THE EVALUATION OF THE AUGMENTED PROGRAMME FOR ND ANALYTICAL CHEMISTRY AT THE ML SULTAN TECHNIKON FOR THE PERIOD 1994-1999

by

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submitted in part fulfilment of the requirements for the degree of

MASTER OF SCIENCE

In the subject

CHEMICAL EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF N A OGUDE

January 2005

DECLARATION

Student No:551-952-7

I declare that “The Evaluation of the Augmented Programme for the ND:Analytical Chemistry at the ML SultanTechnikon for the period 1994-1999” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Table of Contents

Acknowledgements

The author would like to express special thanks to the lecturing and tutoring staff from the Chemistry Department of the ML Sultan Technikon that willingly agreed to be interviewed as part of this study.

The ML Sultan Technikon Research Committee is acknowledged for the travel grants awarded that made visits to my supervisor possible.

Prof Rajen Chetty assisted with the interviews for which I am truly grateful as well as his moral support and input.

The Management Information Services Department for their assistance and training in the use of the Integrated Software (ITS) package that enabled access to the student records.

Thanks to the Dean of the Faculty of Science, Mr. B Bisnath and the Head of Department of Chemistry, Mr. DK Chetty for granting permission for the study.

My gratitude goes to my supervisor, Prof NA Ogude for her enduring support, encouragement, patience and guidance.

My husband, Kelvin and sons, Evan and Lance, to whom I would like to express my heartfelt thanks for their sacrifices, support and tolerance throughout my studies.

Last but by no means least of all thanks be to My Lord and Saviour Jesus Christ for granting me the wisdom and good health to complete this study.

Abstract

Due to the inadequate schooling system and the underpreparedness of learners in South African High Schools, Higher Education Institutions are faced with learners who do not meet the minimum criteria for acceptance into mainstream science programmes. In an attempt to increase access into the institution and meet the demands of more science and technology graduates, the Department of Chemistry at the historically disadvantaged ML Sultan Technikon introduced the Augmented programme for the National Diploma: Analytical Chemistry in 1994.

This study provides a report on the profile of the students registered from 1994 to 1996, their graduation rate and a correlation of their points calculated for matric symbols with their graduation rate as well as their performance in Analytical Chemistry, the major subject of their diploma. Interviews are used to determine the perceptions of the lecturers regarding the structure of and teaching in the Augmented programme.

List of Tables

List of Figures

List of abbreviations

AARP	Alternative Admissions Research Project
B Sc	Bachelor of Science degree
B Tech	Bachelor of Technology
CAP	Context Advancement Programme
COS	College of Science
CPP	Career Preparation Programme
CTP	Committee of Technikon Principals
DoE	Department of Education
ECP	Extended Curriculum Program
HAI	Historically Advantaged Institution
HDI	Historically Disadvantaged Institution
HG	Higher Grade
IDT	Independent Development Trust
ITS	Integrated Tertiary Software
MIS	Management Information Systems
MoE	Ministry of Education
NCHE	National Commission on Higher Education
NGO	Non governmental Organisation
NPHE	National Plan for Higher Education
NQF	National Qualifications Framework
PoE	Place on Examination
Pr	Practical
PTEEP	Placement Test in English for Educational Purposes
SAPSE	South African Post School Education
SAQA	South African Qualifications Authority
SFP	Science Foundation Programme
SG	Standard Grade
SI	Supplemental Instruction
TAFE	Technical and Further Education
TFC	Tertiary Foundation Course
TELP	Tertiary Education Linkages Program
Th	Theory
TTT	Teach-Test-Teach
UNIFY	University Foundation Year
UPE	University of Port Elizabeth

1 Chapter 1

1.1 Introduction

This chapter provides a brief background for this study and places the study into context in relation to the National Transformation of Higher Education.

1.2 Background and rationale

The Chemistry Department at ML Sultan Technikon introduced an augmented programme for students studying towards the National Diploma: Analytical Chemistry in 1994 to provide access for under prepared matriculants. This programme was also in response to an increasing need for Higher Education Institutions to meet the 'shortage of highly trained graduates in the fields of Science and Technology in South Africa' (DoE, 1997a: 8). This demand can only be met if access to as well as success in Higher Education is achieved. Thus the aim of this study is to evaluate the participation and success rate of the students registered in the first three years of the three-year augmented programme for the ND: Analytical Chemistry as offered at the M L Sultan Technikon.

The ML Sultan Technikon has come to the end of an era through the merger with Technikon Natal in April 2002. The new merged institution, the Durban Institute of Technology (DIT), has new Management and the findings of this study will be useful to inform them of the success of the programme

The report of the National Commission on Higher Education (NCHE, 1996), the Education White Paper *'A Programme for Higher Education Transformation'* (DoE, 1997a) and the Ministry of Education's National Plan for Higher Education (MoE, 2001) are documents that address the transformation of Higher Education with respect to increased participation and massification of the higher education system. In particular, the Education White Paper (DoE, 1997a) sets twelve goals at a national level of which the following three are relevant to this study:

- To provide a full spectrum of advanced educational opportunities for an expanding range of the population irrespective of race, gender, age, creed or class or other forms of discrimination;
- To facilitate horizontal and vertical mobility by developing a framework for higher education qualifications which incorporates adequate routes of articulation, as well as flexible entry and exit points;
- To improve the quality of teaching and learning throughout the system and, in particular to ensure that curricula are responsive to the national and regional context

The Higher Education Act of 1997 expresses the need for an increased participation and success rate of black students in general and of African, Coloured and women students in particular, especially at diploma levels in science, engineering and technology programmes. This increased participation and success rate of black students is necessary in order to address the inequities of the past both in education and in industry. However, many of the prospective black high school students attended and many still attend under resourced schools and are under prepared for careers in science as highlighted in the DoE's White Paper on Higher Education:

> The effects of Bantu education, the chronic under funding of black education during the apartheid era, and the effects of repression and resistance on the culture of learning and teaching, have seriously undermined the preparedness of talented black students for higher education. (DoE, 1997a: 22)

The higher education system is in effect required to respond to the gap that exists between learners' school attainment and the intellectual demands of higher education programmes. To date, the short-term response has been in the form of bridging and access programmes. Another alternative is a systematic change in higher education programmes in terms of their pedagogy, curriculum and the structure of degrees and diplomas. The introduction of the National Qualifications Framework and outcomes based education according to the SAQA Act (1995) aims to achieve this systematic change in not only higher education but in all education and training in South Africa.

The Higher Education Act (1997) places Universities and Technikons together as part of a single co-ordinated higher education system. The Technikon function is 'to train students in the application of knowledge rather than in basic knowledge itself with the view to high-level career training' (NCHE, 1996:10). Amongst the characteristics of Technikons is the 'system of convenor Technikons that are responsible for individual instructional programmes' (DoE, 1997b). The ML Sultan Technikon is the convenor Technikon for Chemistry and Analytical Chemistry instructional programmes and thus this study will inform the curriculum process for the wider Technikon Community. As the Convenor Technikon for Chemistry and Analytical Chemistry, the Department of Chemistry of ML Sultan Technikon "shall take full responsibility at national level for the development, introduction and maintenance according to existing policies and procedures of programmes or groups of programmes" (CTP, 1997). This implies that the Convenor Technikon will share any changes made in the chemistry/analytical chemistry courses.

The Chemistry Department at the ML Sultan Technikon offered a Pre-technicians (Pretech) course in the 1980's to cater for those students who failed to meet the entrance requirements for science courses in the Faculty of Science. This pre-technician's course was a one-year post matric course of a general nature offering Chemistry, Physics and Mathematics at a level between matric and first year. The number of students enrolling for this course as well as their success rate increased. The students could not all be accommodated in the different science programmes resulting in disillusioned students. Hence the Chemistry

Department decided to stop the Pre-technicians course in 1994 and opted for a different course, the augmented programme for the National Diploma in Analytical Chemistry.

The National Diploma in Analytical Chemistry programme was extended from a three-year programme to a four-year programme specifically for disadvantaged students[1], that is, those students who did not meet the minimum entrance requirements for the diploma. The structure of the programme is presented in Table 1.1.

Table 1-1. The Structure of the Augmented Programme and the Mainstream Programme[2] showing differences in the programmes

National Diploma: Analytical Chemistry **Augmented Programme**	Common Subjects For both programmes	National Diploma: Analytical Chemistry **Mainstream**
Year 1 *12 months* Four periods of tutorials per subject per week	Physics 1 Mathematics 1 Communication Skills 1 Analytical chemistry 1 Chemistry 1	Semester 1 *6 months* One tutorial per subject per week
Year 2 *12 months* Four periods of tutorials per subject per week	Analytical Chemistry II Analytical Chemistry: Practical II Organic Chemistry II Physical Chemistry II Inorganic Chemistry II	Semester 2 *6 months* One tutorial per subject per week

[1] This term will be described in detail in Chapter 2

[2] This term will be described in detail in Chapter 2

Year 3 *12 months* (Students on Augmented programme follow the same programme as the students on the mainstream for year 3 and Year 4) One tutorial session per subject	Analytical Chemistry III Analytical Chemistry: Practical III Organic Chemistry III Physical Chemistry III Inorganic Chemistry III Chemical Quality Assurance	Semester 1 & 2 *12 months* One tutorial session per subject
Year 4	In-service training in Industry	

The content covered in the augmented programme subjects is the same as for the mainstream programme. The students on the Augmented programme have separate lectures from the students on the mainstream programme for Year 1 and Year 2 and attend the same lectures for Year 3 and Year 4. According to the Head of Department, this is to allow for the same standards in both the programmes so that the students on the augmented programme would not be at a disadvantage when they join the mainstream programme. Thus the only difference between the subjects offered for the Augmented programme and those for the mainstream programme was the longer time given. There was no value added subjects such as in other bridging or access programmes (discussed in Chapter 2) in the curriculum to cater for the under-preparedness of the learners. The added value was to be built into the programme in the tutorial sessions since the students in the Augmented programme had four tutorials per subject in the first two years which was three more than the mainstream students. The number of tutorial sessions decreased over the years from 4 periods per subject in 1994 to 2 periods per subject in 1999, due to funding constraints. The number of three-hour practical periods and the content of the practicals for the augmented programme were the same as those for the mainstream programme. The difference was that practicals per subject were held fortnightly instead of weekly over the whole year for the Augmented programme.

The Department of Chemistry initiated the Augmented programme in 1994 with funding provided by the Independent Development Trust (IDT) to pay for the additional tutorials in the programme. However, the funding from IDT was only available for three years resulting in the reduction of the tutorial support after three years. The staff that taught the mainstream students taught the subjects in the Augmented programme with additional tutors employed to conduct the tutorials. At that time, Academic Development or Support had not been established on a full scale at the ML Sultan Technikon and the tutors were employed solely for the Augmented programme by the Department of Chemistry.

The Department of Education at present does not fund programmes like the Augmented programme through the South African Post Secondary Education (SAPSE) funding formula. The Technikon has to cover the cost for the extra year of study for each of these students since the diploma is only funded for a three-year duration and not a four-year duration as in the case of this programme. Thus this study will inform the new Technikon Management of the success of the programme and hence influence financial decisions regarding the support of the programme.

Other Higher Education institutions in South Africa also embarked on “access” programmes. However, there was no concerted effort by these institutions to work together in designing access programmes such that they are fully SAPSE funded. Thus there are varying models of access across the institutions that are not SAPSE funded but funded through donors (Rollnick, 2000 and Sharwood, 2000) or as self-supporting foundation programmes. The National Plan for Higher Education (NPHE) has earmarked funds to ‘enable institutions to introduce, or continue to offer, extended curricula in key subject areas, as a means of improving access and success rates for students from disadvantaged backgrounds (Ministry of Education, 2001). The new funding framework will commit to effective programmes that meet the teaching and learning needs of the students they admit and as such, it is important that the Augmented Programme for Analytical Chemistry at ML Sultan Technikon be evaluated. Another reason for this evaluation is to inform the choice of programme for the new merged Institution, Durban Institute of Technology, which came about as a result of the merger between Technikon Natal and ML Sultan Technikon in April 2002. Technikon Natal did not offer any access programme for Analytical Chemistry that could be compared with the Augmented Programme at ML Sultan Technikon.

The Augmented Programme at the ML Sultan Technikon is different from programmes offered at some Universities since all the subjects in this programme are credit-bearing towards the Diploma and there is no subject choice for the students, their subjects are all prescribed as per NATED 151. Furthermore, the entrance requirements of students at the Technikon are a Senior Certificate whilst the University entrance is a Matriculation exemption. A literature review in chapter 2 provides information regarding the various access programmes nationally and internationally.

1.3 Research Questions

The overall aim of this study is to measure the success of the Augmented programme at ML Sultan Technikon during the period 1994-1999. Two problems exist though namely, the small sample size and the problem as to how success is measured with all the various criteria or indicators of success that can be used. These criteria range from registration rates, to pass rates on individual courses, graduation rates, graduation rates during a particular time period, potential graduation rates, retention rates and broader criteria with respect to student perceptions. For this study, the pass rate on an individual subject as well as the graduation rate for the students will be used.

Quantitative methods will be used to provide the student profile, the comparison of matric points against graduation rates for the students and their performance in Analytical Chemistry. Interviews with lecturers will be undertaken as part of the qualitative methods to gain their perceptions of the programme.

A profile of only the first three cohorts of students that registered in 1994, 1995 and 1996 in the augmented programme will be used for this study since complete student records were only available for these three cohorts of students which constitute the first three years of the programme.

The performance in the subject Analytical Chemistry at levels 1, 2 and 3 in the Diploma was chosen since it is the major subject of the Diploma (see Table 1.1 above for the other subjects in the Diploma). Since this is a small-scale study, time does not allow for a full study of all the subjects in the Diploma as well as for a comparison with the students on the mainstream programme. It is not possible to do a meaningful comparison of the results for the students on the Augmented programme with students on the mainstream for the subjects (that is Analytical Chemistry 1,2 and 3) since the student numbers are very different, less than 20 students in the Augmented programme and approximately 60 students in the mainstream programme per year. Another factor is that there are too many variables for the subjects at year 1 and year 2. Some of the variables are the time taken for the subject (six months against one year), the number of tutorial periods (four periods against two or one period per week), differing number of tests during the programme, to mention a few.

The graduation rate for the students is defined as the percentage of the students who graduate from the programme. The performance in Analytical Chemistry subjects and the graduation rates of the students is analysed in terms of gender to establish the success rate of the males and females registered for the programme.

Selected lecturers and tutors in the Department of Chemistry at the ML Sultan Technikon are interviewed to determine their perceptions of and attitudes towards the augmented programme and the students in the programme. Only lecturers and tutors that taught these students are interviewed. The students were not interviewed as part of this study since the time available was too short to track the students, as most of them are no longer studying at the institution.

The main question to be answered from this research is “What is the success of the National Diploma: Analytical Chemistry Augmented programme at the ML Sultan Technikon?” The sub-questions for the research are:

1. What is the profile of students admitted to the Augmented programme?
2. What is the relationship between matric symbols (marks) and the graduation rates for the students?
3. What is the performance of the students in Analytical Chemistry?
4. What is the difference between the graduation rates of females and males in the programme?
5. What are the lecturers’ and tutors’ attitudes/ perceptions of the structure and role/purpose of the Augmented programme ?

A comparison with the mainstream programme will not be undertaken since this is small-scale research project and the data for the mainstream programme is too much to include in this study.

As a lecturer in the Department of Chemistry access to all student records and to lecturers was provided once an ethics clearance for the project was obtained from The Technikon Ethics Committee.

1.4 Summary of chapters 2 – 5

Chapter 1 provides a background in terms of National documents that informed the introduction of the Augmented programme for the National Diploma: Analytical Chemistry at the ML Sultan Technikon. The objectives, significance and limitations of the study were also briefly discussed.

Chapter 2 provides a literature review of access programmes offered at other South African and International Higher Education Institutions for disadvantaged students. This chapter concludes with a review of the teaching and learning of disadvantaged learners in Higher Education Science courses.

The methodology used for this study is discussed in chapter 3 which includes aspects of quantitative and qualitative research methods, sampling participants and interviews.

The analysis of the quantitative data and the interviews is reported in chapter 4 with recommendations and consolidated findings in Chapter 5.

2 Chapter 2: Literature Review

2.1 Introduction

The purpose of this chapter is to provide 'a picture …of the state of knowledge and of major questions in the subject area being investigated' (Bell, 1999: 93). Various models of programmes that provide access to students to ensure the elite-mass transition of Higher Education Institutions both internationally and in South Africa are presented in this review to determine which model best represents the ML Sultan Technikon programme. Internationally the programmes cater for the minority population groups whereas in South Africa these types of programmes cater for the majority population group. In this move to massify higher education in South Africa, Universities and Technikons have developed programmes to provide access for students, in particular, disadvantaged black students from high schools. However, access is one side of the coin with success being the other side. It is of no value to have access without ensuring success of these students in the programmes. Thus the performance of students in these access programmes needs to be monitored to measure their success rate.

Lastly, the reports on skills and abilities of disadvantaged students are examined and the teaching styles and coping abilities of lecturers involved in the programmes are reviewed.

2.2 Disadvantaged students

Students that gain access to the augmented programme are generally Black and disadvantaged. One definition of Black students is those students from African, Coloured and Indian origins as previously classified in the South African apartheid era. Another definition excludes Coloured and Indian persons. For this study the term black student will mean the latter definition.

Disadvantaged students mean that they come from low socio-economic backgrounds, are rurally isolated and from non-English speaking backgrounds. For the purpose of this study, Afrikaners in rural areas are excluded since they had access to Higher Education.

These black students were identified as being educationally disadvantaged students due to the fact that the schools most of them attended were 'inferior as the classes were very large; the facilities were limited and inferior; there were insufficient teachers and they frequently were not adequately qualified' (Futter, 1999: 11). Statistics reported in 1990 showed that only '9,9% of the teachers in black secondary schools in South Africa were graduates and the pupil-teacher ratio was 39:1 in the Department of Education and Training black schools' (Webb and Erwee, 1990: 87). This situation has not changed much over the last decade with duRand and Viljoen (1999) reporting that 87% of all black teachers are underqualified to teach in high schools. According to the National Strategy for Mathematics, Science and Technology Education in General and Further

Education and Training report (DoE, 2001), most mathematics and science teachers are not qualified to teach these subjects since only 50% of the professionally qualified teachers had specialised training in Mathematics in their training and 42% were qualified in Science.

Besides the issues of underqualified teachers, these students are also disadvantaged in other areas such as socio-economically and studying through the medium of a foreign language. Many of these students live under poor conditions and English is hardly spoken at home. Their home language is either Zulu, Xhosa or any of the other eight African languages.

McNamee's (1995) definition of disadvantaged persons as having 'gaps in knowledge of concepts, processes, self and culture' is an appropriate description of the students that are accepted on the augmented programme especially in relation to gaps in knowledge and concepts. These disadvantaged students have been traditionally underrepresented in higher education in South Africa and these gaps exist when compared with mainstream students in higher education. Mainstream students are those students that meet the entrance requirements of programmes in higher education. Disadvantaged students that may possess necessary knowledge of concepts and processes and have sufficient self-confidence may well fail in mainstream institutional culture because of a lack of awareness of the rules or norms of the foreign higher education culture. Examples cited by McNamee of some the values of Higher Education are:

> 'plagiarism is unacceptable and punishable while referenced paraphrasing is an acceptable practice' and also that 'collaboration is rewarding while copying answers is cheating'. (McNamee, 1995:109)

In South Africa, the disadvantaged persons are in the majority and thus access to Higher education of this group can result in the massification of Higher Education and social justice. Access to Higher Education for black students has been an issue since the 1980's in South Africa due to the elitism and apartheid policies of many of the higher education institutions .

2.3 Access to Higher Education

Access to Higher Education is not an issue that is peculiar to South Africa; it has been an issue in USA, Australia and Europe to mention but a few countries, since the early eighties (Fulton & Ellwood, 1989; Parry & Wake, 1990; Rosen, 1990; Berdahl, Moodie & Spitzberg, 1991; Saunders, 1992; Boezerooy & Vossensteyn, 1999;). The introduction of the Commonwealth Higher Education Equity programme in 1985 by the Australian Federal Government resulted in considerable growth in the number of access and bridging programmes for disadvantaged persons (McNamee, 1995) and in the United Kingdom, through policies developed in White Papers like *Higher Education: Meeting the Challenge,* government gave support to widening access (Parry & Wake, 1990). Widening access to Higher education is taken as meaning 'providing equal opportunity to enter higher education to all those able to benefit from it, without any distinction for this purpose between them' (Parry & Wake, 1990:14). In South

Africa as mentioned previously, access to higher education for blacks and also for women in particular is needed to:

- change the profile of students in higher education to more closely resemble the demography of South African society
- enable social reform or reconstruction and thus allow participation in the professions.

However, because these students are disadvantaged, they are generally under prepared for higher education resulting in ‘access without success’ (NCHE, 1995). The Technical Committee of the NCHE lists major factors that contribute to poor student access and success:

- ‘The vast majority of black students are academically under-prepared for entry to traditional higher education courses. Furthermore, very few black students are graduating from high school with passes in mathematics and physical science at a level that would qualify them for admission into higher education science and technology programmes;
- The lack of articulation between higher education and black schooling. The current curricular organisation and funding of higher education programmes continues to be based on assumptions about starting levels that no longer hold for the majority of entrants. There is thus a mismatch between the demands of higher education programmes and the academic preparedness of students, the result of which is gross inefficiency in the system.

- The rigidity of the curricular structure of current first degrees and diplomas assumes a homogeneous student intake which no longer applies, and militates against student progression. (NCHE, 1995:2)

These factors mentioned above support the definition of disadvantaged as given earlier, highlighting the need for programmes or courses to meet the needs of these students.

Higher education needs to be able to meet the demands of access especially in science and technology, in a flexible and responsive manner while maintaining acceptable standards of quality and meeting budgetary constraints.

Access programmes to address the gap that exists for students entering higher education could be either foundation programmes or bridging programmes. As a result of this educational gap experienced by disadvantaged students, many will fail and repeat or leave Higher Education (Masha and Mayeya 1999). Masha and Mayeya (1999) as well as the Directory of Science, Engineering and Technology Foundation Programmes[3] and the NARSET report[4] mention different ways of dealing with the problem of the gap that exists for students entering higher education. One type of model is that of support activities or extra tutorials, offered at the higher education institution, on the side of existing courses with

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[3] Wits Directory of Science, Engineering and Technology Foundation Programmes & Proceedings of the 'Indaba' of Science, Engineering and Technology Foundation Programmes compiled by Dee Pinto, June 2001, University of the Witwatersrand College of Science

[4] NARSET report (1997) – Issues relating to Access and Retention in Science, Engineering & Technology in Higher Education UNESCO/DACST

reduced load. These support activities are normally co-ordinated by academic development units and are provided to “at risk students”, that is, students that come from disadvantaged schooling. The workload for the students is distributed across the whole study period. Academic Development staff and student assistants or mentors, especially senior students, conduct the support activities and there is hardly any integration into departments. Furthermore these extra tutorials mean extra contact time for the students, with less time available for independent study, reflection and internalisation of ideas. The assumption of this intervention is merely to fill the “gaps” in the knowledge base of the student.

A second model could just be spreading the content of a mainstream course over double the time by decreasing the pace of presentation of the material. Such courses have problems in that they do not prepare students for the increased workload in later years and do not address the background of the students.

A third model will be to offer ‘zero-level’ pre-degree courses which are seen as remedial initiatives that could be credit-bearing. The Bridging and Foundation courses generally fit into this model. The duration of these courses could vary from as little as one week to a full academic year (Wits Directory, 2001). Traditionally, Bridging courses were seen to be ‘backward-looking’ in that the material covered was typically based on the High school syllabus whilst the Foundation courses were ‘forward-looking’ by including the essential elements of the university course material. In practice though, a hybrid of the Bridging and Foundation courses is offered.

Problems with the foundation courses could be issues of ownership and the fact that the course could be an add-on at the bottom especially if the support activities are a range of add-on supplementary and /or remedial sessions. Ownership could be in the discipline department or the Academic development department, it is however best when in the discipline department and taught by experienced staff rather than contract (add-on) tutors (Jack, 1995). This issue will be examined and discussed for the augmented programme at the ML Sultan Technikon during the interviews with staff in Chapter 4.

A further model is the re-organised degree structure in which the degree is extended by one or more years with the first year usually completed over two years. The programme runs parallel to the regular degree structure up to a certain level after which they combine. This model is seen as the developmental initiative as compared to the remedial initiative discussed above. Students receive credit towards the degree and 'foundation type material is introduced as required. The problem with this model is that the students are not necessarily prepared for the pace of subsequent courses.

The first model is cost effective and provides work experience to the mentors whilst the sustainability of the other models is very doubtful due to funding issues and acceptance of the students by the Higher Education Institutions. The successes or otherwise of Higher Education Institutions in the United Kingdom, Australia and South Africa in implementing these models in various types of science-related programmes will be discussed in the sections below.

2.3.1 Access Programmes in the UK

Huddersfield Polytechnic in the UK designed a Technology foundation course for Women, in 1985. This one-year course was to help women compensate for their previous lack of experience in technology and to prepare them to enter diploma and degree courses in higher education which would afford them career options in science and technology (Newton & Williamson, 1987). The women admitted to the course ranged in age from 18 to 50 years and had few, if any, formal qualifications in science and mathematics. The reason why the course was specifically designed for women was based on success reported in teaching women non-traditional subjects in single sex groups, since, most women prefer this situation and find it more supportive and less threatening than a big group.

This foundation course for women had a wide focus organized around a basic core of four subjects: mathematics, physics, chemistry and computing. It also included a module on study skills and careers information another module on design and materials and one on people and technology. There were few formal lectures and most sessions were informal and group-centred with both men and women acting as tutors for the course. Twenty of the original 24 students were reported to have completed the course. Sixteen out of the twenty students were offered places on diploma or degree courses in a range of subjects from engineering, commerce, computers and sciences and they were doing well. The initial group of students made positive responses regarding the course, however, no further information is available on the sustainability of the course.

2.3.2 Access Programmes in Australia

Access to Australian Universities for disadvantaged students was mainly through bridging programmes. Two examples of these programmes are discussed below.

At Monash University, the Faculty of Education offered special bridging courses, for the Faculty of Engineering students, in Chemistry and Physics to students who had the appropriate high entry scores, but who had not studied either one or the other of these subjects during their Year 12 program (Mitchell and de Jong, 1994). The intention of these bridging courses was to broaden the base of potential students for Engineering courses. The two bridging courses were pre-requisites for first year Chemistry and Physics and they were run concurrently with other first semester subjects and involved six hours of class time per week. These students worked until 7.15 p.m. on one evening a week as well as four hours on each of two Sunday mornings per month. The courses were offered in the Faculty of Education since the nature of the content of the courses, the tutorial class sizes and the learning and teaching strategies required correlated more closely to the skills held by Education Faculty staff than those of the Engineering or Science staff. The courses were designed to cover most of Year 11 and Year 12 chemistry and physics in 13 weeks. Mitchell and de Jong (1994) report that these classes were better than average Year 12 classes, slightly weaker than the average first year group and were doing under sufferance a subject, such as chemistry, they disliked. The bridging students integrated successfully into standard engineering courses and they took one extra semester to complete their Engineering degrees. In terms of teaching and learning strategies, meaningful understanding of the subjects was made possible through pre-reading of material to be discussed, small group discussions and co-operative construction of meaning. A problem area of the courses was to co-ordinate the timing of the practical work and theory as well as to integrate the presentation of both practical and theory. Overall though, the first four years of the bridging program was found to be successful in assisting disadvantaged students to cope with standard academic courses which require those subjects as pre-requisites for further study.

Bridging programs in science and mathematics were designed for Australian Aborigines at Curtin University of Technology to compensate for their inadequate secondary level education and to qualify them for entry into undergraduate science and technology courses in higher education (Fraser, Malone and Taylor, 1990). Aborigines were among the groups under-represented in higher education, similarly to the South African situation regarding Black students. This program was designed for Aborigines who had studied mathematics, chemistry, physics or physical science at year 11 as well as students who had completed Year 12 but had not performed well in university entrance examinations.

Mathematics and Chemistry were the subject areas for the bridging programme with cultural support and academic support offered as part of the program. The content of the Mathematics and the Chemistry were based on the Western Australia syllabi for Mathematics II and III and Chemistry which are the preferred subjects for students who wish to gain entry into tertiary level undergraduate science and technology courses. The Centre provided the cultural support for Aboriginal Studies at Curtin University, to assist students in the development and enhancement of their Aboriginal identities. Academic support subjects such as Study Skills, Assertiveness Training and Communication skills were offered. A constructivist model of knowledge development provided a conceptual framework for the programme which means that knowledge is actively constructed in the mind of the learner on the basis of pre-existing cognitive structures (Pope and Gilbert, 1983). Academic support was further provided by means of diagnostic assessment, individualized instruction, short term learning goals and independence of learning. Regular diagnostic assessment of individual students helps to identify and remedy problematic background knowledge prior to students constructing their new content knowledge. Individualized instruction recognizes that cognitive development is a personalized phenomenon and that students have individual student learning needs. Continuous, summative assessment provides the opportunity for students to focus on achieving short-term learning goals and to validate their newly constructed content knowledge. For students to be responsible for the success of their own knowledge construction, opportunities are provided for them to exercise self-management in relation to the planning, conduct and evaluation of their learning activities.

The initial success of the programme could not be meaningfully measured in a quantitative manner since only four students registered for the programme since the pool of potential candidates was very small – the Aborigines are a minority group. However, of the four students, two left before completing, of the two that were successful, one is progressing satisfactorily in a Medical Science undergraduate course and the other is enrolled in a college of Technical and Advanced Further Education (TAFE) and is currently studying for his Commercial Pilot's licence.

These bridging programs were later found to have broad application to anyone who currently has an inadequate secondary level education and mature age candidates. Subsequently, these programmes have been purchased by 100 tertiary, TAFE and secondary institutions throughout Australia (Fraser, Malone and Taylor, 1990).

2.3.3 Access Programmes at South African Institutions of Higher Education

South African Higher Education Institutions existed as two sectors, either Technikons or Universities with the former catering more for vocationally-based education whilst the latter for discipline-based qualifications. Both Technikons and Universities experienced the problem of access and students having a gap between high school and entrance into Higher Education. Thus various structures of programmes were introduced at the Institutions as indicated in Table 2.1[5] for Technikon programmes and Table 2.2[6] for University programmes.

[5] Wits Directory of Science, Engineering and Technology Foundation Programmes & Proceedings of the 'Indaba' of Science, Engineering and Technology Foundation Programmes compiled by Dee Pinto, June 2001, University of the Witwatersrand College of Science pp 21
[6] Ibid pp22

Table 2-1: Programme structure for Technikons

Issues of programme structure (technikons)

ORGANIZATION/ PROJECT	A T/E/S	B Prog size	Duration	ZERO LEVEL + MAIN-STREAM	COMMENTS
Border Technikon (TFC)	**S**	**M**	1 yr	1 + 3	*Started 1992*
Cape Technikon	**-**	**-**	-	-	*No formal programme yet*
E. Cape Technikon	**-**	**-**	-	-	*Foundation managed by student Affairs*
Free State Technikon (CAP)	**S / E**	**n/m**	1 yr	1 + 3	*Co-ordinated by faculties*
Mangosuthu Technikon	**-**	**-**	-	-	*Access route via PROTEC*
ML Sultan Technikon	**S / E**	**M**	2 yrs	2 + 2	*Augmented progr*
Technikon N-Gauteng	**-**	**-**	-	-	*No formal programme yet*
Technikon Natal	**S**	**n/m**	½ yr	½ + 3	*Some credit-bearing courses*
Technikon N-West	**S / T**	**L**	½ yr / 1 yr	½ + 3 or 1 + 3	*Started 1986, but modified*
Peninsula Technikon	**-**	**-**	-	-	*Access route via Natn'l Access consortium*
PE Technikon	**S /T**	**S: M T:S**	½ yr	½ +3	*Started with 12 students, now 200*
Technikon Pretoria -Certif for lab assists -Techn Access Programme	 **S** **E**	 **M** **L**	 ½ yr ½ yr	 ½ +3 ½ +3	*Science planning to change course; relatively large numbers*
Technikon SA	**S**	**M**	½ yr	½ +3	*No credit-bearing*
Vaal Triangle Technikon	**-**	**-**	-	-	*No formal programme yet*
Technikon Witwatersrand	**E / HS**	**L**	1 yr	1+ 3	*Currently being reviewed*

Key to Programme Size:
Less than students = **S**
Between 50 – 100 = **M**
More than 100 students = **L**
Not mentioned = **n/m**

Table 2-2 Programme structure: Universities

ORGANIZATION / PROJECT		T/E/S	Prog size	Course length	Zero Level + Main Stream	COMMENTS
MEDUNSA		**S**	**S**	1yr	1 + 3 OR 6	*Some credit toward BSc*
UCT	*GEPS*	**S**	**L**	2yrs	2 + 2	*Arose from AD progr*
	ASPECT	**E**	**M**	2yrs	2 + 3	*Expanding AD in faculty*
UDW *(SEFP)*		**S / E**	**M**	1yr	1 + 3	*Going since 1993: restructured*
U Fort Hare *(EFYP)*		**S / T**	**L**	1yr	1 + 3	*AD expertise drives programme*
U Free State *(CPP)*		**S / T**	**L**	1yr	*Combined tech & univ – career prep & placing*	
UN-D	*Augmented prog*	**S**	**S**	1yr	1 + 3	*'One over two' – reduced load*
	UNITE	**E**	**S-M**	1yr	1 + 4	*Some credit-bearing courses*
UN-Pmb *SFP*		**S**	**L**	1yr	1 + 3	*Going since 1991*
U North *UNIFY*		**S**	**L**	1yr	1 + 3	*Plan to increase to 300 Ss*
U North-West		**S / T**	**n/m**	n/m	n/m	*Common foundation course for S & T*
UPE *UPEAP*		**S**	**L**	1yr	1 + 3	*New, and has grown large very quickly*
U Potch	*TECHPUK*	**S**	**S**	1yr	1 + 3	*Articulation with Technikon*
	OPIPUK	**E**	**n/m**	2yrs	2 + 3	*Some credit-bearing courses*
U Pretoria *UPFY*		**S / E**	**M-L**	1yr	1 + 3	*Planning to increase*
Uni Qwa		*Foundation programme is currently in the planning stages*				
RAU *Learning Centre*		**S/E/T**	**S**	1 or 2 yrs	1 + 3/ 2 + 3	*Developing certificate in S, E and T*
Rhodes U *SFP*		*Not a formal programme – Dean's discretion*				
UNISA		*No fomal programme – 'Access' modules in Maths, Chemistry & Physics*				
U Stellenbosch *EFP / SFP*		**S/E**	**n/m**	4yrs	1 + 3	
U Transkei *SFYP*		**S**	**M**	1yr	1 + 3	*Plan to increase to400 Ss*
Uni Venda *SFP*		**S**	**S**	1yr	1 + 3	*No credit-bearing courses*
Vista U *4-yr B.Sc* *(Soweto Campus)*		**S**	**M-L**	1yr	2 + 2	*Planning pre-degree certificates*
UWC *SFP*		**S**	**L**	1yr	1 + 3	*Plan to keep as is*
Uni Wits	*Coll of Science*	**S**	**L**	2yrs	2 + 2	*Integrated into mainstream*
	PUBS	**E**	**M**	1yr	1 + 4	*1-yr add-on*
	Eng FP	**E**	**M**	1yr	1 + 4	*Ss selected after April tests*
Uni Zululand *SFP*		**S**	**n/m**	¼yr	**¼ + 3**	*Very new; 3-monts foundation*
U Eduardo Mondlane *BUSCEP*		**S**	**L**	¼yr	**¼ + 4**	*May become part of Education Faculty*
U Namibia *Access course To H.E.*		**S/T**	**n/m**	¾yr	¾+ 3	*Planning to increase numbers*

T/E/S in Table 2.1 represent the categories of Technology, Science and Engineering. From this table it can be seen that the programme offered at ML Sultan Technikon is for both Engineering and Science courses, however this study will only be looking at the Science course as part of this small scale study.

Furthermore this table shows the programme at ML Sultan as being a medium size between 50 and 100 which was the case as from 2001 with 60 students enrolled for the Augmented programme and only 20 students for the mainstream programme which was a management decision based on the ‘poor quality’ of matriculants making application for the mainstream national diploma programme. The typical duration of the programmes at Technikons was one semester with the programme at ML Sultan the only one of a two-year duration before the learners joined the mainstream class for the last two years of the programme.

Table 2.2 shows that as of June 2001, only Medunsa, University of Natal-Durban, University of Potchefstroom, RAU and University of Venda offer small, that is, less than 50 student, size programmes for Science. The other universities have larger number of students with plans to increase numbers further. University of Free State allows for articulation with Technikons.

The identity of the Technikon and University programmes in terms of whether it is integrated into the Faculty, credit-bearing and whether the mainstream courses have been restructured in any way is shown in tables 2.3[7] and 2.4[8]. The ML

[7] Wits Directory of Science, Engineering and Technology Foundation Programmes & Proceedings of the ‘Indaba’ of Science, Engineering and Technology Foundation Programmes compiled by Dee Pinto, June 2001, University of the Witwatersrand College of Science pp 24

[8] Ibido pp 25

Sultan Technikon programme (Table 2.3) and the University of Cape Town programmes (Table 2.4) are the few programmes that were integrated into the Faculty, however, other programmes such as the College of Science, Wits, receive support in the form of recognition within the academy.

Table 2-3 Programme Identity - Technikons

INSTITUTION / PROGRAMME		**Faculty Integration: In or Out**	**Credit-Bearing? (Accreditation)**	**Mainstream courses restructured?**
Border Technikon		Partly	No	No
Cape Technikon *(See Nat Access Consortium – W. Cape in Directory)*				
E. Cape Technikon		-	-	-
Technikon Free State		Partly	Yes	No
Mangosuthu Technikon *(See Protec entry in Directory)*				
ML Sultan Technikon		In	No	Yes
Technikon N-Gauteng		*		
Technikon Natal		n/m	Yes	No
Technikon North-West		Out	No	No
Peninsula Technikon		*		
P.E. Technikon		Out	Yes	No
Technikon Pretoria	*Science*	Out	No	No
	Engineering	Out	No	
Technikon S.A.		Out	No (only computers)	No
Vaal Triangle Technikon		*		
Technikon Witwatersrand		Out	No	No

*** No formal programme**

Table 2-4 Programme Identity : Universities

INSTITUTION / PROGRAMME		Faculty Integration: In or Out?	Credit-Bearing? (Accreditation)	Mainstream courses restructured?
MEDUNSA		Out	Partly	No
U Cape Town	*GEPS*	In	Some	Yes
	ASPECT	In	No	Yes
UDW	*SEFP*	Out	No	No
U Fort Hare	*EFYP*	Partly	Yes	No
U Free State	*CPP*	Out	Yes	
U Natal – Durban	*Augm Prog*	Out	Some	No
	UNITE	Out	Yes	No
U Natal - Pmb	*SFP*	Partly	No	No
U North	*UNIFY*	Out	No	No
U North-West	*(No formal programme)*		*	
U Port Elizabeth	*UPEAP*	Out	No	No
U Potchefsroom	*TECHPUK*	Out	No	N/m
	OPIPUK	Partly	Some	No
U Pretoria	*UPFY*	Out	No	No
UniQwa	*(No formal programme)*			
RAU	*Learning Centre*	Partly	Yes	No
Rhodes U	*SFP*	Out	No	-
UNISA	*(No formal programme)*			
U Stellenbosch	*EFP/SFP*	Re-structured degree curriculum		
U Transkei	*SFYP*	Out	No	No
UniVenda	*SFP*	Partly	No	No
Vista U	*4-yr B.Sc*	In	Yes	Yes
UWC	*SFP*	Out	No	No
U Witwatersrand	*Coll of Science*	In	Yes	yes
	PUBS	Partly	No	No
	Eng FP			No
U Zululand	*SFP*	In	Yes	No
U Eduardo Mondlane	*BUSCEP*	Out	No	No
U Namibia	*Access course to HE*	Out	No	no

From the NARSET report (1997) and the Wits Directory (2001) mentioned above, it is evident that the structure and identity of programmes for access are far from static more so now due to the changing landscape in Education in general and specifically in Higher Education in South Africa.

A description of some of the science programmes mentioned above will be given as well as reports of the successes and challenges facing these programmes. The similarities and differences between these courses and the augmented programme at the ML Sultan Technikon will also be highlighted.

2.3.3.1 Technikons

Border, Technikon North West (TNW), Port Elizabeth and Pretoria Technikon offer access programmes for the students in Natural Sciences which is similar to the ML Sultan Technikon target group (Wits Directory, 2001). These programmes cater for students that have not met the matric minimum entrance requirements for entry into the National Diploma and institutions use standardised assessment tests –TNW, battery of psychometric tests – Port Elizabeth and Pretoria as well as interviews to select the students for the programmes. The major problems that these institutions face are the identification of students with potential and issues of funding, since the courses were not government subsidized until recently.

The programme at Port Elizabeth Technikon is the only one that offers a credit-bearing course and will be discussed in more detail.

2.3.3.1.1 Port Elizabeth Technikon

A six-month foundation programme, the Pre-Technician course, was introduced at Port Elizabeth Technikon in 1989 to address the poor success rate of Black students in Science and Technology Programmes (Sharwood, 2000). The Anglo American Chairman's Fund provided funding for the programme. The curriculum catered for "at risk" students who were identified on the basis of their school marks and a battery of competency tests. These students must have passed both Mathematics and Science on the Higher Grade at school with an E symbol, in some cases, an F symbol was accepted.

The course consists of:

- Mathematics 1 (Credit Subject)
- Physics
- Chemistry or Technology
- Technical English
- Life Skills

The students follow the same Mathematics 1 syllabus, tests and examinations as the mainstream students. These students, however, have 8 periods per week as opposed to 6 periods per week for the mainstream students. This subject provides the students with an idea of the standard required and the pressure under which they will be required to work in the mainstream class. Nearly 70% of the 1500 students that have enrolled for the Pre-Technicians programme since its inception have continued their studies in Higher Education.

Class sizes are kept small (approx 25) to allow for individual attention and working in small groups. The programme is presented in an integrated way by a team of ex-teachers. Initially, lecturers in the programme were from mainstream departments, however, this was found to be unsuitable since they treated students as school children and taught them only very basic work. (Sharwood, 1999)

The programme together with the counseling in the life skills course, gives the students a good basis on which to choose their careers.

2.3.3.2 Universities

Universities have also had problems of funding these programmes and selection of students and the NARSET report (1997) mentions the possibilities of moving such programmes to Technical Colleges. The models for Science programmes at Universities of Natal(PMB)-SFP, Witwatersrand-CoS, Free State-CPP, North-UNIFY, and Cape Town- GEPS are fairly well established and will be discussed since these students prepare for Chemistry as a career, The University of Potchefstroom programme for the natural sciences allows entry to students who have completed N4 level courses at the technical college.

2.3.3.2.1 University of Natal Programmes

The Science Foundation Programme (SFP) at the University of Natal, Pietermaritzburg is a one year long programme preceding entry into a degree in

Science or Agriculture. It is designed to identify academically able but underprepared Black students and equip them with the resources, skills and confidence to embark on a degree programme (Downs et al, 1995). Students spend a year studying Biology, Chemistry, Mathematics and Physics. In addition part of the SFP is a language development subject, Learning, Language and Logic, which develops among other things the following skills- topic analysis, reading critically, writing effectively, communicative strategies, generalisation and making predictions and the ability to generate other examples.

Downs et al (1995) report that the educational philosophy of SFP draws strongly on:

- Vygotsky's theories of learning as social activity. Through experiential learning, students are encouraged to learn the social language of science and internalisation of cognitive functions and practices are desired learning outcomes
- the constructivist theory of cognitive science posits that learners make sense of their world through their own experience of reality, Learners are involved in the process of knowledge construction and therefore the structure of instructional activities are important

This philosophy is the same as that for the UNIFY programme at the University of the North.

The Gencor Science Foundation Programme (SFP) (Raubenheimer, 1998) was evaluated and found to be effective in achieving its goal of preparing students to enter mainstream university courses. The evaluation was done in the context of proposed changes in student numbers for the course from 110 in 1997 to 160 in 1998. The success of the programme was investigated particularly in relation to student performance. This study showed a positive correlation between the matric points and the student aggregate in the SFP year. There were some exceptions found but generally, students with less than 20 matric points[9] performed below average. The mean SFP aggregate for all students each year showed a decrease in student performance from 1991 to 1996 and an analysis of variance showed that overall this trend is statistically significant ($p = 0.018$). This decline in performance was paralleled by a decline in average matric points for 1996(analysis of variance, $p = 0.0003$). Interviews conducted with students revealed that communication skills, time and stress management skills as well as discipline related skills covered in the SFP were beneficial to their studies. Raubenheimer (1998) further found that the 1992 and 1993 ex SFP students were as successful as the average for the science faculty in graduating with a BSc degree and that female students performed better than male students.

[9] Matric points are calculated using the table below (Rutherford and Watson, 1990)

Symbol	A	B	C	D	E	F
Higher Grade	6	5	4	3	2	1
Standard Grade	4	3	3	2	1	

The University of Natal, Durban supplemented a first semester chemistry course to improve the prospects of success of black African students (Miller and Ford, 1995). Their study indicated the need for more curriculum time so that underqualified learners can attend extra sessions to prepare them for mainstream topics. The augmented students benefited from the tutorial programme and their results improved over the first year of study. On average, however, only 40% of students who entered this programme completed their B.Sc degrees (Parkinson, 2000). Furthermore few students graduated in minimum time of four years with a possible reason being the increased workload and lack of tutorial support from year 2 to year 3.

2.3.3.2.2 University of Port Elizabeth

University of Port Elizabeth (UPE) introduced the Extended Curriculum Program (ECP) for Bachelor of Science Students in 1995 (Dixie and Lithauer, 1997) and after studying institutions offering programmes in South Africa as well as in Australia, introduced the UPEAP – The University of Port Elizabeth Advancement Programme in 1999 (Wits Directory, 2001) The program aimed to provide for those students who have the potential to graduate in the Faculty of Science, but due to their educationally disadvantaged background, did not achieve acceptable results at school. The admission requirements of the programme like other access programs are based on matriculation results that do not meet the ordinary requirements for admission to the Bachelor of Science studies through the Swedish Point System and the UPE Admissions and Placement Assessment (APAP) battery psychometric tests by Student Counseling Department and interviews with the Dean. The programme has three curricula, Science, Commerce and General. The subjects offered in the science curriculum include Foundation Physics, Mathematics and Chemistry with English for Academic purposes, computer literacy and life, social and study skills. In all the science subjects, practical work is done extensively and the smaller groups (30 students) in semester one are combined to larger groups (120 students) in semester two to prepare students for the first year degree courses. There are plans to include degree modules with the foundation modules for the students from either first or second semester.

Some of the problems experienced are the lack of experienced staff to teach as well as to keep track of the students after they have completed the UPEAP.

2.3.3.2.3 University of Witwatersrand

The University of Witwatersrand offered a one-year bridging course in science in 1979 that was superseded by a two-year reduced load curriculum with voluntary add-on academic support classes leading to second year B.Sc. (Rutherford, 1995). The results for this course were mixed. Students perceived to be in need of academic support preferred not to take this route since it involved extra work. Those who did enroll for the support found the transition from the bridging years to the second year a difficult one, thus a new programme was developed, namely the College of Science programmme in 1991. The students on the College programme are registered in the Faculties of Science or Engineering as appropriate and use the same lecture theatres, laboratories, tutorial rooms and central services as other students. The students thus have the opportunity to adjust to the pace and demands of university scholarship. The programme aims are (Rollnick, 2000):

- to provide access to University study for able students who would not otherwise have had the opportunity to study science at University
- to provide a route to degree study for students who have only been able to do standard grade mathematics
- to address in the programme, issues of disadvantaged schooling by building in strategies to assist English Second Language learners

The first two years of the four-year B.Sc programme are offered by the College of Science and the second two years are the second and third year of a normal B.Sc programme.

Applicants for the programme must have a Matriculation Exemption[10] with a rating of less than 24 points plus have obtained at least an E symbol in Higher

[10] A Matriculation Exemption is a certificate issued by the Committee of Principals in terms of the provisions of section7(1)(e) and (3) of the Universities Act,1955 (Act No.61 of 1995), as amended, read with Section 74 of the Higher Education Act, 1997 (Act No 101 of 1997); admitting

Grade Maths (or a C at the Standard Grade). Mature age applicants are also considered for admission provided they are able to obtain a mature age exemption certificate from the Matriculation Board. The Matriculation Exemption is required since students are admitted as fully-fledged first year students. Eligible students write a number of selection tests (which assess science aptitude, spatial ability, logical reasoning, basic physical science and basic mathematics), complete a biographical questionnaire and, for certain candidates (who have done well on some and not on other tests), attend an interview. Seventy to eighty percent of each intake is male but only 57% of those graduating are male with an increase in the number of female graduates over the years (Rollnick, 2000; Rutherford, 1995).

Approximately 200 students are enrolled each year for the programme. The average percentage students that have graduated from the programme are about 30% (Rollnick, 2001). Some students have registered for honours degrees and others have been successful in studies outside the Science Faculty. The students do face difficulties when they enter into mainstream and thus take longer than the four years to complete the degree.

The courses for the programme, listed in Table 2.3, carry a credit towards a B.Sc degree. Students from the programme thus have more credits than those from an

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a candidate to bachelor's degree of study at a South African university without any conditions or limitations.

ordinary 3-year B.Sc programme. These students also have access to a student counselor who assists them in counseling, orientation, financial matters and residence life.

Table 2-5 Courses offered in the College of Science

First Year	Second Year (3 of the following)
1. Mathematical Sciences 1A 2. Physical Sciences 1A 3. Biological Sciences 1A or Earth Sciences 1A	1. Mathematics 1B 2. Physics 1B 3. Chemistry 1B 4. Biological Sciences 1B or Earth Sciences 1B or a mainstream course

Students benefit from small-group tuition and individual attention in tutorial sessions. Lectures are made interactive and staff are conscious of language issues throughout the course and try to explicitly teach study skills (Rollnick, Green, Staskun, White and Bennett, 2000). Teams of lecturers for the programme are lodged in the various schools with a co-coordinator for each team and academic development support staff. The University funds tenured posts in each of the major departments for staff dedicated to the College.

The challenges of the programme are the student adjustment to mainstream, the written language abilities of the students and the funding of the programme (Rollnick, 2001).

Green, Rollnick and Rutherford (1998) used interviews and questionnaires to ascertain the attitudes and experiences of the College of Science (COS) at University of Witwatersrand access students when they joined the mainstream students in their second year (mainstream) of study. Some of the findings were that the COS workload and pace was too light during the second access year, and that certain attitudes and skills such as organising study time, taking lecture notes, motivation to study, language skills, memory were a problem in their second year (mainstream) of study. Further research is been conducted in this area.

2.3.3.2.4 University of the Free State

The University of the Free State established the Career Preparation Programme (CPP) in 1993 to offer students not meeting their admission requirements an opportunity to study. This programme is a one year bridging course that has the following three study options, Economic and Management Sciences, Human and Social Sciences and Natural Sciences of which the latter option is of interest to this study.

The overall enrolment for the CPP increased from 73 in 1993 to 423 in 1999 with 17% of those enrolled in 1999, taking the Natural Science option (www.uovs.ac.za/ss/cpp/prevsuc.htm).

The Natural Sciences option in the Career Preparation Programme offers five subjects -:

- Chemistry
- Mathematics
- Introductory Communication & N4 Communication
- Introductory Information Processing & N4 Computer Practice

- Foundation course in Lifelong Learning

Chemistry and Mathematics are University-credited courses in which females outnumber males in enrolments (63% females and 37% males). The Foundation Course in Lifelong Learning addresses the students wider needs with regards to quality of personal, life, study and reading skills, self-assertiveness, problem-solving and other generic competencies.

The success rate of the University accredited subjects is 48% and the students are required to pass all the subjects to enable them to continue studies at the University of the Free State.

2.3.3.2.5 University of Cape Town

The university started with a Science Foundation Programme (SFP) in 1986 which was non-credit bearing first year in a four year degree programme (Directory, 2001). This SFP eventually developed into the General Entry Programme in Science (GEPS). GEPS provides access to the BSc for students with potential from educationally disadvantaged backgrounds. The 'forward looking' curriculum takes account of the poor preparation in Mathematics and Science as well as the fact that English is not the first language of the majority of the target group. The students are selected based on their matric points a SG B for Mathematics and the Alternative Admissions Programme test (AARP).
The subjects offered as half first year credits in Year one are Mathematics, Physics, Chemistry and one other course from Computer Science, Earth Science

or Life Science. These subjects include foundational material and in the Year two, the remaining half of the subject is completed to obtain a full first year credit. In terms of registration, students register for the regular degree programme in Year two, ending with full first year credits. Students on a regular degree course are allowed to transfer out to one or more GEPS courses if they are not coping.

There is an issue of the students passing their first year courses for the degree over the two years but then failing the second level courses and not graduating which could mean a restructuring of the senior level courses in the degree.

2.3.3.2.6 University of the North- UNIFY Programme

The University of the North offered the one year UNIFY programme since 1993 to cater for students who did not have the required Matric symbols to enter Science degree programmes directly (Smith and Cantrell, 1995). Most of UNIFY's budget was provided by external funds initially, but now, most of the funding is provided by the Institution. UNIFY stands for **Uni**versity **F**oundation **Y**ear and its aims are to:

- provide access to science degrees for students and increase the numbers for the three Science Faculties of Agriculture, Health Sciences, Mathematics and Natural Sciences
- Equip disadvantaged students with knowledge and skills in the Sciences and Mathematics so that they will be more successful in their degree studies (Smith and Cantrell, 1995:297)

Masha and Mayeya (1999) list seven operational objectives of the programme as:

- acquisition of knowledge and practical skills in basic mathematics and science through the provision of a balanced and integrated programme
- transition between school and university education by a phased introduction of appropriate teaching strategies
- defragmentation and remediation of concepts formed due to inappropriate approaches used in disadvantaged educational settings
- preparation for tertiary studies in sciences through the development of appropriate attitudes, practical skills, cognitive skills, study skills and language skills
- preparation for responsible citizenship by
  - provision of career guidance counselling, leading to rational course and career decisions
  - provision of academic and personal guidance counselling systems

To achieve the objectives the students take five compulsory courses – biology, chemistry, physics, mathematics, English and Study Skills with Information Technology serving as a complementary instructional medium. Staff who use a constructivist approach in their teaching are employed to teach in the programme. UNIFY staff are generally junior staff but they are included on respective departmental boards and spend half their time teaching mainstream courses. However, initial evaluation of the programme showed that all lecturers did not share the common educational philosophy of the programme and there was no strong evidence of a particular and common theory of learning underpinning curricula in all subjects (Masha and Mayeya, 1999). Thus, more recently, the UNIFY staff are in continuous academic and professional development for ultimate take-over of the sole responsibility for the whole programme (Masha, 2000).

Smith and Cantrell (1995) reported a measure of success for the 1993 cohort of UNIFY students of an overall pass rate of 68% compared to 60% for direct entry students and 52% for repeaters. In addition, in many subjects, UNIFY students did better than direct entries and they displayed attributes such as attentiveness and willingness to contribute to classroom discussions. Since 1994, the performance of UNIFY students exceeded the expected 70% pass rate to reach 89% in 1999 (Netsihisaulu, 2000). Contributing factors to this success could be the selection mechanisms and instruments used (Zaaiman, 1998) and the type of assessment given to students (Netshisaulu, 2000). Students are assessed on a continuous basis to enable them to monitor their own progress throughout the programme as well as providing lecturers with an indication of who needs special attention.

2.3.4 Selection of learners into Access programmes

Alternative selection methods to only looking at the Matric symbols are implemented at most institutions (Zaaiman, 1998, Steyn etal., 1998 , Skuy et al 1996,Rutherford and Watson,1990).Selection of the students with academic potential is one of the issues that has been researched by Zaaiman (1998) and Zaaiman, van der Flier and Thijs (1998) for the UNIFY programme at University of the North. The UNIFY programme now uses the selection tests for its students and is willing to assist Institutions in their selection process.

University of Pretoria has in place a potential test for their Science Orientation course (Steyn et al, 1998). The basis of the test is mathematics, science and language skills; unfortunately no reports are available regarding the success of this test.

The battery of tests that are being researched for the COS programme at Wits tests the skills and abilities of the students and have been found in initial studies to be better at accounting for variance in student end of year exam than matric rating would be (Rutherford & Watson, 1990).

Other research in the selection of students include the Teach-Test-Teach (TTT) selection programme of the University of Natal, (Craig, 1992; Griesel, 1992) the Alternative Admissions Research Project (AARP) of the University of Cape Town, (Yeld and Haeck, 1997), the Place on Examination (PoE) Indicator (Dawes, Yeld and Smith (1999) and more recently the Desmond Tutu Educational Trust TELP standardized assessment tests specifically for historically disadvantaged Institutions (Yeld, 2001).

The central aspect of the TTT programme is the development of appropriate learning tasks which allow for the assessment of potential academic ability. Success rates of students admitted through the TTT are encouraging with 37% of the first group graduating in minimum time (Griesel, 1992). However, the programme is resource-intensive and can cope with a limited number of students only. This may present a problem with the increasing number of disadvantaged students making applications to the Institutions. The Placement Test in English for Educational Purposes (PTEEP) used in AARP at University of Cape Town is linked to the academic programme. This test is used as a diagnostic entry test for all students. The TELP tests are separate tests for language, science and maths that were developed as diagnostic tests that would elicit a range of performance, and accurately identify those students who are in need of some kind of assistance during their studies. However, more recently, these tests have been piloted at University of the Western Cape to identify students whose Senior Certificate results do not make them eligible for selection to Higher Education (Yeld, 2001). The pilot study showed that the language test was a useful predictor for the 2 out of 7 University courses.

2.4 Summary of comparison of the access programmes to the Augmented programme at ML Sultan Technikon

From the literature review above, it is clear that the programmes offered vary amongst other things, in terms of:

- their structure from bridging and foundation to extended or augmented;
- their duration from a few weeks to one or two years;
- credit bearing and non-credit bearing courses or subjects;
- teaching by the mainstream lecturers or specialist lecturers;
- integrated or add-on academic support.

Each programme has reported varying successes with some of them having no formal reports available of their success. The UNIFY programme at University of the North, the College of Science programme at University of Witwatersrand, the Science Foundation Programme at University of Natal (Pietermaritzburg), the General Entry Programme in Science University of Cape Town and the PreTechnicians programme at Port Elizabeth Technikon have been actively engaging in research into their programmes and their findings were very useful for this study. All the access programmes offered in the UK and Australia are for minority groups and they tend to be more of the bridging type model as discussed previously which makes them different to the augmented programme which caters for the majority group and is of the extended curriculum model.

The entrance requirement for the augmented programme is a Senior Certificate with special requirements for Matric Maths, Physical Science and English. The Senior certificate is regarded as sufficient in that the student is registering for a Diploma and not a degree as at the Universities where a Matric Exemption is required. For most of the programmes discussed earlier, the students require a minimum number of Matric points (based on the symbols obtained for Matric subjects) as well as criteria in subjects such as Mathematics, and in some instances tests and interviews. However, for the augmented programme, points for only three Matric subjects are considered for entry.

The structure of the augmented programme at ML Sultan is similar to the COS programme in that there are no separate modules or courses for study skills, time and stress management skills, language development and careers information. These skills would have been included during the tutorial sessions thus resulting in an integrated curriculum. Whether this is actually happening will be checked during the interviews with the tutors for the programme. In addition the lecturers taking the augmented students are the mainstream lecturers that is similar to the COS programme yet different to the University of Natal SFP, UNIFY and PE Technikon programmes. Interviews with the lecturers will ascertain whether the teaching strategies they use cater for the disadvantaged students.

Furthermore, the students are registered for a Technikon credit-bearing programme from the first day of registration and are thus part of the institution as opposed to the Pre-Technicians programme at PE Technikon and the other foundation programmes at the Universities of Natal, the North and Witwatersrand. This Technikon credit-bearing programme is restrictive for the student as well in that all the subjects are prescribed according to the NATED 151[11] report and the student does not have flexibility of subject choice as the University programmes. This means that the students make an early career decision when registering for the augmented programme.

The duration of the augmented programme again is similar to the COS programme in that the first year is offered over two years. This extended time of one year for the augmented programme is funded by the institution since the initial donor funding is no longer available and the mainstream programme is government funded for a three-year period.

2.5 Teaching and learning approaches used for disadvantaged learners

The Academic support or development required in the teaching and learning of the disadvantaged learners has been covered in the various programmes and courses above but will be briefly discussed in this section with particular reference to science or chemistry education. Teaching and learning should not be separated from assessment; however, in this study the emphasis will on the teaching and learning.

[11] NATED 151 report is a Department of Education document that provides details of all the SAPSE funded programmes at the Technikons

Research in science education focuses on the following key elements –

- the knowledge to be learned;
- the teacher;
- the learner and
- the social environment in which learning occurs (Sanders, 1988).

From this research, a viewpoint emerged that knowledge is not a body of facts that can be poured into the learner's waiting head, but a personally constructed idea developed by every individual learner. Teachers and learners need to be aware of the process of learning and good teaching methods. According to Novak (1984) discovery methods of teaching need not necessarily result in meaningful learning and meaningful learning can occur with reception methods of teaching.

Ausubel's concept of meaningful learning as cited in Sanders (1988) states that learning will only be meaningful if the new idea or concept to be learned is consciously related by the learner to relevant concepts which the learner already knows. Rote-learning (memorization) occurs when the learner does not integrate a new idea into their existing mental (cognitive) structure. Furthermore, the two essentials for meaningful learning are firstly, that the learner must know how to learn meaningfully and intend to do so. Secondly, the material to be learned must be potentially meaningful to the learner. This can be achieved by linking to the real-world knowledge of the students, if meaningful learning is to occur (Shuell, 1987). Rote learning is unsatisfactory in the sciences and in this case, chemistry, which demands understanding, logical reasoning and abstract thought. A surface approach to learning results in rote-learning whilst a deep approach is necessary to understand the concepts and relations within each subject as well as to experience the relevant connections between subjects (Steyn and de Boer 1998).

Piaget (as cited in Sanders, 1988) postulated that all learners pass through several stages of mental (cognitive) development, and that all learners would not be able to cope with abstract reasoning before they reached a certain stage in their development. Bruner (as cited in Sanders, 1988) built on and modified the ideas of Piaget because of his belief that educational experiences could affect the rate of mental development. The level of development of the learners must be determined, and the cognitive demands of the curriculum materials should be within their capabilities.

Learning is an active rather than a passive process (Pastoll, 1992) and hence appropriate teaching strategies need to be used to ensure that students are actively involved in learning. Active learning implies that the learner's mind is acting on the material to be learned, thus mentally processing it. This can be achieved in various ways such as reading, thinking or discussing the work in appropriate ways. Carin and Sund (1980:76) discuss the following educators regarding active learner involvement:

- Dewey who believed that “we learn by doing and reflecting on what we do”;
- Piaget claimed that there was no learning without action, and that meaningful learning only occurs when a person reflects; and
- Bruner, a supporter of “discovery learning” who stated, “the student is not a bench-bound listener, but should be actively involved in the learning process”.

Discovery learning implies that the teacher does not tell the learner the facts, but guides them in an appropriate way to obtain the information for themselves from some other source. Learners who have used discovery methods think and function more autonomously, (Carin and Sund, 1980) which is one of the goals of higher education.

The constructivist approach separates the individual and the world which makes the point of departure dualistic. A non-dualistic point of departure is offered by the phenomenograhic theory. According to Prosser & Trigwell (1997) and Marton (1981), there is an internal relationship between the individual and the world; the two are not constituted independently of one another. Individuals and the world are internally related through the individuals’ awareness of the world. Mind does not exist independently of the experienced world around it and people relate to the world in qualitatively different ways described in terms of a set of categories of description.

Renstrom, Andersson and Marton (1990) found six distinctively different conceptions of matter in a study of upper level compulsory school students. Some of these students also displayed alternative forms of the same conception, which depicts how thinking about matter may vary qualitatively between and within students. These differences in the conception of various aspects of reality between and within individuals are discussed fully by Marton (1981). It is these changes in the individuals' way of interpreting certain aspects of reality that are often a crucial component of scientific discoveries. There is always a variation in the way learners understand the concepts and principles presented by the teacher or by the author of a textbook. Staff and learners need to be made aware of the variation in peoples experiences of the same thing; its structure and relevance as part of the process of helping them experience the world in a different way. Phenomenography identifies and classifies the concepts of the learner within the context of science but does not offer much in terms of the worldview of the learner. The teaching that occurs when phenomenographic theory is used as the basis is one that fosters only a scientific view of the world and fails to recognize that students' everyday conceptions differ from science because they serve a different purpose in the world.

Cobern (1996) in discussion of worldview theory states that "conceptual change should become more plausible for students when they have been invited to a discourse on what are the important questions of life, what are the various answers, and what does science have to contribute to the common human quest for a meaningful life". A concept or belief thus has force if it is central in an individual's thinking rather than marginal and the concept has scope if it has relevance for the individual over a wide range of contexts. Worldview is the sum of the cultural components that a person embraces. Some components will have more force and scope than others but the goal for scientific literacy, which is required for science education, seems to be that the scientific context is greatest. For a chemistry teacher, concepts such as pH and chemical equilibrium can be relevant over biology, mathematics and everyday cooking, swimming and eating, as an example. The teacher needs to be aware of the learners everyday life and the influences on it in other words, their worldview, as Cobern (1996) gives the example of a grade 8 learners' model of clashing currents which he learnt from his father who was an electrician. The students worldview supported this model and hence it was acceptable to the student.

Worldview provides a learner with presuppositions about what the world is really like and what constitutes valid and important knowledge in the world. Science conceptual change has previously required a breaking with what is essentially students' natural understanding of their world because so much of science is counter-intuitive. This approach has led to a perception and experience of difficulty in science. Whereas science should undergo enrichment and deformalization, getting cross-connected with the familiar phenomena of everyday life; the familiar 'common sense' ideas should not be suppressed or

declared wrong but reconnected and reconstructed. Science education should teach scientific understanding within the actual worlds in which people live their lives. It is thus important for the teacher to understand the fundamental culturally based beliefs about the world that students bring to class and how these beliefs are supported by the student's cultures; because science education is successful only to the extent that science can find a niche in the cognitive and sociocultural milieu of the students. The worldview theory however does not suggest that every cultural or social difference is the result of a different worldview.
Aikenhead(1999) encourages the idea that teachers should be "cultural brokers" who will help students move back and forth between their indigenous culture and the western culture of science. When students move from their everyday culture into the culture of the classroom science, the move is called "cultural border crossing" (Aikenhead, 1999) which is not smooth for the majority of students whose home view differs from the worldview of school science which is definitely the case for the disadvantaged students on the augmented programme.

Practical work in science subjects is meant to motivate the learner and develop skills (Head, 1982), however West and Pine (1985) claim that the use of practical work to supplement instruction does not improve understanding in a subject. The reason given is that most practical work is not done with understanding, but uses a recipe/verification approach. The "recipe-style" laboratory often is an exercise in reproducing well-known results in the form of reports that resemble the original set of instructions and does not lend itself to foregrounding basic elements of experimentation (Allie & Buffler, 1997). Driver and Bell (1986) emphasise the importance of practical activities, but stress that experiences alone are not sufficient to change student conceptions. Strategies designed specifically to enable the learners to reflect, construct meanings and develop conceptual change are essential and have been implemented by Allie and Buffler (1997) at UCT for their SFP. They reformulated standard laboratory tasks into "quasi-real" problems that could be solved by recourse to an experimental investigation. Hewsen (1980) suggests that students should be presented events to challenge misconceptions, foster hypothesizing and allow for the generation of alternative interpretations. For disadvantaged students, this exploration should be done in a non-threatening way such as with small group discussions and provide chances to use the new ideas.

Both the UNIFY programme at the University of the North (Smith, 1995) and the SFP at the University of Natal, Pietermaritzburg (Grayson, 1997) have the following groups of objectives to ensure success for the students:

- Objectives related to improving cognitive and practical skills
- Objectives related to the development of attitudinal skills conducive to learning
- Objectives related to the achievement of a better understanding of the fundamental aspects of Mathematics and Science and a mastery in English as far as needed for further science studies at Year 1 level.

These objectives are met by a student-centred approach to teaching and using the teaching strategies (Smith, 1995, Allie and Buffler, 1997) that form a whole and start where the students are as well as:

- Organising the teaching-learning process in small groups
- Purposefully selecting the content to have a “skills driven” rather than “content driven” syllabus
- Focusing on practical work
- Verifying understanding by obtaining student feedback and by testing and test design
- Adjusting pace by providing more exercises or using different teaching approaches
- Improving English and emphasizing the role of language by amongst other things, setting essays in science and mathematics and mastery of English within a context of science and mathematics
- Developing the transfer of skills and content between subjects, and at developing transfer needed in problem solving
- Developing the meta-cognitive skills of awareness of own understanding
- Reinstalling self-discipline which was lost as a result of erratic schooling
- Stimulating co-operation between peers
- Counseling and career guidance

These strategies have been successfully employed for UNIFY and SFP - UN PMB and UCT(SFP then GEPS) thus the application of these strategies in the

Augmented programme will be explored during the interviews with the lecturers and the tutors.

Warren (1998) in a discussion of the educational interventions[12] at University of Cape Town (UCT) highlights the fact that historically disadvantaged learners 'have not yet acquired assumed knowledge, or desired proficiency in English, learning skills or academic skills such as formal argumentation, reading and writing.' These skills were also lacking for learners in all the previously mentioned programmes (Grayson, 1997, Masha and Mayeya, 1999 and Sharwood, 2000).

Separate educational interventions for disadvantaged learners could be extra tutorials[13] and separate language-based courses whilst integrated interventions, which are preferred interventions, include adjunct language-based programmes, mainstream courses based on Academic Development principles[14], core entry level and senior level curricula. The voluntary, non-credit bearing, extra tutorials were originally designed for a minority group of students to address their learning difficulties, develop their study and writing and clarify key concepts and elements of content. These tutorials are effective when space is allocated for them in the

[12] An educational intervention refers to the purposeful shaping of the instructional process to address the learning needs of students in particular teaching contexts. (Warren, 1998)

[13] A Tutorial is a small group of learners who meet under the guidance of a tutor. (Amos, 1999)

[14] Fostering of students' academic, learning and communication skills, and understanding and application of concepts, theory and method.

curriculum, they are held regularly with fewer rather than more learners and when they are aligned to a mainstream course that has a developmental agenda (Pastoll, 1992, Allie and Buffler 1997, Warren, 1998 and Amos, 1999). Pastoll (1992) describes the ideal learning environment in a tutorial as one where there are peers rather than authority figures and the tutors act as facilitators rather than fountains of knowledge. The presence of a tutor who is a senior student within a discipline is preferable to and academic staff member.

The language-based courses are credit bearing with skills integrated with relevant content whilst the language-based programmes develop reading or writing skills through tutorials tied to credit-bearing course or via tasks in the discipline. The advantage of the language-based programme over the language-based course is that transfer is encouraged because skills are grounded in learning the discipline, however the programme is limited by time constraints.

The core curricula integrate skills building, such as critical thinking skills, with learning of knowledge. The principal aim of such curricula is to provide an integrated learning experience in which there is strong conceptual coherence and skills development across component courses, and through which students acquire a sense of the nature of the various disciplines before consolidating their decision as to which line of study to pursue. This aim is achievable for the foundation programmes but would not serve the same purpose for a Technikon student that has already chosen the line of study as in the Augmented programme. The outcomes for the Core curriculum that was introduced at ML Sultan Technikon in 1999 for first year students were the development of:

- Effective learning
- Effective communication
- Effective thinking, problem solving and decision-making
- Effective personal values and interpersonal relationships
- Effective collaborative skills, and
- Effective information management (Seedat, 2000)

The core curriculum was offered as a non-credit bearing module core linked to a first year subject and students were given a project that would constitute a portion of the year mark for that subject. The lecturers in the core module, from Educational development department and the library meet regularly with the subject lecturer to ensure an integration of the content into the skills offered through the module. This module was only introduced into the Augmented programme in 2000, so it is too soon to determine its' impact.

It is impossible to overcome a lifetime of disadvantage in one year, but with a holistic approach in the design and implementation of a programme, the cognitive, practical, metacognitive and psycho-social needs of the learners can be addressed. The tutors that were initially employed for the Augmented programme were moved to the Educational Development Department of Academic Development at ML Sultan Technikon to introduce the Supplemental Instruction (SI) programme (Martin and Arendale, 1993; Wolfendale and Corbett, 1996 and Blanc, DeBuhr and Martin, 1983) within the Science Faculty from 1998 and the Core Curriculum programme in 1999 to meet the needs of learners. The SI programme was introduced for traditionally difficult first year subjects. SI for subjects in the Augmented programme was only introduced in 1999. The impact of SI on the augmented programme and in the institution has not been reported but it does have Executive Management support and is donor funded. The Core Curriculum is similar to the core entry-level curriculum at University of Cape Town for the development of students' academic literacy[15] (Warren, 1998) and was only piloted in the Augmented programme in 2000.

The perceptions of lecturers teaching in the augmented programme regarding the two interventions discussed above will be discussed in chapter 4.

2.6 Indicators of Success

Matric points are generally used as predictors of success whilst actual performances in examinations and hence throughput rate, are regarded as indicators of success. Other indicators of success as presented in the NARSET report (1997) could include the following:

[15] Academic literacy is the set of competencies required to think critically, ask questions, communicate and access relevant resources in Higher education

- Number of students entering degree programmes who would not normally have done so together with their drop-out reasons (attrition) and pass rate on intervention.
- Efficiency in physical access- percentage of number of students entering the programme and those registering for the degree
- Pass rates for intervention and non-intervention courses at the same level and pass rates subsequent to the intervention course
- Student perceptions of the programme and student adjustments
- Graduation rates for reasonable graduation time
- Perceptions of stakeholders
- Articulation with mainstream in the form of curricula and structures

Performance of students can be measured in terms of credits obtained in the examination or in terms of the actual pass grade obtained by a student or pass grades obtained in all subjects. Jawitz (1995) in his study of performance of 211 first year students used a number of credits obtained by students as a performance variable where the credits reflected the amount of work and time required of students for the year. These credits were categorised to produce a normal distribution, according to those who were excluded (less than 14 credits), those who passed some courses (credits from 14 to 35) and those who passed all courses (credits above 35). An average exam mark performance variable was also used by Jawitz (1995) and analysis showed a normal distribution and that the performance of matriculants from Black Education departments was worse than from White Education departments. As discussed earlier, the apartheid system that existed in South Africa meant that education for Blacks and Whites was under separate departments with the schools in the Black education departments under-resourced. This study also revealed that matric point scores were good predictors for White Education department matriculants but less so for Black Education department matriculants, with matric Physical Science a better predictor than matric Maths for both first and second year engineering courses at the University of Cape Town (UCT). Whether matric Maths and matric Physical Science can be used as indicators of performance for the Augmented programme at the ML Sultan Technikon needs to be established since the entrance requirement for the course is that a student must have attempted Mathematics, Physical Science and English at matric level.

Bargate (1999) in a study at Technikon Natal found that there was no correlation between the study of Mathematics at matriculation level and the passing of the first year of an accounting programme. The correlation was between the number of subjects passed (pass mark is 50%) and the matric Mathematics mark. A recommendation from this study was that the influence of matric subject combinations, motivation of the students and changes in teaching methods at tertiary institutions should be investigated further to find a more suitable predictor of pass rates. This finding is relevant since it explored the use of matric

Mathematics as an indicator at a Technikon even though it is for a different programme.

A further indicator of success is the grades obtained in examination results overall and not per individual student as indicated in the study of Access programmes by Osborne, Leopold and Ferrie (1997). This overall result provides an indication of the spread of grades and how well the learners are performing in the subjects per programme and hence indicates the relative success of the programme. It is important to note though that the performance of learners can be affected by many other variables such as socio-economic factors which are not a part of this study.

2.7 Summary

This chapter provided a literature survey of access programmes for disadvantaged learners in Higher Education both nationally and internationally. The curricula for these programmes or courses were analysed to determine the similarities and differences to the Augmented Programme at ML Sultan Technikon.

The academic support or development required for the teaching and learning of disadvantaged learners with particular reference to science or chemistry education has been discussed as well in this chapter. The constructivist, phenomenographic and worldview theories of learning are briefly discussed as suitable theories on which teaching strategies in science or chemistry can be based. Constructivist theory is the common and most used with worldview theory only been explored more recently. The structure and philosophy of educational interventions such as core curriculum and Supplemental Instruction as they are implemented at the ML Sultan Technikon are also presented.

Matric results overall or for specific subjects were shown in this chapter as being generally used to determine whether a learner will be successful in a Higher education programme. However, the literature survey showed that they are not good indicators for success in all cases. The Augmented programme uses Matric results only as an entrance requirement and hence as a possible predictor of success. The success of the students in the programme will be analysed in terms of their performance in the examinations for the major subject, Analytical Chemistry which is a compulsory subject for all the students. The use of examination results is a common measure of the performance of students in a programme.

3 Chapter 3: Methodology

3.1 Introduction

This study can be categorized as evaluation research since according to Reaves (1992) and Ramsden (1992) it focuses on the effectiveness of the programme for the purpose of determining how the programme is working and how to improve things. The various categories of evaluative research are briefly discussed in this chapter. The sampling strategy and factors affecting it are important considerations that need to be placed into perspective in a small-scale study that is not to be used to generalize findings. A description of all the participants, instruments used and the procedure for the study are also provided in this chapter which precedes the chapter on data analysis.

3.2 Qualitative and Quantitative Research

This study involves the use of aspects of both quantitative and qualitative research. These two types of research can be differentiated, according to Reaves (1992), as follows:

> ‘Quantitative research is research that involves measuring quantities of things, usually numerical quantities. Qualitative research…involves assessing the quality of things’ (Reaves, 1992: 16).

The quantitative approach to research insists that personal experiences are quantified, that is, measure on some scale before they can be scientifically interpreted. On the other hand, qualitative research explores the personal, individual meanings of experiences to the people who lived them. Thus both the approaches have a place in this study, with the quantitative approach well suited to measuring the performance of the students and obtaining their biographical profile and the qualitative approach for the perceptions and attitudes of the lecturers and tutors who were part of the programme.

3.3 Evaluation research

Evaluation research could be summative or formative or a bit of both and it can be further classified as being impact or process evaluation research. Summative evaluation research focuses on the current effectiveness of the programme whilst formative evaluation research focuses on diagnosing areas of the programme that are weak making recommendations for improvement (Reaves, 1992). This study does not fall neatly into any one of the above since aspects of each type are relevant. It is summative and formative in the sense that firstly, it will inform the new Technikon Management of the success of the programme and influence financial decisions regarding the support of the programme and secondly, as the Technikon is the convenor, amongst all Technikons for curriculum issues, for Analytical Chemistry programmes, the findings will be used to make recommendations whether this programme should be continued or for improvements in the curriculum.

3.4 Sampling

The quality of a piece of research depends on the methodology, instrumentation and also the sampling strategy employed (Cohen *et al* 2000). The population on which the study will be focused needs to be defined by the sampling strategy used. Cohen also mentions four key factors that need to be taken into account when sampling: the sample size, the representativeness and parameters of the sample, access to the sample and the sampling strategy to be used. Each of these factors will be briefly discussed in the next paragraph.

Firstly, the sample size depends on the purpose of the study, the nature of the population under study and the style of the research. Cost in terms of time, money, administrative support, the number of researchers and resources all tend to constrain the sample size. Secondly, the extent to which the sample represents the whole population needs to be considered. The parameter characteristics of the wider population are to be clearly and correctly set by the researcher. Thirdly, problems of permission, sensitivity of the situation and protection of intellectual rights affect access to the sample. Fourthly, one of two possible sampling strategies needs to be considered by the researcher. Probability or random sampling and non-probability or purposive sampling are two different sampling strategies described by Cohen *et al* thus:

> In a probability sample the chances of members of the wider population being selected for the sample are known, whereas in a non-probability sample the chances of members of the wider population being selected for the sample are unknown (Cohen *et al,* 2000: 99).

In probability sampling every member of the wider population has an equal chance of being included in the sample whilst in non-probability sampling, some members of the wider population definitely will be excluded and others definitely included. There are several types of probability samples: simple random samples; systematic samples; stratified samples; cluster samples; stage samples and multi-phase samples. All these types have a measure of randomness built into them and therefore have a degree of generalizability (Cohen *et al* 2000).

Non-probability sampling involves the targeting of a particular group that does not represent the wider population. The types of non-probability sampling are convenience sampling, quota sampling, dimensional sampling, purposive sampling and snowball sampling. In purposive sampling the cases to be included in the sample are handpicked based on their judgment of typicality. This sample thus satisfies the researchers needs and it is 'deliberately and unashamedly selective and biased' (Cohen *et al,* 2000).

Non-probability samples have the disadvantages of non-repesentativeness but for small-scale research, this is outweighed by the simplicity and inexpensiveness in setting up. Furthermore, this strategy is appropriate where researchers do not intend to generalize their findings beyond the sample. In this study thus, purposive sampling as a type of non-probability sampling was appropriate to select the students and staff in the augmented programme to be evaluated at the ML Sultan Technikon.

3.5 Participants in the study

The National Diploma: Analytical Chemistry augmented programme that is being evaluated has been offered at the ML Sultan Technikon in Durban since 1994.

The main question to be answered from this research is “What is the success of the National Diploma: Analytical Chemistry Augmented programme at the ML Sultan Technikon?” The sub-questions for the research are:

1. What is the profile of students admitted to the Augmented programme?
2. What is the relationship between matric symbols (marks) and the graduation rates for the students?
3. What is the performance of the students in Analytical Chemistry?
4. What is the difference between the graduation rates of females and males in the programme?
5. What are the lecturers’ and tutors’ attitudes/ perceptions of the structure and role/purpose of the Augmented programme ?

The biographical, matric and subject data for students registered as first year National Diploma: Analytical Chemistry augmented programme students in 1994, 1995 and 1996 respectively, will be used as the sample for research sub-questions 1, 2, 3 and 4.

Table 3.1 below gives the breakdown of numbers of students whose records were tracked. These three cohorts of students were tracked from their first year through to their graduation. Students were not interviewed or surveyed in the form of a questionnaire since the majority of them were no longer registered and for some of them, their whereabouts were unknown. To establish contact with them would have taken far too long and thus the time for the study would have been exceeded. Further, the responses from questionnaires may have been too few, considering that there were only 51 students in total.. Thus a quantitative study based on document analysis was undertaken in order to address questions 1 to 4.

Table 3-1 Breakdown of student numbers

Year	Number of students registered for first year National Diploma: Analytical Chemistry augmented programme
1994	17
1995	23
1996	11

Sub-question 5 will be answered by interviewing three senior lecturers, three lecturers and two past tutors from the Department of Chemistry. All the lecturing staff are full-time academic staff members that work in the same department as the researcher. The lecturers all lectured to the students in the augmented programme as well as to the students in the mainstream semester programme from first year through to their final year of study.

The lecturers were selected because they taught one or more of the following subjects in the programme - Chemistry 1, Analytical Chemistry 1, 2 or 3. The tutors interviewed were employed as full-time tutors for the augmented programme when the programme was started in 1994 until 1998. At present, the tutors are employed as Educational Development lecturers in the Academic Development Department of ML Sultan Technikon responsible for implementing the Core Curriculum and Supplemental Instruction (SI) programmes in the Institution. These programmes were offered in the Academic Development department from 1998 as previously discussed in chapter 2.

Informal discussions rather than formal interviews were held with the Head of Department: Chemistry and the Dean: Faculty of Science. The information gleaned from these informal discussions will be used as necessary.

3.6 Instruments

3.6.1 Quantitative tests

The data regarding students' biographical data, matric results and examination results was obtained from the ML Sultan Technikon Management Information Systems (MIS) Department. The Integrated Tertiary Software (ITS) used by the MIS department enabled easy access to reliable student data. All student records on the ITS, including biographical data of students is routinely captured by administrative clerks at registration and after examinations. The students originally verified the registration details, with certified copies of matric results and identity documents. The examination data obtained from the ITS system was verified by checking against the records kept by staff in the Chemistry Department. The data from the ITS database was downloaded onto a spreadsheet before it was sorted, analysed and interpreted. Microsoft Excel®, the spreadsheet software program, was used to analyse the data and produce statistics and graphs. Microsoft Excel® has the ability to sort data (in alphabetical or numeric order), perform calculations, generate statistical data and produce pie graphs, histograms and other graphs.

The selection of students to both the mainstream programme and the augmented programme is based on their matric points. The matric points for both programmes are calculated as follows from the symbols obtained in the matric examination:

Table 3-2 Ratings for Matric Points Calculations

Matric symbol (Percentage range)[16]	A +80	B 70-79	C 60-69	D 50-59	E 40-49	F 33.3-39	G 25-33.2
Points on Higher Grade	8	7	6	5	4	3	2
Points on Standard Grade	6	5	4	3	2	1	

[16] These ranges were obtained from Zaaiman, H (1998). Selecting students for Mathematics and Science : The Challenge Facing Higher Education in South Africa. HSRC publishers. Pretoria

Table 3.2 can be interpreted as follows: -Students with an E symbol on the HG in a subject and with a C symbol on the SG for another subject will obtain 4 points each for the subjects.

A student must meet the following requirements for entrance into the mainstream programme:

- A Senior Certificate pass in Matric and
- A minimum of a Higher Grade E or Standard Grade C symbol in Matric Maths (regardless of the symbols obtained in the other subjects) and
- A minimum total of twelve (12) points for Maths, English and Physical Science.

A student not meeting the requirements above is eligible for entry into the augmented programme.

The correlation between the following sets of data was determined:

a) points at matric level for each of English, Mathematics and Physical Science were compared to the graduation rate;

b) combined points (called the entry points) at matric level for English, Mathematics and Physical Science were compared to the graduation rate;

c) the total matric points for all subjects was compared to the graduation rate

The graduation rate for the students is the percentage of the students who graduate from the programme.

The performance in Analytical Chemistry 1,2 and 3 was undertaken to determine whether the students excelled in the subject.

Research question 4 was answered in measurements taken in question 2 showing the gender breakdown.

3.6.2 Interviews

Goode and Hatt (1980) defined interviewing as a common social act, that is a pseudo conversation, a process of social interaction whose primary purpose is research. In order for the interview to be successful, it requires the warmth and personality exchange of a conversation, with the clarity and guidelines of scientific searching. The interviewer needs to be a good listener and silence need not be embarrassing since it can be taken as a matter of course. However, the interviewer should not only be a passive listener but also a critical and intelligent questioner so as to obtain the facts.

The interviewer uses probing questions:

- To ensure that the interviewer understands the answer and that it is actually the answer to the question.
- When the interviewee is not able to answer the question directly. In this case, the question needs to be either rephrased to be made clearer or to ascertain that the interviewee really does not know the answer.

The interviewer and interviewee both have insight or intuition and thus the interviewer must be:

- Conscious of the real meaning of answers given by the interviewee
- Alert to appearances, facial and manual gestures and intonation

Cohen *et al* (2000) describes 14 types of interviews, which are dependant on the source one reads. A list of types of interviews together with their reference source is given in Table 3.3.

Table 3-3 A list of types of interviews

Source	Type of interview
Le Compte and Preissle (1993)	1.Standardized interviews 2.In-depth interviews 3.Ethnographic interviews 4.Elite interviews 5.Life-history interviews 6.Focus groups
Bogdan and Biklen (1992)	7.Semistructured interviews 8.Group interviews
Lincoln and Guba (1985)	9.Structured interviews
Oppenheim (1992)	10.Exploratory interviews
Patton (1980)	11.Informal Conversational interviews 12.Interview guide approaches 13.Standardized open-ended interviews 14.Closed quantitative interviews

Source Cohen *et al* (2000)

According to Kvale (1996: cited in Cohen *et al*, 2000), there could be a degree of similarity in the classification and hence it is better to view the types of interviews along a series of continua depending on their openness of their purpose, their degree of structure, the extent to which they are exploratory or hypothesis testing, whether they seek description or interpretation, whether they are largely cognitive-focused or emotional-focused.

Interviews are thus adaptable and allow for the interviewer to follow up ideas, probe responses and investigate motives and feelings, which the questionnaire can never do. Questionnaire responses have to be taken at face value, but a response in an interview can be developed and clarified. Further relative merits, as suggested by Tuckman (1972: cited in Cohen *et al,* 2000), of the interview versus the questionnaire are listed in Table 3.4.

Table 3-4 Summary of relative merits of interview versus questionnaire. *Source* Cohen *et al,* 2000: 269)

Consideration	*Interview*	*Questionnaire*
1 Personal need to collect data	Requires interviewers	Requires a secretary
2 Major expense	Payment to interviewers	Postage & printing
3 Opportunities for response-keying (personalization)	Extensive	Limited
4 Opportunities for asking	Extensive	Limited
5 Opportunities for probing	Possible	Difficult
6 Relative magnitudes of data reduction	Great (because of coding)	Mainly linked to rostering
7 Typically the number of respondents who can be reached	Limited	Extensive
8 Sources of error	Interviewer, instrument, coding, sample	Limited to instrument and sample
9 Emphasis on writing skill	Limited	Extensive

Oppenheim (1992: cited in Cohen *et al,* 2000), suggests that

> "interviews have a higher response rate than questionnaires because respondents become more involved and, hence motivated; they enable more to be said about the research than is usually mentioned in a covering letter to a questionnaire, and they are better than questionnaires for handling more difficult and open-ended questions."
>
> (Oppenheim, 1992)

The disadvantages of interviews are as follows:

- They are time consuming thus limiting the number of interviews that can be conducted and transcribed
- Taking down full written notes during an interview is time-consuming and can affect the relationship and free flow of conversation between the interviewer and the interviewee. This can be obviated by audio-taping with the consent of the interviewee
- The audiotaping does have limitations in neglecting the visual and non-verbal aspects of the interview and in the time consuming transcribing process. This can be obviated by video taping which in itself can be distracting to the interviewee and make them uncomfortable. Hence video taping is only used when body language is critical in the interview
- Analysis of responses can present problems of identifying themes or clusters from the responses especially in unstructured interviews due to the possible subjectivity and bias on the part of the interviewer

Interviews are audiotape-recorded (with the permission of the interviewees) using a tape recorder. The tape recording provides not only a complete and accurate record of the entire interview, but it also preserves the emotional and vocal character of the responses. The tape recording can be replayed and the interview can be transcribed. Cohen *et al* (2000) however, cautions that transcription represents the transition from one set of rule systems (oral and interpersonal) to another very remote rule system (written language) and hence data can inevitably be lost from the original encounter.

To overcome the disadvantages mentioned above, only eight lecturers were interviewed and the interviews were audio-recorded to ensure that the conversation flowed without being hindered by extensive note-taking. Another researcher with experience in interviewing, Dr Rajen Chetty, conducted the first group interview to assist the researcher in conducting a group interview and to minimize the inherent subjectivity and bias in the interviews. The interviewees may be biased since the researcher is working in the department and some views expressed may be biased in support of the researcher or otherwise depending on the relationship that exists between the researcher and the interviewees.

In this study, the semi-structured interview and the group interview were found to be appropriate. The semi-structured interview and the interview guide approach are very similar in that the topics and issues to be covered are specified in advance, in outline form and the interviewer decides sequence and working of questions in the course of the interview. According to Flick (1998), in semi-structured interviews, more or less open questions are brought to the interview situation in the form of an interview guide. The interviewee answers the questions freely. The starting point of the method is the assumption that inputs that are characteristic for standardized interviews or questionnaires, and which restrict when, in which sequence or how topics should be dealt with, obscure rather than illuminate the subject's viewpoint. Problems with this interview type are: problems of mediating between the input of the interview guide and the aims of the research question on the one hand and the interviewee's style of presentation on the other. Thus the interviewer can and must decide during the interview when and in which sequence to ask which questions. The interviewer also faces the question of if and when to inquire in greater detail and to support the interviewee in roving far afield, or when rather to return to the interview guide when the interviewee is digressing. The advantage of this method is that the consistent use of an interview guide increases the comparability of data and that their structure is increased as a result of the questions in the guide.

Semi-structured interviews with academic staff, each of approximately 20 minutes in duration, followed by two one-hour group interviews were held. The questions for the interview guide were initially piloted with 3 colleagues that were not involved in the augmented programme but taught other chemistry programmes in the Department of Chemistry at ML Sultan Technikon.

Group interviews require skilful chairing and attention to physical layout of the room so that everyone can see everyone else. Group size is also an issue; too few and it can put pressure on individuals; too large and the group fragments and loses focus, a group of six to seven is an optimum size according to Lewis (1992: cited in Cohen *et al,* 2000).

This method according to Paton (1990) is a highly efficient qualitative data-collection technique, which provides some quality controls on data collection in that participants tend to provide checks and balances on each other that weed out false extreme views. And is fairly easy to assess the extent to which there is a relatively shared view among the participants.

Watts and Ebbutt (1987: cited in Cohen *et al,* 2000) set out the advantages of group interviews which include the potential for discussions to develop, thus yielding a wide range of responses. This type of interview:

- Helps to generate discussion and so reveal the meanings that people read into the discussion topic and how they negotiate meanings.
- Is low cost and rich in data since it stimulates the participants and supports them in remembering events, and they can lead beyond the answers of the single interviewee

Watts and Ebbutt further explain that

> 'Such interviews are useful… where a group of people have been working together for some time or common purpose…' (Cohen *et al*, 2000: 287).

The lecturers have been lecturing in the programme since its inception in 1994 so it was useful to have group interviews with them.

Paton (1990) gives limitations of the method as being how to document data in a way that allows the identification of individual speakers and the differentiation between statements of parallel speakers. Also, there are a limited number of questions it is possible to address and there are problems of taking notes during the interview. He therefore suggests the employment of pairs of interviewers, one of whom is free to document the responses while the other manages the interview and the group.

3.7 Procedure

Permission for the study to be undertaken was granted after a letter of request was submitted to the Director of Research at the ML Sultan Technikon. A copy of the letter is attached as Appendix A. Once this permission was granted, individual meetings were setup with the Dean of Faculty of Science, Head of Department of Chemistry and the Head of MIS to inform them of the study and obtain their co-operation regarding persons to work with for data required. The lecturers were verbally asked to voluntarily participate in the study and all agreed to participate. The anonymity of the lecturers was agreed to before the interviews were conducted.

Access to confidential student records was obtained as long as the names of the students would not be revealed in the report. The staff in the MIS department converted the data from the ITS system into a format that was compatible to be downloaded onto a Microsoft Excel® spreadsheet. Once the spreadsheets were setup with all the students information, the data was verified by accessing individual student records, which was password controlled, on the ITS system and checking it against the data on the Microsoft Excel® spreadsheet. The records of the graduation ceremonies were also checked against individual student records to ensure that the student completed their studies. The pass rate in the subjects was verified by checking the student data against the SAPSE (South African Post School Education) fulltime equivalent (FTE) funding data to ensure that the data regarding the number who wrote and passed the examinations was the same.

Research question 1: What is the profile of students admitted to the Augmented programme?

The following data obtained from ITS was tabulated:

- Year of registration
- Student number
- Gender
- Age
- Home language
- Matric points calculated for English, Mathematics and Physical Science
- Total Matric Points calculated

A profile of the students was generated from the spreadsheet data.

Research questions 2, 3 and 4:

The statistical and graph tools of Microsoft Excel® were used to obtain the biographical profile of the students, the mark distribution for the specified subjects – Analytical Chemistry 1, 2 and 3, the graduation rate – the percent students that graduated from the programme and the Pearson correlation for the relation between the matric points for

- o required subject namely Mathematics, Physical Science and English;
- o total entry points and

- the total points for all subjects-

and the graduation rate.

Research question 5

The 20-minute semi-structured interviews with lecturers were conducted in each lecturer's office in the first semester of 2000. Verbal appointments were made with lecturers at least one week before the interview. The purpose of the study as well the importance of the interview was explained beforehand. The interviews were conducted in the morning during a time when the lecturer was available. The interview was audiotape recorded after the lecturer at the beginning of the interview granted permission. Notes were also taken by the interviewer during the interview to assist in the transcribing process. The purpose of this interview was to obtain a general idea from lecturers of their perceptions of the programme. All the interviews were categorized according to the questions as set out in Table 3.5. The statistical data on the student performance and biographical data was not yet computed at the time of the individual interviews.

Table 3-5 Questions for semi-structured interviews with academic staff

Duration: 20 minutes (held in the morning between 9 and 12) *Interviewer: Mrs D N Timm* *Venue: ML Sultan Technikon - staff offices* 1. What are your qualifications and experience in lecturing? 2. What do you perceive the role of the augmented programme to be? 3. What teaching and learning styles are used/present in augmented programme – group work, rote-learning etc, 4. Who provides tutorial support? 5. What type of tutorial support is offered? 6. About the Practicals – how are they conducted, what are perceived abilities of students, integration with theory? 7. Comments on entrance requirements and structure of course

The following suggestions emerged from the pilot that was undertaken with lecturers not involved in the augmented programme:

- Question one was too general and could have been more specific in terms of differentiating between educational qualifications/experience and chemistry related qualifications/experience, to obtain a more accurate profile of the lecturers.
- Another possible question that could have been included was ascertaining their definitions of disadvantaged students and also tutorial sessions. A major assumption was made that the lecturers' understanding of disadvantaged students and tutorials was the same.

Both these suggestions were taken into account in the actual interviews of the lecturers.

Group interviews were held one month after the semi-structured interviews. The group interviews allowed for discussion among the lecturers of ideas raised during the individual interviews and to determine the extent of consensus or no agreement on the programme. Also, the statistics regarding matric results and hence entrance points of students, pass rate in subjects, and time for completion of diploma were available for discussion in the group interview but not for the individual interviews.

The questions used for the first group interview are presented in Table 3.6.

Table 3-6 Discussion questions for the first group interview

Time: 10H00 - 11H00 Venue: Classroom (T2-7) *Interviewer: Dr R P Chetty, Associate Director: Research – Faculty of Arts, MLST* *Present: 8 members of staff that were initially interviewed* 1. What is the role or purpose of the augmented programme? 2. Please comment on the teaching style that you used, i.e.interactive strategies, group discussions etc 3.Who conducted tutorials especially for the subjects - anchem 1, 2 and 3? 4.What was the format of these tutorials - include how many periods? 5.How effective were the tutorials? *Did they have any effect on the performance in Analytical Chemistry subjects?* 6. How were the practicals conducted and assessed? *What do you think accounted for the differences in performance in the practical and the theory components of a subject?* 7. General comments on the augmented programme - entry requirements, format of the course, effectiveness of the whole programme etc.

Dr Rajen Chetty, the Associate Director Research in the Faculty of Arts, chaired the first group interview whilst the researcher took notes. This group interview was held one month after the individual interviews since that was the only time when the interviewer and interviewees were available. Dr Chetty was asked to chair the interview since he is an experienced interviewer and also to reduce the bias by the researcher. There were all eight lecturers present at the group interview which was held in a classroom with the interviewer and interviewees seated in a circle to allow for maximum participation of all interviewees and easier audiotape-recording. Statistics regarding matric results and hence entrance points of students, pass rate in subjects, and time for completion of diploma were available for discussion in the group interview. Similar questions were posed at the group interview to check the reliability of the data obtained in the individual interviews. This interview was analysed and the major issues that required probing were identified.

The questions for the second group interview, which was chaired by the researcher, are presented in Table 3.7. A second group interview was held to enable further probing of the major issues that came up in the first group interview.

Table 3-7 Group Discussion on Major issues relating to Augmented programme

Time: 09:00 – 10:00
Venue: Faculty of Science Boardroom

1. Augmented students are disadvantaged. How would you define disadvantaged?
2. Tell me about the positive and negative attributes of the learners in the augmented class.

Prompt – how motivated are they?
Do they participate well in the class?
Are they consistent workers?
How would you rate their knowledge base in chemistry – do they have any misconceptions?
Do they have the necessary skills to cope with tertiary learning e.g. note taking, study, note making, reading skills??

3. There are instances of students on the augmented programme performing very well and employed as research assistant here-, what do you attribute their success to, considering the fact that they did not meet the entrance requirements for the course?
4. Should teaching strategies used for augmented programme be different to that for the mainstream?
5. The pass rate for practicals is generally very good. How do you rate the actual performance of the students in the lab? *Substantiate the answer.*
6. To what extent is language a problem in the course?

How can it be resolved if it is a problem?

7. What is the purpose of tutorials in the course?

Are they voluntary?
Are they sufficient?
Who should conduct them?

How should they be conducted?

8. What in your opinions are the advantages and successes of the augmented programme?

A further group interview, chaired by the researcher was held approximately three months later to probe the major issues from the first group interview and also to check the responses of the interviewees against the first group interview. This interview was also audiotape recorded then transcribed.

The transcribing process could involve either the making of summaries of the main points raised in each interview or a word-for-word recording. The summary is less time consuming to prepare but poses an inherent danger of losing some of the rich texture of the responses. The word-for-word recording elicits multiple interpretations rather than generalizations from the data gathered and thus is the preferred process. These transcripts also enable the report of the study to contain explanations in the respondents' own words and hence the vivid authenticity of the data is captured in a manner consistent with qualitative approaches to research. The report of the data analysis draws heavily on the use of direct quotations. The transcriptions were captured in electronic format and the data was analysed 'by hand' instead of using computer software packages such as SPSS, SpinxSurvey or Ethnographscale which are suited to large-scale studies.

3.8 Summary

This chapter highlighted the theoretical aspects of qualitative, quantitative and evaluative research that provide a basis for the action plan of this study. The choice of participants and the instruments used are described fully in the chapter.

4 Chapter 4: Findings and Analysis

4.1 Introduction

This chapter provides a report on the analysis of the quantitative data compiled and the qualitative data from interviews conducted as discussed in chapter 3. The analysis of the data attempts to provide answers for the following research sub-questions:

1. What is the profile of students admitted to the Augmented programme?
2. What is the relationship between matric symbols (marks) and the graduation rates for the students?
3. What is the performance of the students in Analytical Chemistry?
4. What is the difference between the graduation rates of females and males in the programme?
5. What are the lecturers' and tutors' attitudes/ perceptions of the structure and role/purpose of the Augmented programme ?

4.2 Research Sub-Question 1: Profile of the students on Augmented Progamme

The biographical detail such as the age, gender and race of the students provides a profile of the students who have registered for the programme. This profile can then be compared with that of students enrolled in similar programmes. After a discussion of the general profile of the students that registered for the programme, the profile of the students who have successfully completed the program will be presented and discussed. The full records for the students are attached as Appendix B.

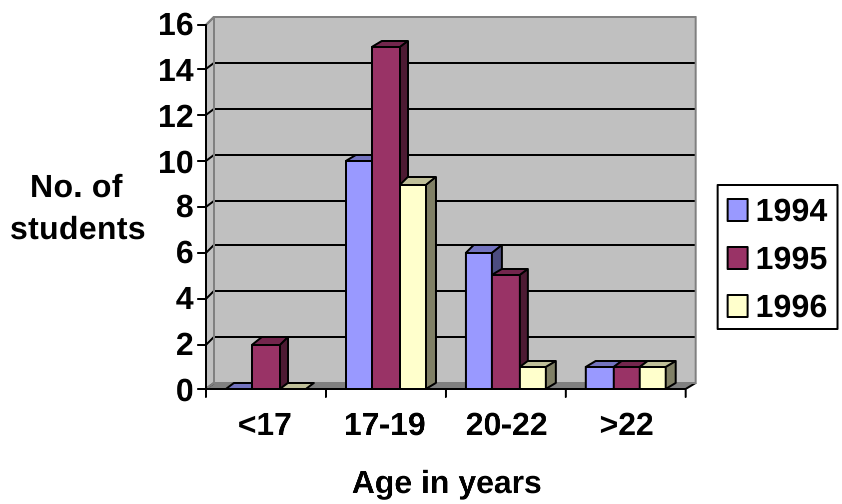

Figure 4.1 Age distribution of students registered for the period 1994 – 1996

From Figure 4.1 it is evident that the majority of the students (actually 67%) are in the age group 17 – 19 years at first registration for the programme, only 3 out of the 51 students (that is, 6%) were above 22 years old and the median age is 19 years for the first year of registration. The youngest student enrolled, who was 16 years old, completed the programme after 6 years and is currently registered for a B Tech:Quality degree. This student missed out a year of studies due to financial reasons, then returned to complete. The oldest student 25 years old at first registration, deregistered after the first year and reregistered to study towards the National Diploma in Public Management at the same institution.

It is important to determine the gender profile of these students to determine whether females are enrolling for science programmes to meet the demands of science and technology requirements of South Africa. Figure 4.2 shows that there was an increase in the percentage of females enrolling for the programme from 35% in 1994 to 72% to 1996

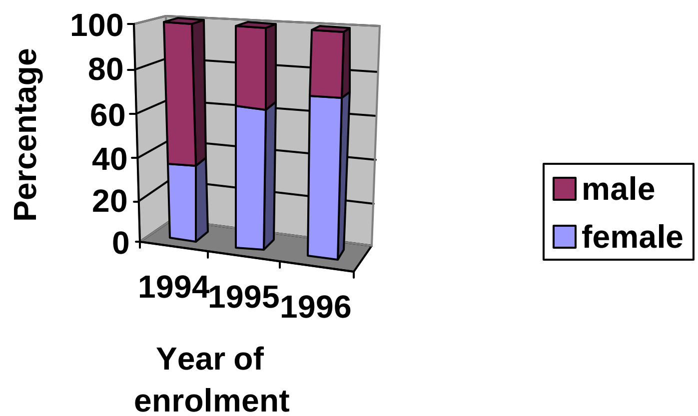

Figure 4.2 Percentage enrolment by gender (1994-1996)

There was no specific strategy employed to target female students or to increase the enrolment of female students, it just happened that more females were accepted on the programme.

Table 4.1 shows the overall gender distribution for those students enrolled and those that graduated from the programme.

Table 4-1:Gender distribution for students enrolled and those that graduated from the Augmented programme

	Female	Male	Total number of students
% enrolled	57	43	51
% graduated	67	33	21

The percentage females actually graduating are 67% of the total number of students that have completed the programme during the three-year period which shows that the females are more successful than the males and the problem of “access without success” does not apply to the females. The College of Science (COS) programme at the University of the Witwatersrand (Rollnick, 2000) shows a similar trend in increasing female student intake over a ten year period- 30% in 1990 to 40% females in 2000. For the 1995-1997 intake at the COS, the number of female graduates exceeded that of males, as is the case here.

The race profile of the students in the programme shows 60% of Black, however, this profile has changed with 100% Black students registering for the programme in 1999. The Indian students registered for the programme because they did not meet the Mathematics requirement for the mainstream National Diploma and at that time, the programme accepted Blacks, Indians and Coloureds. The Indian and Coloured students were regarded as disadvantaged because they also attended under-resourced schools as discussed in chapter 2.

The home language of the students in the programme is either English, Zulu, Sotho (North or South), Swati, Venda or for some students this information was recorded as “unknown”. See Appendix B for the distribution. Twenty-four students (47%) did not have English as a first language for Matric- twenty-one had Zulu (41%), one had North Sotho (2%), one had South Sotho (2%) and one had Tswana (2%) as a first language with English as a second language.

The profile of the students that graduated by 2001 presented in table 4.2 shows no particular trend in age, gender, points calculated for matric or subjects in matric and time taken to complete. The data in table 4.3 confirms that there is no relationship between either the total Matric points, the separate Maths, Physical Science or English points or the entry points[17] and the number of years it takes to complete the programme.

Students that took longer than four years either:

- had a one year break in their studies due to financial reasons,
- took long to find jobs to complete their one year inservice training (required for year 4) or
- failed semester one subjects in year 3.

The above reasons for students taking more than four years to complete the course, show that number of years to complete the programme cannot be used as an indicator. The first two reasons mentioned above are beyond the control or influence of the design of the programme.

[17] Combined Maths, Physical Science and English points

Table 4-2: Profile of students that graduated by 2001

Number	Year of registration	Age	Gender M-Male; F-Female	Total Matric points	Points for English	Points for Maths	Points for Physical Science	Entry points	Years taken to complete
AA	1994	20	F	19	3	4	2	9	4
BB	1994	21	M	15	4	3	1	8	7
CC	1994	20	M	13	4	2	2	8	7
DD	1994	19	M	25	6	1	4	11	7
**EE	1994	18	M	20	3	4	3	10	4
FF	1994	18	M	28	5	2	6	13	5
*GG	1995	20	F	30	5	2	4	11	4
**HH	1995	20	M	23	5	3	4	12	5
II	1995	18	M	20	5	1	4	10	5
**JJ	1995	18	F	21	5	3	4	12	5
KK	1995	18	F	26	6	2	4	12	6
**LL	1995	17	F	24	5	3	3	11	6
*MM	1995	18	F	33	6	4	4	14	4
NN	1995	17	F	29	5	2	5	12	5
OO	1995	16	F	28	5	2	3	10	4
PP	1995	16	F	17	4	0	1	5	6
QQ	1996	17	F	26	6	1	5	12	5
RR	1996	17	F	32	6	1	5	12	4
**SS	1996	17	F	29	5	3	4	12	4
**TT	1996	18	F	27	5	2	6	13	4
UU	1996	19	F	14	4	3	1	8	5

* These students registered and completed the Bachelor in Technology Degree in Chemistry within the minimum required period on completion of the Augmented programme.

** These students are registered for varying levels of the Bachelor in Technology Degree in Quality.

4.3 Research Sub-Question 2 and 4: The graduation rate for the students enrolled during the period 1994-1996

The graduation rate for the students is the percentage of the students who graduate from the programme. The minimum period for the students to graduate is four years and the maximum period allowed according to the Technikon regulations was eight years, that is, double the duration of the programme. The data collected during the period of this study, covered seven years for those students registered in 1994, six for those in 1995 and only five for those in 1996. Thus the graduation rate per year calculated in the last column of Table 4.3 shows the rate up until the end of 2001 with the figure in brackets showing the rate for a five-year period. The graduation rate of the students (completing within five years) has increased over the years from 18% to 45%.

Table 4-3 : Graduation rates of students enrolled during the period 1994 - 1996.

Year of Enrollment	Number of students	Year of graduation				Tot no of students graduating*	% students graduating
		1998	1999	2000	2001		
1994	**17**	2	1		3	**6**	35 (18)
1995	**23**		3	4	3	**10**	43 (30)
1996	**11**			3	2	**5**	(45)

* up until the end of the period of study – end of 2001

The figures in brackets indicate the percent of students graduating within five years of registration

4.3.1 Relationship of Matric Points for the students to their graduation rate

The students are selected for the programme based on them not meeting the entrance requirements for the mainstream National Diploma programme. The entrance requirement for the mainstream programme is a Higher Grade (HG) pass in Mathematics with a minimum of an E symbol or a Standard Grade (SG) pass in Mathematics with a minimum of a C symbol and a minimum of 12 points for Mathematics, Physical Science and English. The points are awarded according to the symbol obtained for each subject and whether the subject was taken on the Higher Grade (HG) or Standard Grade (SG). The points allocated is given in Table 4.4. Each university has their own formula for calculating the matric points per student for entry thus the same matric symbols will produce different matric points at various institutions and hence could be a “bad” or “good” predictor of success depending on the Institution.

Table 4-4 Points allocation for Grades and symbols for Matric subjects in the Chemistry Department at ML Sultan Technikon

Matric symbol (Percentage range)	A +80	B 70-79	C 60-69	D 50-59	E 40-49	F 33.3-39	G 25-33.2
Points on Higher Grade	8	7	6	5	4	3	2
Points on Standard Grade	6	5	4	3	2	1	

The total points obtained for all the subjects in matric are not considered for selection into the Augmented programme. A graphical representation of the total matric points for the 51 students in the augmented programme is presented in figure 4.3 below to give an indication of the spread.

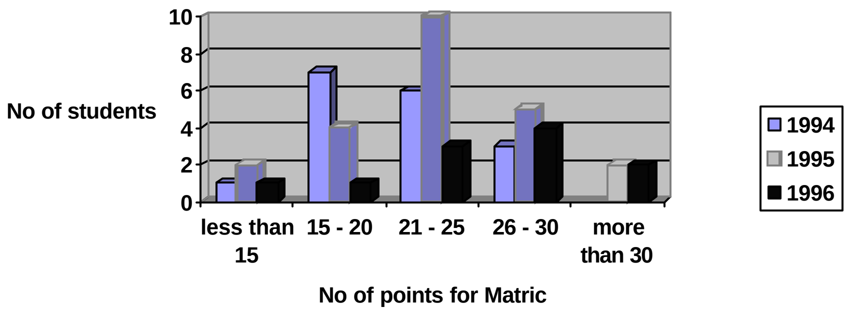

Figure 4.3: Distribution of total matric points of Augmented students

The trend in Figure 4.3 shows that generally, the average total matric points for the students increased from 17 points in 1994, 24 points in 1995 to 25 points in 1996. This means that according to the total matric points, the prediction would be that a better performing group of students was enrolling for the programme even though this was not used as an entrance requirement. This prediction correlates with the data in Table 4.3 that shows an increase in the graduation rate from 1994 (18%) to 1996 (45%). However the low Pearson correlation coefficient of 0.14874 from individual student data as represented in Appendix B does not fully support this prediction. Furthermore the small population means that generalizations cannot be made with this data. Table 4.5 provides a summarized version of the data found in appendix B and was not used to determine the correlation coefficient, but merely provides an overview of the spread of matric points and the graduation rate.

Table 4-5 Graduation rate in relation to the total matric points

Total Matric points	Total number of students	Number of students that graduated	Graduation rate
11-15	6	3	50%
16-20	10	4	40%
21-25	19	4	21%
26-30	12	8	67%
31-35	4	2	50%

4.3.2 Relationship of Entry Points for the students to their graduation rate

A student who gains entry into the augmented programme generally has a symbol lower than an E for Mathematics on the HG or lower than a C for Mathematics on the SG, also the total points calculated for Mathematics, Physical Science and English (called ‘entry points’) for these students varies from 14 to 4 (see Fig 4.4). The trend from figure 4.4 shows that the entry points of the students increased over the three year period with the 1996 cohort having the highest number of students with more than 10 entry points.

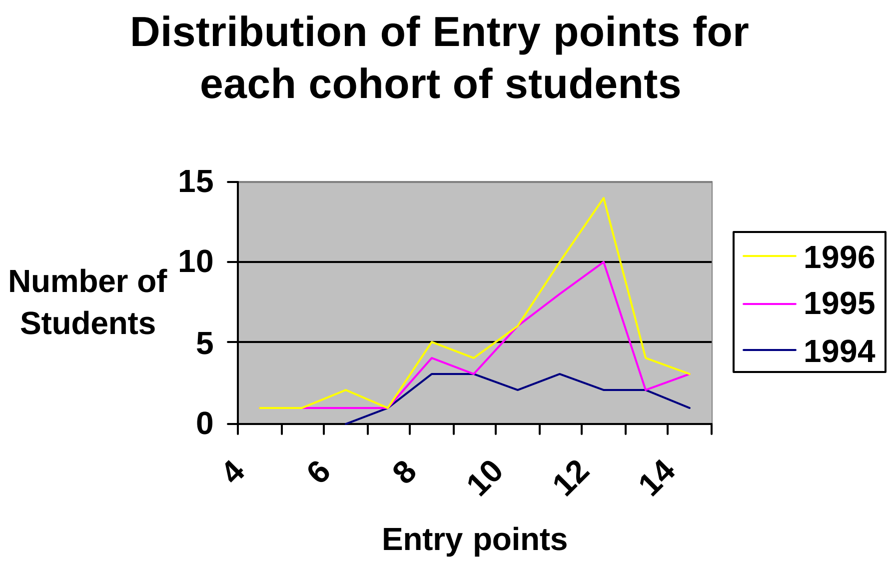

Figure 4.4 Distribution of Entry points (=Total points for Matric Mathematics, Physical Science and English) for students gaining entry into the programme

The graduation rate for all the students based on their entry points presented in table 4.6 shows an increasing graduation rate with increasing entry points from 4 to 12 points after which the rate remained the same. There is a higher positive correlation (0.16468) between the graduation rate and the entry points than for matric points. The Pearson correlation was calculated using the individual student data in Appendix B and Table 4.6 provides an overview of the data.

Table 4-6: Graduation rate in relation to the entry points

Entry points	Total number of students	Number of students that graduated	Graduation rate
4-6	4	1	25%
7-9	10	4	40%
10-12	30	13	43%
13-14	7	3	43%

4.3.3 Relationship of Points for each of Matric Mathematics, Physical Science and English for the students to their graduation rate

The summarized data from Appendix B is presented in tables 4.7 to 4.9 for each of the points for the entry subjects, namely, Mathematics, Physical Science and English and graduation rates.

Table 4-7: Graduation rate in relation to points for Matric Mathematics

Points for Mathematics	Total number of students	Number of students that graduated	Graduation rate
0-1	13	4	31%
2-3	31	13	42%
4-5	7	3	43%

Those students with points for Matric Mathematics higher than four[18] are in the Augmented programme because they either had a re-mark of their matric Mathematics paper or they did not meet the 12 points minimum for the total of Mathematics, Physical Science and English in Matric.

Table 4-8: Graduation rate in relation to points for Matric Physical Science

Points for Physical Science	Total number of students	Number of students that graduated	Graduation rate
0-1	5	3	60%
2-3	18	5	28%
4-5	25	11	44%
6-7	3	2	67%

[18] The minimum entry into the mainstream course is 4 points for Matric Mathematics.

Table 4-9: Graduation rate in relation to the points for Matric English

Points for English	Total number of students	Number of students that graduated	Graduation rate
0-1	0	0	0%
2-3	3	2	67%
4-5	34	14	41%
6-7	13	5	38%
7-8	1	0	0%

The Pearson correlation coefficients tabulated in table 4.10 were calculated using the individual data from Appendix B.

Table 4-10: Pearson Correlation Coefficients for Matric subjects (subjects on which selection is based) in relation to graduation rate

Matric Subject	Pearson Correlation Coefficient
Mathematics	0.003245
Physical Science	0.454564
English	-0.30008

From table 4.10 it is evident that Physical Science has the highest correlation coefficient out of the three matric subjects with English showing a negative correlation. Mathematics shows the lowest correlation with graduation rate.

Table 4.11 is a summary of all the correlation data calculated for the relationships to determine the best predictor for success of the students on the Augmented programme.

Table 4-11 Correlation data for possible predictors of success (N=51)

Possible predictor	Correlation coefficient*
Matric Physical Science Points	0.45456
Entry Points (three matric subjects combined)	0.16468
Total Matric points (all subjects)	0.14874
Matric Mathematics points	0.00325
Matric English points	-0.30008

* Coefficient calculated from possible predictor as independent variable and graduation rate as dependant variable

From table 4.11 it can be seen that using the Pearson correlation coefficients, Matric Physical Science will be the best predictor out of the four options investigated during this study with English having the highest negative correlation.

4.4 Research Sub-Question 3: Performance of the students in Analytical Chemistry 1, 2 & 3

Having established the overall performance of the students, an analysis of their performance in the main subject of the augmented programme in National Diploma: Analytical Chemistry, namely, Analytical Chemistry from levels 1 to 3 was undertaken. These subjects were chosen to ascertain how well the students performed in their major subject. The performance for Analytical Chemistry for all three levels per student is attached as Appendix B.

The pass rate for each cohort of students by year per subject is tabulated in table 4.12 with the total number of students in brackets.

Table 4-12 **Pass rate for Analytical Chemistry subjects for each year during 1994-1996**

Subject	**1994**	**1995**	**1996**	**overall**
An Chemistry 1 (%)	88%(17)	74%(23)	100%(11)	87%(52)
An Chemistry 2 T (%)	87%(15)	94%(16)	100%(7)	94%(38)
An Chemistry 2 P(%)	100%(15)	100%(16)	100%(7)	100%(38)
An Chemistry 301 T (%)	58%(12)	92%(12)	100%(7)	81%(31)
An Chemistry 301 P (%)	100%(12)	100%(13)	100%(7)	100%(32)
An Chemistry 302 T (%)	100%(10)	100% (11)	100%(7)	100%(28)
An Chemistry 302 P (%)	100%(11)	100%(12)	100%(7)	100%(30)

An = Analytical ; T= Theory; P=Practical

The Analytical Chemistry 1 mark includes the practical assessment mark

.

The pass rate in Analytical Chemistry 301 theory module is low for students which corresponds with the “gap” experienced by the COS students (Green et al, 1998). The students on the augmented programme joined with the mainstream students when they did Analytical Chemistry 301 theory module. This module was also their first semester examination (written in June) as opposed to their normal annual examination written in November. The students thus had an exam after six months of lectures. The Analytical Chemistry 302 theory module also had an examination after six months, however, for the students it was the second six-month period.

A more important piece of information is how well the students performed within the subjects.

Table 4-13 Statistical Data for the student perfomance in Analytical Chemistry 1, 2 & 3

Subject	AnChem 1	An Chem 2 T	An Chem 2 P	An Chem 301 T	An Chem 301 P	An Chem 302 T	An Chem 302 P
Average	62	64	70	55	64	64	66
median	62	63	71	53	64	64	66
max	89	83	83	82	80	83	81
min	10	42	50	22	52	50	50

Note:1) the pass mark in a subject is 50%. 2) these stats were based on all students registered on the augmented programme from 1994 – 1996

The results presented thus far show that students performed better in the Practical components than the theory components. This could be due to the fact that the practicals are hands-on sessions and students are assessed more on demonstration of manipulative skills than conceptual understanding of a practical as mentioned by the lecturers during the interviews.

Furthermore, the average mark is the lowest for Analytical Chemistry 301 Theory module and the average for the practical components of subjects is higher than for the theory. The students have also obtained distinctions (>75%) in the subjects from first level right up to the third level.

The next section presents an analysis of the tutors and lecturers' attitudes and perceptions of the structure and role/purpose of the Augmented programme.

4.5 Research Sub-Question 5: Lecturers' and tutors' attitudes and perceptions of the structure and role/purpose of the Augmented programme

The responses from each of the semi structured interviews, the focus group interviews and the second group interviews were carefully analysed to identify consistency of the lecturers' perceptions and to obtain clarity on what was said. The responses to the questions regarding the role and structure of the Augmented programme will be discussed before the teaching and learning issues experienced in the classroom. Issues that were identified as being outside of the scope of this research are briefly discussed in Chapter 5 of this report.

4.5.1 The Experience and Qualifications of the lecturers and tutors

The information obtained from the first question of the semi-structured interview regarding the lecturers' qualifications and experience in lecturing is tabulated in Appendix C. In summary, the two tutors are young Indian females (mid twenties) who both had B.Sc qualifications and were studying towards an education qualification. These tutors had one-year experience of teaching at schools and had been tutors as senior students at University. Other than that experience, they had no formal training as tutors and basically trained themselves as they proceeded. The tutors were initially based in the Department of Chemistry but were transferred in 1998 into the Educational Development Department of the Academic Development Unit. The tutors are identified as T1 and T2 to preserve their anonymity and confidentiality.

The lecturers that were interviewed had B.Sc degrees from University and five out of six of them had a National Higher Diploma in Chemistry obtained from the ML Sultan Technikon. They were all at different stages towards obtaining their Masters qualifications in Chemistry, had some experience of working in the Chemical Industry and had a range of lecturing experience from 2 years to 23 years. As mentioned before in Chapter 3, the lecturers were selected because they taught the subject Analytical Chemistry at either of the levels 1 to 3. These lecturers were based in the Department of Chemistry and taught the students in both the Augmented programme and the Mainstream students. For confidentiality and anonymity, the lecturers have been identified as lecturer A to lecturer F.

4.5.2 The role and structure of the Augmented Programme

The structure for the Augmented programme is similar to the mainstream programme for Analytical Chemistry; the difference is more periods per subject and extra tutorials allocated to the Augmented programme which is offered annually whilst the mainstream programme is offered on a semester basis. The content for each subject is identical for the two programmes. The rationale from the Head of Department was that the standards would thus remain the same and there would be no gaps in the knowledge when the students join at year three.

The purpose of the question on role and structure of the programme in the interviews was to determine whether all the lecturers and tutors shared the same philosophy regarding the programme.

The lecturers' views on the role of the Augmented programme was mainly that it allowed for more time, with hardly any of them mentioning that its purpose was to improve the skills of the disadvantaged learner or to increase the access of science students to Higher Education, to quote a few of their responses.

Lecturer A: *"it is a sort of bridging to the mainstream"*

When probed about the use of the word "bridging" the lecturer identified the fact the students are weak in maths and science and "the pace of teaching is slower and therefore it … and you can spend more time with the students".

Lecturer B *"to teach them [the augmented students] the whole syllabus which is spread over the whole year…I think they need time to adjust and get into the groove of things"*

The lecturer shared that some of them had not been in a laboratory before and that their Chemistry background was very weak and a whole year as opposed to a semester course, gave them “time to understand and time to work on things they don’t understand”

Lecturer C: *“to help students who have not met the formal requirements for entry into the programme and the thinking would be by giving them a longer period, they would cope that much better and come that much prepared”*

Lecturer E: *“it replaced the bridging programme… the pre-Technicians course… it is for students who got less than the 12 points for the three matric subjects”*

Lecturer F: *“to give them [the augmented students] more time to mature in the subjects”*

However,as lecturer C warns about the danger of considering the longer time since “the longer you experience something the better you should be has flaws in it especially if you are experiencing nothing, nothing will change”. The feeling was that the students had too much free time in their timetable and that the tutorials were not very efficient in adding value to the learners. Lecturer E felt that the Augmented programme even though it had replaced the Pre-Technicians course, did not afford the students the flexibility to go into any science field after year 1 or year 2 like the Pre-Technicians course.

Lecturer D: *“ it is for slow learners…to give students an opportunity to develop their potential, their skills at their own pace, so in other words, they don’t feel pressurized competing with the mainstream students”*

This lecturer expressed the view that the class size for these ‘slow learners’ needed to be small. Unfortunately, the lecturer was not probed further into what was meant by “slow learner” at this interview but it was explored further in the group interview. The response given then was that since these students are disadvantaged in terms of their schooling experiences, they did not have the necessary background to readily understand the concepts and work in a laboratory.

In the subsequent group interviews, lecturers all confirmed that the programme aim was to give disadvantaged students who don't normally meet entrance requirements a chance to get into a specific programme and for the students to obtain assistance in terms of tutorials. They further highlighted that these students were disadvantaged because the schools that these students attended lacked resources and had large class sizes. Their definition of disadvantaged included Blacks, Coloureds and Indians. The other aspect of disadvantage is in terms of the students' home language to quote "English is their second language."

4.5.3 Teaching Strategies

Not all the lecturers share the view of lecturer A that:

> *" because they [augmented students] have more time than the mainstream so we could change our teaching styles, actually we experimented the teaching styles with the augmented." (Lecturer A)*

All the lecturers use a lecture style with only three of the six lecturers using some group work, seminars and videos. Some lecturers do not use group work since "it takes too much time in the class" and the venues are not suitable for group work. When probed further on the use of group work one lecturer responded:

> *"just put them into groups of four or five according to the register which is the same as the practical groups… and gave them problems to solve in the class"* (Lecturer A)

Further discussion during the group interviews revealed also that the groups did experience racial tension (there were Indian students in the group) and dominance by one or two group members, which was a problem that the lecturer found difficult to solve, and hence other lecturers said that they did not like to use group work. This view was of concern because it demonstrated that lecturers did not understand what groupwork is.

Lecturer E reported in the interview and explained further in the group interview :

> *"I often relate my lectures to Industry…. I use a question and answer method as when they have preknowledge of something, and then I use that as a basis… I always question them on what they know to show them how that can lead on to what I am teaching currently."*

In the group interview, this lecturer explained how the concept of dilution was taught using the idea of diluting of a cup of tea or a glass of juice. The other lecturers agreed that students performed very well in the subject and they were participative in the class of lecturer E. This lecturer uses the constructivist approach in teaching which could easily lead to adopting a worldview theory of Cobern (1996).

On the other hand, lecturer F used only the lecture style of teaching and reported that the students did not participate well in the class and they also "rote-learnt". When probed as to whether students asked questions in the class, the response was "no" and that they did not even answer questions posed to them. Further probing as to possible reason for the non-participation in class revealed the following comment:

> (after a long silence by the lecturer)… *I don't know, maybe lack of confidence in themselves, lack of the fact that they do not do any work at home, the fact that they do not read-up before they come, so yes, a lack of prior knowledge I would say* (Lecturer F)

All the lecturers did not agree with everything made in this comment. Most of them felt that the students were motivated and had some confidence in their abilities but that they definitely did not read sufficiently and lacked conceptual knowledge in chemistry. Other skills that they felt the students lacked were note-taking and note-making, organizational and study skills. The students also tended to use their Mother tongue in discussions with their peers and not English which is the medium of instruction and examination; they thus experienced difficulties with English. The lack of these skills is synonymous of disadvantaged students in other institutions (Grayson, 1997; Warren, 1998; Masha & Mayeya, 1999; Sharwood, 2000 and Linkonyane & Sanders, 2000).

The teaching strategies and styles of the lecturers is heterogenous with a predominance of the use of the lecturing style and chalk-and talk.

4.5.4 Tutorials

Tutors were specifically employed to conduct the tutorials for this group of students for the first two years of the course. The number of tutorials remained four per subject for these students and only decreased to two periods for the first year students in 1998 due to funding constraints.

The lecturers themselves conduct the tutorials for the An Chem 3 modules (at year 3 when the students combine with those in the mainstream) and one period of tutorials is allocated per module for all the students.

The tutorials are compulsory for the students on the augmented programme but they are not credit bearing. The tutors had Chemistry qualifications but no training on conducting tutorials when they were employed. They met informally with lecturers to discuss the work to be covered in the tutorials for the first and second year of the programme.

Interviews with the tutors revealed that the lecturers teaching the subjects prepared the tutorial material and they were content based. The tutors' role in the tutorials was to supervise and check that the students had done the work set and to provide the necessary assistance in problem solving. The problem solving included conceptual as well as numerical problem solving. Their approach is in keeping with that of Pastoll (1992) who defines a tutorial as

> *An occasion for students to receive feedback about their own constructions of meaning"* (Pastoll, 1992: 1)

The tutors also covered academic literacy skills in their sessions:

> *it involved liaising with the lecturers and providing the students with tutorial exercises which were given to the students and which they had to complete, either at home and bring to the class or they had to complete it in the class and I had to supervise and check that the work had been done and provide the necessary assistance in problem- solving and so on.*
> *it was content-based but it was on stuff like exam preparation and life skills and so on. We did exercises like note-taking and note making exam preparation and test preparation and so on.* (Tutor T1)

> *we used to look at academic literacy skills, things like note-taking, note-making skills, summarising skills, assignment writing, maybe, exam techniques, test preparation and things like that, so it was all those things that we used to incorporation the context of chemistry.*
> *…take something like assignment writing, what we used to do was look at an assignment that they were assigned to do, like so the students had been given an assignment so, what we did looked at what the assignment was, how they need to research the assignment, how to deconstruct the question, firstly of the assignment to look at, key words, what is expected of them in terms of those key words, things like criticise and discuss and also firstly to deconstruct the question, then to look at how to research the material that they needed and finally putting the assignment together he formatting of it in terms of the introduction, the body, the conclusion and writing the references and things like that. So it was actually using what they were assigned in their subject and embedding that into their assignment writing and things like that. It was very much content based. In fact let's see even with their chemistry stuff itself, we looked at terminology, we looked at a lot of the deconstructing terminology, a lot of using problem-solving skills and teaching them strategies to solve problems but, using actually chemistry problems to help them work out strategies and techniques of solving problems.* (Tutor T2)

The manner in which these tutorials were conducted is consistent with that of Pastoll (1992) which gives feedback to the students and allows for participation in the session. The students worked in groups of 4 or 5 students in the tutorial sessions. Tutors reported that attendance at the tutorial sessions for the augmented students was very good at about 90 – 95%. The advantage of the tutors based in the department was the constant contact with the lecturers and the students saw them as part of the Department.

The lecturers that did their own tutorials did not have set periods for the tutorials and tutorials were done

> *"at a convenient point in the lecture, when I have covered certain basic theory then I do numerical problems and at this stage I present the problem and work it out" (Lecturer F).*

The students are however informed before-hand when a tutorial session is to be held. The lecturer felt that setting a fixed time on the timetable for tutorials is restrictive in that enough work might not have been covered for a tutorial. The emphasis in tutorials is on working through numerical problems. The lecturers did agree that more conceptual understanding should be covered in the tutorial sessions as well as skills such as note taking and others as mentioned earlier. However, they felt that they were unable to do such skills development which a tutor should be doing. Reasons are that they have no time and they do not have the training to undertake the skills development. The 1994–1996 cohort did not experience the SI programme or the Core curriculum since it was introduced only after 1999. The lecturers did comment on the fact that they did not like the SI programme since the students that were employed as SI tutors did not have "sufficient experience in chemistry" to conduct the tutorials and these tutors usually left as soon as they found permanent employment. These tutors were generally repeating one or two subjects in the third year of their diploma and were seeking employment in Industry to complete their in-service training. The lecturers' expectations of the SI programme were that only numerical problem solving would be done which is not the aim of the SI programme.

The lecturers see tutorial sessions as an extra time for students to complete numerical problems and they do believe that the skills mentioned earlier that the students lack should be covered in tutorials.

4.5.5 Practicals

The students on the Augmented programme are disadvantaged and they come from under-resourced schools so most of them have never been into a laboratory or done a hands-on practical. The programme includes a three-hour practical session for each of the Chemistry and Analytical Chemistry subjects. The practical manuals used for the augmented programme are the same as for the mainstream programme and the students follow the "recipes" during the practical sessions. The excitement of discovery is not included in the practicals since laboratories are costly, time consuming and predictable.

The practicals were hands-on sessions with students working individually at first and second year while in third year, they worked in small groups of about 5 to 6 students. Lecturer D commented as follows regarding the hands-on approach:

> *The augmented students preferred to do practical work, they are much more enthusiastic about practical work as opposed to the mainstream students. There is some kind of enthusiasm about them doing practical work. Maybe they prefer working with their hands rather than being bored with theoretical work.*

Lecturer C commented about their coping abilities:

> *Generally I feel they cope much better than they would cope in the tutorial or test*

Lecturers commented during the group interview that it was easier to pass practicals because it is hands-on and because continuous assessment methods are used. The lecturer also commented on the assessment as follows when asked for the possible reason for a high pass rate and level of performance in practicals:

> *…they [the students] are doing things rather than explaining things or writing a lot so the…what we find if we do a good job of the demonstration of the pracs and what is to be done and monitor it properly and if students attend every single session and submit every single report, it is very unlikely that they will fail and get less than 50%, very unlikely. The reason students fail sometimes is that they do not get the reports to us on time and they get zero for the report.*

Each student is assessed individually though they may do the practicals in groups. The lecturers do the demonstration of the practicals during a pre-practical period to all the students. During this period, the background theory for the practical is explained especially if the theory has not been covered in the class. Once again lecturer E showed his constructivist approach:

> Whenever I did practicals with my students, I did discuss the theory …on which the practical is based, principle for example in Analytical Chemistry, the principle on which the method is based, I quickly did a quick talk of 5 minutes… you actually build it up from matric level…I always refer to those.. to gain the knowledge that they have gained and work from there and make it understandable as possible…

The lecturers feel that the practicals should be synchronized with the theory lectures on a topic, very much in keeping with the philosophy of the practicals in the UNIFY programme. However, at times this is not possible and the practical is completed before the theory is covered in the classroom. It is at these times that the pre-lab sessions are found to be very useful. Overall the lecturers are very pleased with the format of the practicals, their content and the students abilities in practicals in spite of the poor laboratory facilities at schools. Examples of the type of practicals are Calcium content of sea shells by a titrimetric method (Analytical Chemistry 1), Determination of the hardness of water (Analytical Chemistry 2) and the Determination of the Chromium and Manganese content of steel using Atomic Absorption Spectroscopic method (Analytical Chemistry 3).

4.5.6 Other issues related to the programme

There were issues raised in the interviews such as the need for Career counseling for the students, the unsuitability of some of the lecturing venues, the fact that the students do not read books, that they do not own textbooks which the lecturers see as being essential for the students.

As mentioned in section 4.2, English is a second or possibly third language for these students. The lecturers mentioned in the interviews that students tended to speak in their mother tongue when communicating with each other in the class. Some lecturers felt that this was acceptable behaviour whilst others did not approve of this in their class. The feeling was that the students needed to speak English since it is the "language of existing texts, the workplace and research documents". This is possibly an area of further research for the programme.

5 Chapter 5: Conclusion and Recommendations

5.1 Introduction

In this chapter the findings from all the research questions are consolidated and recommendations are presented for the programme in the Durban Institute of Technology, the new merged Institution between ML Sultan Technikon and Technikon Natal. It is important to conduct formative and summative evaluation of any programme in an institution on a regular basis to inform the curriculum process. This study was limited to only three cohorts of student results from 1994 to 1996 that were registered for the Augmented Programme of the National Diploma: Analytical Chemistry. The reason for this delimitation was to track the students until graduation, allowing for the maximum time spent at the institution which is double the duration of the programme. The duration of this study itself which is a mini-dissertation did not permit a longer period. The study examined the student records since the students were not available to be interviewed. The small number of students (less than 100) means that the results cannot be generalized but are reported as specific cases highlighting significant issues and trends. An analysis of each subject in the Programme was not undertaken, rather an analysis of the major subject at all levels in the diploma, namely, Analytical Chemistry was completed as an indicator for the success of the programme.

5.2 Consolidated Findings

The research project set out to determine the effectiveness of the Augmented programme as an access programme at the ML Sultan Technikon. The ML Sultan Technikon came to the end of an era when it merged with Technikon Natal in April 2002 and as such needed to evaluate the Augmented programme. In addition, most recently, a Foundation programme for Science at the Technikon has been proposed. The successes of the existing programme within the Technikon sector need to be documented for future reference.

The findings are based on the five sub questions of the study, namely,

1. What is the profile of students admitted to the Augmented programme?
2. What is the relationship between matric symbols (marks) and the graduation rates for the students?
3. What is the performance of the students in Analytical Chemistry?
4. What is the difference between the graduation rates of females and males in the programme?
5. What are the lecturers' and tutors' attitudes/ perceptions of the structure and role/purpose of the Augmented programme ?

The answers for sub question one showed that the majority of the students (67%) that registered for the programme during 1994 to 1996 are in the age group 17 – 19 years and overall there were 57% females with a trend of increasing numbers for the females. This age group shows that the programme is catering for mainly matrics that have entered tertiary study immediately after school and are not mature adult learners from Industry. The majority of students are English second language speakers and the lecturers feel that they do experience problems in the class in communicating with the students in English. The home language of the students in the programme is either English, Zulu, Sotho (North or South), Swati, Venda or for some students this information was recorded as “unknown”. These students of whom 60 % were classified black (from 1998 there are 100% black students), in addition, have a record of poor performance in Matric Mathematics and Science and the lecturers have agreed that they do come to the class with misconceptions and even lacking of conceptual understanding in Chemistry. This immediately highlights a problem as discussed by Smith (1995), the programme should be able to meet students where they are at and take them to where they need to be in Higher Education. Thus there should be something in place to assist the students to “catch up” which is arguably the introduction of academic support or development. Furthermore, Steyn et al (1998), support the notion that the mere establishment of extended courses to redress deficiencies in the background knowledge of under prepared students and to foster advanced scientific knowledge is not the only solution to address the problems encountered in the tertiary education of mathematics, physics and chemistry. Steyn et al (1998) are in agreement with de Boer and van Rensburg (1997) who remark that the education system in South Africa is embedded in a Western Culture and that the curriculum includes aspects unfamiliar to most African Cultures. This aspect though does not form a part of this study but needs to be borne in mind for future curriculum development especially in the light of Thabo Mbeki's African Renaissance programme.

Matric points whether based on select subjects as in the case of this programme, or on the total matric points is not a very good predictor of the success (in terms of graduation) of the students since the correlation coefficients are not very high. They range from 0.45456 for Matric Physical Science to -0.30008 for Matric English as presented in Table 4.11. There are other variables that could affect the graduation rate, besides the Matric points, such as, type of school attended in terms of resourced or underresourced. Further work is required to determine the predictors of success for this programme and perhaps include a comparison with the students on the mainstream programme. Other instruments for selection and placement of the students should be investigated.

Additional or alternate instruments need to be used such as the Desmond Tutu trust TELP tests for English, Science and Mathematics (Yeld, 2001) or the UNIFY selection tests (Zaaiman, 1998). However, success is not dependant only on the Matric points. According to Zaaiman (1998) :

> *"Selection should be seen as a contract to teach at the student's level. This contract requires that selected students must be adequately supported to succeed in the programme selected for after admission. (Zaaiman, 1998:181)"*

This study showed that for some students the teaching style and possibly the increased workload had some effect especially in year 3. There is a drop in student performance from year 2 to year 3 which is consistent with trends in other programmes (Parkinson, 2000 and Green etal 1998). Lecturer F who taught Analytical Chemistry 301 was interviewed and suggested possible reasons for the high failure as:

- "an understanding of the subjects has been a problem… electrochemistry especially". And
- "they [students in semester 1 of year 3] carry physics or maths…they repeat them in the first semester…. so they would have a greater number of subjects in that semester as compared to semester 2

Interestingly though, this lecturer's teaching strategy is only to lecture and uses no discussions and group work in his classes.

This poor conceptual understanding of electrochemistry is not something new in Chemistry. Ogude and Bradley (1994) found that students held misconceptions relating to electrochemical processes from High School through to tertiary level. In addition, they mention that traditional methods of instruction and some textbooks appear to cause or foster some of these misconceptions. They recommend that teachers should deal with misconceptions explicitly and spend time making specific mention of possible areas of confusion. The lecturer F that taught electrochemistry to Analytical Chemistry 3 students, unfortunately, used the traditional lecture method of teaching and complained of "not enough time to complete syllabus".

The graduation rate for students for the period of study is 18%, 30% and 45% for those students registered in 1994, 1995 and 1996 respectively. Females comprise 67% of the total number of students that graduated during the period of study even though they were 57% of the enrolled students..The time taken for graduation varies from 4 years (which is the minimum) to 7 years. So students can make it in the minimum time. Those that have taken 7 years have had financial difficulties and had to miss a whole year of study during their study period. In addition some of these students continued to enroll for B Tech degrees in either Chemistry or Quality and they are progressing well in these degree courses.

The students in the Augmented programme attended different classes (theory and practicals) to those in the mainstream programme for year 1 and 2 but the lecturers for the subjects (theory and practicals) were the same lecturers as for the mainstream programme which is an idea supported by the UNIFY model.

The UNIFY model supports staff from the cognate department lecturing to the students on the UNIFY programme since they see that it allows for a continuous change of ideas regarding the specific needs of students at the various levels and the formulation of solutions to address them thus having an impact on the teaching-learning in cognate departments (Smith, 1995). On the other hand, the Science Foundation Programme at University of Natal (Grayson, 1997) and the Pre-Technicians Course at Port Elizabeth Technikon (Sharwood, 2000) employ separate lecturers for their programmes who meet formally with mainstream lecturers to help influence the teaching and learning in the mainstream. The lecturers on this Pre-Technicians Course use a variety of teaching strategies such as group work and interactive teaching that are not traditionally used by lecturers at University or Technikon. Although most of the lecturers on the

Augmented programme use the ‘lecture’ method, some of them see the need to use other styles and do use groupwork, seminars and videos. The lecture style is not to be disregarded completely since it can be successfully used with techniques to maintain the students attention and to keep students engaged. Using short student discussions, paradoxes, puzzles, avoiding direct repetition of material in textbooks and making connections to current events and everyday phenomena are some of the techniques recommended in the *Science Teaching Reconsidered – a Handbook* (1997).

Smith (1995) and Grayson (1997) in the design of the UNIFY programme at University of the North and the Science Foundation Programme (SFP) at University of Natal, respectively, state that it is essential to use different teaching approaches in the classroom to cater for the disadvantaged students and the diversity in the students. Learning is enhanced when a classroom environment is created that provides students with opportunities to learn in several ways. Teachers can uses a range of active learning approaches when teaching science (talking and listening, writing, reading and reflecting) and varied teaching techniques and strategies (such as lectures, videos, demonstrations, discovery labs, collaborative groups and independent projects). By using a variety of teaching techniques, lecturers can help students make sense of the world in different ways, increasing the likelihood that they will develop conceptual understanding.

Dinan & Frydrychowski (1995) and Kovac (1999) have reported successful uses of group work in the teaching of chemistry and Grayson (1997) and Smith (1995) both report that small group teaching is well suited to teaching disadvantaged students on their SFP and UNIFY programmes, respectively. Dinan & Frydrychowski (1995) used a team learning method and found that team learning is well received by students and that more material was actually covered. Furthermore, working in groups minimized student feelings of alienation and marginality and provided a network of support for students encountering either academic or personal problems. These aspects of group work definitely make it suitable for use in the Augmented programme. Kovac (1999) used co-operative learning workshops during which students were divided into groups and assigned specific roles and the lecturer acted as facilitator, encouraging and asking leading questions rather than providing information. Students were graded on the process rather than on the number of problems solved correctly. Students' response to the co-operative learning workshops was that it helped them to learn chemistry and made the course less intimidating.

The tutorial support for the programme was provided initially by tutors who were members of staff and later by peer support. These tutorials were generally "content driven" with some academic literacy skills. The effect of tutorials needs to be researched further to establish the effect of the decrease in tutorial periods from 4 to 2 per subject in 1998 and the effect of the peer system of tutoring. Fraser et al (1990) support the fact that tutors for bridging courses should assist the students in self-management skills and provide support through knowledge and understanding of students' individual circumstances. The focus of tutors needs to be on individuals rather than the whole class and thus group work is recommended. Model of tutors based in the depts.- this model is good to encourage integration of strategies for the mainstream lecturers, however, the disadvantage is that the tutors are generally seen as juniors in the department that have no valuable contribution to make – “they are inexperienced lecturers” was the comment made in the group interview. This is in contradiction with Pastoll’s (1992) view that the ideal learning environment in a tutorial is one where there are peers rather than authority figures and the tutors act as facilitators rather than founts of knowledge.

In terms of practicals, the lecturers agree that the pre-reading helps the students and that they can cope with the manipulative skills in the laboratory even though they may come to the programme with no manipulative skills. Sharwood (2000) and Grayson (1997) both reported that students on their programmes “love working in the laboratory” and it is the part of the programmes that they enjoy the most. There is still a problem experienced with the conceptual understanding in practicals as has also been identified in other programmes offering science subjects in South Africa.(Almekinders, Thijs and Lubben (1998), Doidge and Korving (1998), Allie, Buffler, Kaunda,Campbell and Lubben (1998), Buffler, Allie, Campbell and Lubben (1998), Davidowitz and Craig (2000), Rollnick, Lubben, Dlamini, Lotz and Irving (1999),Rollnick, Lubbe, Dlamini and Lotz (2000)).
Experimental work is fundamental to the teaching of Chemistry since it aids in the development of conceptual understanding. The purpose of laboratory sessions in

the SFP at University of Natal is to develop students' practical skills, to allow them opportunities to gain familiarity with apparatus, to build up their knowledge base through their own observations and experimentation, and to participate in the process of science Grayson (1997). Based on similar purposes, the UNIFY programme provides the following guidelines for designing and executing practical work:

- All practical work should be fully integrated with the rest of the course; that is, it deals with topics under discussion in lectures and tutorials in the same teaching week
- Skills-based and concept labs are separated to avoid mental overload. (Smith, 1995)

However, with the small numbers in the laboratories, the science of inquiry and discovery methods could be used for the augmented programme.

The other issues that the lecturers found was that the students do not read often and some of them are registered for the course not knowing what it is about and not sure what career they would like to follow. Mention was made of using texts that are relevant for English second language learners and not those designed for English first language learners.

Some changes that lecturers suggested for the programme were:

- Reviewing of the entrance requirements and selection procedures since they felt that

  - “students were not even sure whether they had chosen the correct career in Analytical Chemistry” and also
  - “the weak Maths and Physical Science background of the students is a problem”
- The need to integrate more language issues in the tutorials to cater for the deficiencies in English
- More life-skills to be introduced

From these suggestions it is evident that these lecturers still operate in the ‘deficient model’ and not in the developmental model of Academic Development.

The role of the Augmented Programme according to Chetty (1993) was to increase access to Higher Education for disadvantaged Black matriculants in science and to improve the skills of these disadvantaged students. The initial philosophy of the programme was that the additional time that these students had would be used to improve their skills and content which is in keeping with the philosophy of bridging and foundation programmes.

The increased time has advantages for students in that the content can be taught at a slower pace with more intensive lecturing in the subjects (Stanton, 1987). In addition, Parkinson (2000), states that the extended time enables the lecturer to go more slowly and integrate pre-first year material into the subjects since the students come with gaps in their knowledge. Both Stanton (1987) and Parkinson (2000) mention that together with a slower pace, the time allows for additional small group tutorials, use of special modes of instruction and in some cases supplementary courses in language and learning skills.

5.3 Shortcomings of the Research

When evaluating a programme, the student, teacher or lecturer and the educational philosophy of the programme should be examined. This research attempted to achieve the above however there were shortcomings in the study. The student voice was not included in the study in terms of either a questionnaire or interview which would have given their view on the success of the programme. This was not done since the specific students were no longer registered at the institution and their whereabouts were unknown. The students that left after first year did not pass all the subjects and most probably realized they had chosen the wrong career or the programme did not meet their expectations since their fees were all paid. Those that left after year two and year three had not passed all the subjects in each year and could have left due to financial reasons or due to lack of interest. It is unfortunate that these students left the Institution with no qualifications since at that time, the idea of multiple exits as per the National Qualifications Framework (NQF) of SAQA (SAQA Act, 1995) had not been implemented. If time had permitted it would have been useful to interview or send a questionnaire to the students to determine their reasons for their poor performance or for them leaving the programme.

In addition, the course material used in the programme could have been investigated to determine whether the constructivist approach to learning or otherwise was used.

5.4 Recommendations and Implications of the Results

A recommendation would be that research be undertaken at the Durban Institute of Technology (as a result of the merging of Technikon Natal and ML Sultan Technikon) for the use of the Desmond Tutu Educational Trust TELP tests as a selection method since it is appropriate for the student population and they are freely available for use from the Trust. These test are used in an inclusive manner in that they are not used to exclude students but rather to direct students that have already been selected based on interviews and matric results to the appropriate support programmes. The selection tests developed for the UNIFY programme may also be worth looking at to ensure that students with potential are selected. Furthermore mechanisms need to be looked at to select the possible learners who are working in the chemical industry and gaining qualifications in Industry at NQF level 4 which is an equivalent to the Matric Certificate. These learners of, course are also more mature.

The numbers of students taken per year for the Augmented programme was very low at approximately 20 thus the impact of the number of these science diplomats on the skills shortage and on promoting access is very low. The Department did increase the intake to about 60 students from 2000. However discussions with the Head of Department revealed that the student performance was not as well as expected. This could be due to the larger class size and not enough personal tuition and attention for the students in two tutorial periods per subject per week which is required according to Raubenheimer's (1997) evaluation of the Gencor Science Foundation Programme at the University of Natal, Pietermaritzburg.

In view of the latest trends in the country, more matriculants passing with poor symbols in Mathematics and Science, there will be a continued need for means of identifying/selecting learners with potential and providing support for these learners in higher education to ensure that they succeed.

The teaching strategies and content of the subjects needs to be further investigated to ensure that conceptual and procedural understanding of Chemistry is present and academic literacy skills is integrated. Any future changes in the programme should be underpinned by recent research trends especially good practice from South African Institutions which have been involved in Academic Development for a longer period. All the lecturers that teach on the programme should use strategies that cater for the disadvantaged students and the diversity of students in the programme. There is a need for Career planning and counseling for the students.

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Annexures

Appendix A

Mrs D N Timm
Senior Lecturer
Department of Chemistry
M L Sultan Technikon
18 January 2000

Prof R Bharuthram
Director : Research
M L Sultan Technikon
P O Box 1334
Durban

Dear Sir

Request for permission to conduct research at M L Sultan Technikon

I am currently registered for a M Sc - Chemical education (part-time) with UNISA. This is a part course work and part mini-dissertation masters programme. The results of the course work examinations that I wrote in January 2000 will be available at the end of February 2000 and the research for the mini-dissertation will be conducted during the first six months of this year (2000), whilst I am on study leave.

I hereby request for permission to conduct my research at the Technikon. The proposed title of my research is : *An evaluation of the Augmented programme for National Diploma :Analytical Chemistry students, as offered at the M L Sultan Technikon, for the period 1994 to 1999.*
As a senior lecturer and programme team leader in the Department of Chemistry, I believe that an evaluation of this programme which has been offered at the Technikon since 1994 is important since we need to know:
1. What is the performance of these students relative to the mainstream students?
2. What are the factors that influence the performance of the students on the augmented programme?
3. Should the course continue with greater numbers of students or should a foundation course be introduced?

The data will be collected from :
a) student records available from MIS (ITS data);
b) recorded interviews with the Head of Department of Chemistry, staff and students in the department;
c) questionnaires completed by ex-augmented students - information supplied by Alumni office.
A written request will be made to MIS for the data, following the approval of this request. Statistical analysis of the data will be performed using the SPSS-X programme available on campus.

The student records and names of students and staff participating in the research will be kept confidential. Coding will be used for the questionnaires to ensure anonymity. The interviews will be conducted on campus in consultation with the Head of Department: Chemistry.

Appendix A

As part of examination regulations, a manuscript as well as a research report will be prepared based on the findings of the research. The due date for the research report is the end of November 2000.

A copy of my final proposal will be forwarded to your office on receipt from my supervisor, Professor N A Ogude, UNISA.

I would appreciate your response to this request and should you require further information please contact me on Cell number : 0835950183 or 031-4641755.

Looking forward to your co-operation.
Thank you

Yours faithfully,

Mrs D N Timm.

Recommended to DVC- Academic for approval
18/01/2000

ML SULTAN TECHNIKON
PROF. R. BHARUTHRAM
Director: Research
TEL: 3085496/3085284
P.O BOX 1334, DURBAN 4000

Approved.
18/01/2000.

Copy of research study to be made available to Institu

Appendix B

UMBER	YEAR	ST_NO	age	gender	home language	Matric points	English points	SYMMATH	Maths points	Physical Sc points	ENTRY points
1	1996	20092	25	Male	zulu	21	5	SE	2	4	11
2	1994	*20391	23	Male	outh sotho	20	4	SG	0	3	7
3	1995	23994	23	Female	zulu	17	4	HE	4	4	12
4	1994	23917	22	Female	zulu	25	5	HD	5	4	14
5	1994	24786	21	Male	unknown	15	4	HF	3	1	8
6	1995	26697	22	Female	unknown	15	4	SF	1	1	6
7	1994	*28504	20	Female	unknown	16	2	SB	5	2	9
8	1994	28548	20	Male	zulu	13	4	SE	2	2	8
9	1994	28642	20	Female	outh sotho	19	3	HE	4	2	9
10	1994	28705	20	Male	venda	21	6	SE	2	2	10
11	1994	30077	19	Male	unknown	25	6	SF	1	4	11
12	1995	30564	20	Female	unknown	30	5	SE	2	4	11
13	1995	30572	20	Female	english	20	6	SE	2	2	10
14	1994	30820	19	Male	unknown	24	5	HG	2	5	12
15	1995	31067	20	Male	zulu	23	5	SD	3	4	12
16	1994	31321	19	Female	unknown	29	8	HG	2	3	13
17	1995	31522	20	Female	english	25	5	SD	3	3	11
18	1994	31835	18	Female	orth sotho	15	4	HG	2	3	9
19	1994	32787	18	Male	zulu	20	3	SC	4	3	10
20	1996	33002	20	Male	unknown	34	6	SE	2	5	13
21	1994	33187	18	Male	english	28	5	SE	2	6	13
22	1994	*33278	18	Male	zulu	18	4	SH	0	4	8
23	1994	34447	17	Male	english	25	5	SF	1	5	11
24	1994	34661	17	Female	english	26	6	SF	1	4	11
25	1996	34985	19	Male	english	25	4	SD	3	5	12
26	1995	35648	18	Male	unknown	20	5	SF	1	4	10
27	1995	35656	18	Male	english	26	5	HG	2	4	11
28	1995	35715	18	Male	english	25	5	HF	3	4	12
29	1995	*36176	18	Female	english	23	5	SE	2	3	10
30	1995	36182	18	Female	unknown	21	5	SD	3	4	12
31	1996	36226	19	Female	zulu	14	4	HF	3	1	8
32	1995	36277	18	Female	outh sotho	26	6	SE	2	4	12
33	1995	36574	18	Male	english	25	5	SE	2	5	12
34	1995	36971	17	Female	english	24	5	SD	3	3	11
35	1995	*37064	18	Female	zulu	14	4	SH	0	0	4
36	1995	37166	18	Female	zulu	33	6	HE	4	4	14
37	1996	37210	18	Female	zulu	18	4		0	2	6
38	1995	37386	17	Female	english	29	5	SE	2	5	12
39	1995	37553	17	Female	unknown	35	6	SE	2	6	14
40	1995	37757	17	Male	english	23	4	SB	5	2	11
41	1996	38461	18	Female	english	27	5	SE	2	6	13
42	1996	38707	18	Female	english	26	6	SD	3	2	11
43	1996	39081	17	Female	english	29	5	SD	3	4	12
44	1996	39145	17	Female	english	32	6	SF	1	5	12
45	1996	39197	17	Female	english	22	5	SE	2	2	9
46	1996	39370	17	Female	english	26	6	SF	1	5	12
47	1995	40090	16	Female	zulu	28	5	SE	2	3	10
48	1995	40763	16	Female	unknown	17	4	HGG	0	1	5
49	1994	50475	17	Male	zulu	21	6	HG	2	4	12
50	1995	50682	18	Male	swati	24	6	SE	2	4	12
51	1995	50711	17	Male	zulu	24	5	SF	1	2	8

student repeated the subject

student repeated Yr 1

Appendix B

NUMBER	YEAR	ST_NO	An Chem 1	An Chem2 theory	An Chem 2 Prac	An Chem 301 theory	An Chem 301 Prac	An Chem 302 theory	An Chem 302 Prac	Yrs to complete	notes
1	1996	20092	52								unsatisf student
2	1994	*20391	39								completed pub mgmt 1998
3	1995	23994	0								financial problem
4	1994	23917	38								failed year1
5	1994	24786	62	54	60	50#	61	52	54	7	rep year 3
6	1995	26697	50	55#	71	38	58				could not pass physics 1
7	1994	*28504	50#	59	70	22	59				inorg 2 failed did not pass year3
8	1994	28548	82	55	70	50#	64	57	67	7	missed one year of tuition failed yr3
9	1994	28642	83	66	73	52	67	65	62	4	
10	1994	28705	63	50	70	#	66		59		rep year2 fail yr3
11	1994	30077	64	83	75	65	66	67	74	7	missed one year of tuition rep maths 1twice
12	1995	30564	66	71	80	50	64	66	65	4	passed Btech Chemistry 2000
13	1995	30572	60	69#	50						rep yr2 &inserv out
14	1994	30820	56	50#	64	45#	53	50	56		rep year2 fail yr3
15	1995	31067	62	56	80	50	57	52	64	5	reg for Btech quality
16	1994	31321	62	42	58						failed year 2
17	1995	31522	60	60#	50		54		50		rep year2 fail yr3
18	1994	31835	75	63	64	39#	65	57	58		fail year3
19	1994	32787	87	80	76	56	64	70	62	4	reg for Btech quality
20	1996	33002	53								chem eng in 1998 not complete
21	1994	33187	89	51	66	59	80	83	78	5	still reg for chem eng
22	1994	*33278	53	59	71	34	54				fail yer 3
23	1994	34447	89	74	73	73	76	73	78		failed 3rd yr inorg receptionist at hospital
24	1994	34661	81	73#	71	45#	70	67	81		rep yr2 &3
25	1996	34985	62	56	80	50	69	59	75		fail yr 3
26	1995	35648	69	77	78	82#	73#	60	55	5	
27	1995	35656	42#								failed yr1
28	1995	35715	0								failed all
29	1995	*36176	45								only passed comm skills
30	1995	36182	58	69	80	69#	55	63	62	5	completed Btech quality in 2002
31	1996	36226	58	61	63	50	58	68	63	5	
32	1995	36277	73	77	68	78	60	60	67	6	failed yr3
33	1995	36574	53								mech eng reg '96
34	1995	36971	54	67#	76	53#	75	56	73	6	3rd yer fail reg for Btech quality
35	1995	*37064	10								financial problem
36	1995	37166	74	82	77	59	70	80	74	4	reg for Btech Chemistry
37	1996	37210	52	50	62	55#	52	50	50		cip in 2002
38	1995	37386	60	50	78	65#	68	79	77	5	
39	1995	37553	82	70	78						failed year 3
40	1995	37757	45#								
41	1996	38461	68	63	71	65	63	66	68	4	reg for Btech quality
42	1996	38707	62#								physics failed
43	1996	39081	73	77	80	52#	73	66	78	4	reg for Btech quality
44	1996	39145	70	71	70	59#	58	63	71	4	
45	1996	39197	50#								stil reg for chem eng in 99
46	1996	39370	62	75	60	63	64	77	68	5	
47	1995	40090	69	83	73	53	61	56	59	4	
48	1995	40763	58	74	76	65#	58	70	68	6	missed one year of tuition: reg for Btech quality
49	1994	50475	80	0	52						failed year2
50	1995	50682	55	47	83						failed second yearfinancial problem
51	1995	50711	62	55	52	51	67	55	58		rep yr3

:student repeated the subject

**: student repeated Yr 1

Appendix C

Lecturer	A:	B:	C:	D:	E:	F:
1.Qualifications & experience	• M Tech: Chemistry after National diploma & NHD in chemistry. • 6 years industrial experience • 3 years lecturing exp • studying towards a Dtech	• B Sc hons in chemistry • 2 years tutoring experience at the time • studying towards an M Tech; Chemistry	• BSc, NDH – Chemistry, MSc – chemistry • 15 years lecturing experience • industrial experience • studying towards a PhD	• BSc, NHD-chemistry, UHDE, MSc • 5 years high school • 3 years teaching college • 8 years at the Technikon	• BSc, NHD-chemistry, HED • 4 years high school teaching • 4 years Industry • 20 years Technikon	• Diplomas in health sciences, NHD – chemistry, NHD- post school education. • 23 years teaching