conclusion by citing the work of science educators in Israel, Canada and America. One of the science educators which Kempa quoted, Hofstein, together with a colleague, Lunetta, found that research had failed to show a simplistic relationship between experiences in the laboratory and student learning. (Hofstein & Lunetta 1982; Kempa in Kahn 1990:130)

The British educators, Woolnough and Allsop,(1985) felt that the discovery approach was unrealistic and that it has a weakness as a method to gain theoretical understanding. They also highlighted the expense of this approach. By the end of the 1980s Hodson described some of practical work being conducted in British schools as being confusing and unproductive (Hodson 1990)

Mank (2000) stresses that it is possible to acquire a knowledge of scientific information without doing any practical work at all. The South African educator, Naik (1995), concludes that practical work is often ill-suited to learning theoretical concepts. Agreeing with this opinion, the South African educator, Kahn (1990) commented that a lack of practical science in certain developing countries had not affected their economic development adversely: despite school science in South Korea and Hong Kong being very theoretical, their economies were highly advanced by the 1990s.

Regardless of the contested success of practical science in industrial and developing countries, practical work currently still occupies a central role in science education and should still do so in the future. (Naik 1995)

In Britain the emphasis has changed from the discovery approach to process-orientated science where not only manipulative skills, but also learners cognitive involvement in science investigations are stressed.

The South African education authorities clearly state that practical work must be prominent in science learning programmes and the emphasis on process skills has also been adopted in the new curriculum. At the time when this investigation was being undertaken, educators' lesson planning was being prescribed by the Curriculum 2005. This led to the implementation of the Curriculum 2005 in schools in 1998.

Aims of practical work

The Specific Outcomes for Natural Science relevant to this present investigation were:

1. Use process skills to investigate phenomena related to Natural Sciences.
2. Demonstrate an understanding of concepts and principles, and acquired knowledge in Natural Sciences.
3. Apply scientific knowledge and skills to problems in innovative ways.
4. Demonstrate an understanding of how scientific knowledge and skills contribute to the management, development and utilisation of natural and other resources.
5. Use scientific knowledge and skills to support responsible decision making.
6. Demonstrate knowledge and understanding of the relationship between science and culture.
7. Demonstrate an understanding of the changing and contested nature of knowledge in the Natural Sciences.
8. Demonstrate knowledge and understanding of ethical issues, bias and inequities related to Natural Sciences.
9. Demonstrate an understanding of the interaction between the Natural Sciences and socio-economic development.

(DOE 1997)

It appears that Specific Outcomes 1 to 5 imply practical work. These five outcomes have been incorporated directly or indirectly into the three new Learning Outcomes of Natural Science in the new Revised National Curriculum Statement Grades R – 9 (2002). These new outcomes and their relevance to this investigation of practical work have been discussed from 31 onwards.

Specific Outcomes 1 to 5 also overlap considerably with the six aims of practical work which South African educators identified as 'most important':

1. To make scientific phenomena more real through actual experience
2. To encourage accurate observation and careful recording
3. To elucidate the theoretical work so as to aid comprehension
4. To promote scientific methods of thought
5. To give training in problem solving
6. To arouse and maintain interest

(Naik1995:4).

Aims 2, 3 and 6 have been replicated in the South African science educator, Chacko's list of twenty aims of practical work, whereas the three other aims have been mentioned in a slightly different format.(Chacko, 1997:45). Chacko categorized practical work as 'Teacher Centered' and 'Student Centered', and prioritized twenty aims of practical work. All the aims in Chacko's list appear in a list used by three British science educators, Swain, Monk and Johnson (1999) when they asked British, Korean and Egyptian teachers to rank these aims in order of importance. Swain et al. used a list of aims which two other British educators, Beatty and Woolnough had compiled as result of surveying educators. (Beatty & Woolnough in Swain et al. 1999) This is the list of twenty aims which teachers were given to survey the teachers:

1. As a creative activity
2. To help make phenomena more real
3. To help remember facts and principles
4. To practice seeing problems and seeking ways to solve them
5. To indicate industrial aspects of science
6. To promote a logical reasoning method of thought
7. To encourage accurate observation and description
8. For finding facts and arriving at new principles
9. To be able to comprehend and carry out investigations
10. To elucidate theoretical thought as an aid to comprehension
11. To develop self-reliance
12. To arouse and maintain interest
13. To develop an ability to communicate
14. To develop an ability to co-operate
15. To develop certain disciplined attitudes
16. To develop specific manipulative skills
17. To verify facts and principles already taught
18. To develop a critical attitude
19. To give experience in standardised techniques
20. To prepare students for practical examinations

(Swain et al. 1999:1313)

A substantial amount of research has been conducted in Britain and Australia surrounding educators' attitudes towards aims of practical work, since Kerr surveyed teachers' attitudes towards the aims of practical work. Kerr conducted this survey prior to the implementation of the Nuffield curricular reforms in science education. (Kerr 1964 in Swain et al. 1999:1312).

Differing priorities or aims of practical work led British science teachers to either adopt or adapt the Nuffield ideas of the sixties. In the seventies British teachers expected learners to discover scientific principles for themselves. Rosalind Driver's in her book, *The Pupil as a Scientist?*, argued that learners' naive prior knowledge made it very difficult for them to arrive at the concepts of contemporary science by induction alone. (Driver 1983 in Swain et al. 1999). Two years later Woolnough and Allsop discussed different types of practical work and the aims of practical work. They argued that practical work can be abused when practical activities do not match aims. (Woolnough & Allsop 1985)

Hodson, the experienced British educator, referred to on page 6, felt that practical work in science education should engage the learner's thinking. He concluded that learners needed to have a definite understanding of the purpose of an experiment, if they were to gain anything from conducting it. (Hodson 1990 in Swain et al. 1999)

If learners need to have a clear conception of the aim of an experiment, then it should follow that educators need to be certain of the aim of any practical activity which they plan. Therefore in their introductory discussion on aims of practical work Swain et al. (1999), agree with Loch and Hofstein's opinion that the concern over the aims of practical work in science education has history almost as long as that of compulsory education in Britain. (Loch 1988, Hofstein 1988 in Swain et al. 1999)

In South Africa, besides Chacko's research, no other research appears to have been conducted about how to evaluate whether learners have mastered any of these aims of practical work. However, the Specific Outcomes for the Natural Science Learning Area, can be viewed as different sets or types of aims which need to be achieved as a result of a learning process or activity. The three Learning Outcomes are in the process of replacing these Specific Outcomes, and the assessment standards linked to each Learning Outcome, describes the skills, knowledge and values which a learner needs to have achieved in order to meet a learning outcome at a particular level.

6.1 Assessment of practical work

Recently the Irish science educators, Bennett and Kennedy (2001) argued that practical work should be assessed in such a way that it ensures that the aims of practical work are met. These two educators went further and listed three assessment models:

'the teacher assessment', 'an end – of- year examination' and 'the use of an external examiner as assessor' as part of Ireland's new model of practical work (Bennett & Kennedy 2001:100). They argue that using an external examiner approach can be seen as the 'fairest way of assessing practical abilities'. However this is a very expensive format that not many developing countries can afford.

In Britain, and in many other countries following the British system, the assessment of practical skills for GCSE is conducted with the classes working under 'examination conditions' (Parsons et al. 1991:108). The GCSE practical assessment procedures range from 'mini-practical examinations', where learners are subjected to performing prescribed tasks stipulated by formal worksheets in a specific time limit to 'formal and informal class assessment', to 'informal small group assessment' where groups are provided with open-ended, problem solving style worksheets which can be completed at home.

Assessing in this manner requires a more active cognitive role from learners. This form of assessment has more in common with a process oriented view of science education. It probably developed as a result of the criticism aimed at the 'pupil-centred, hands-on, discovery' approach which was popular in the 1960s and 1970s. This was discussed in section 1.5.1, pp 8-10.

The British educators, Lock and Davies, were pioneers in developing an example of a criterion – referenced form of assessment. Their OCEA science assessment framework can be represented as follows:

<u>Process</u>	<u>Skill</u>
PLANNING	Producing testable ideas Designing investigations
PERFORMING	Manipulating Observing Data gathering
INTERPRETING	Data handling Drawing conclusions Drawing conclusions
COMMUNICATING	Reporting Receiving information

(Lock & Davies 1987: 275-280)

A scheme like this would be over ambitious for assessing most South African learners at this stage. It involves assessing learners against external standards and learners either meet the standard/can perform the task or not. In an ideal outcomes-based approach learners have to be given the opportunity to attempt to meet the standard till or are able to perform a specific task. It would also cost a lot. (Davies 2003)

However, the outcomes-based framework of the National Statement of Curriculum in 1997 as well as the Revised National Curriculum Statement drafted in 2002, use assessment methods “that are able to accommodate divergent contextual factors.”

The new policy demands that assessment should provide indications of what learners have achieved in an “effective and efficient manner” and that assessment should “ensure that learners integrate and apply skills”. (RNCS, Natural Sciences 2002:3)

This perspective of assessment had been stated by the South African science educator, Ntombela in 1992. He felt that meaningful assessment in science education should:

- a) assist and support pupils in their learning, for example formative
- b) assist in identifying problem areas, for example, diagnostic
- c) assist teachers in evaluating their teaching and learning programmes, for example, evaluative
- d) provide information about progress and achievement of individual learners, for example summative.

(Ntombela 1992:58)

Ntombela (1992:61) concludes that:

"Assessment should not only test propositional knowledge, i.e. 'knowing that', but also procedural knowledge, i.e. 'knowing how', and tacit knowledge i.e. 'knowledge that we think with.'"

Ntombela's statement emphasises the assessment of cognitive skills and procedural skills which are highlighted in the new national outcomes-based curriculum. In practice South African educators are using criterion-based and normative assessment to assess practical work. They use rubrics that consist of criteria which describe different achievement levels for science process skills and theoretical knowledge which learners can achieve for Specific Outcome/Learning Outcome. Learners are given marks (norm-referenced assessment) which relate to achievement levels.

The new General Certificate of Education and Training at the end of Grade 9 requires Natural Science educators to produce a portfolio for each learner. These portfolios must contain investigation-style activities. The work in the portfolio is evidence for continuous assessment of the learner and some portfolios are moderated externally. The result of the continuous assessment makes up 75% of the learners mark at Grade 9 level. The other 25% is made up of a series of practical activities and an external exam based on these activities, referred to as the Common Task of Assessment (CAT). All the Grade 9 learners in the country participate in the same CAT annually.