TEACHERS' PERCEPTIONS OF THE EFFECTIVENESS OF IN-SERVICE EDUCATION AND TRAINING (INSET) FOR SENIOR SECONDARY SCHOOL MATHEMATICS TEACHERS IN THE GREATER DURBAN AREA

PHILEMON SIMANGELE NTENZA

Submitted in partial fulfilment of the requirements for the degree of Master of Education in the

Department of Education
University of Natal, Durban.

December 1991.

DECLARATION

The author wishes to state that the whole thesis, unless specifically indicated to the contrary in the text, is his own original work.

P.S. NTENZA

December 1991

Durban.

To Kinenhle, **Thamsanqa**, **Thandanani**

ACKNOWLEDGEMENTS.

I would like to thank all who helped with this thesis. In particular, I would like to express my gratitude to my supervisor, Dr. Paul Winter for his guidance, advice and dedicated supervision. I am also grateful to **Mike** Graham-Jolly, my co-supervisor, who assisted me with the development of certain ideas and in supplying constructive encouragement.

Thanks are also due to the following individuals and institutions who have helped with the study in various ways:

The teachers of the schools and the lecturers of the colleges of education I visited for their co-operation and willingness to participate in the research study.

Sylvie D'Alton for typing the draft form of the thesis.

O.R. Tladi for his magnanimity in agreeing at short notice to proof-read the thesis.

Colleagues at the Shell Science Centre, University of Natal, for their encouragement and assistance.

The Shell Science Centre for the use of its facilities.

My wife, Duduzile, for her continuous moral support, patience and understanding throughout the period of writing this thesis.

ABSTRACT

The project of the Shell Science Centre (SSC) tarted in 1985, in response to the high failure rate in mathematics amongst black pupils, the perceived inadequacy of college mathematics curricula for prospective mathematics teachers, and generally because of the destructive policies of apartheid and the inferior system of education for black pupils.

One of the programmes is to organise and run in-service education and training (INSET) courses for senior mathematics teachers, in collaboration with teachers' Action Committees, with the hope of effecting curriculum change and teacher behaviour in the classroom.

It is important, therefore, for the SSC to know whether the INSET programmes meet the needs of the teachers, especially those who graduated from colleges of education in KwaZulu with a Secondary Teachers' Diploma, since they form the majority of the INSET participants.

Hence, this investigaton aimed to survey and analyse:

(i) mathematics teachers' and college mathematics lecturers' perceptions of the college mathematics curriculum; and

(ii) mathematics teachers' perception of the effectiveness of INSET courses.

Init al data, about the effectiveness of INSET courses and the pre-service training of prospective mathematics teachers, was gathered through informal talks with mathematics teachers during INSET courses. Issues and themes that emerged were "fleshed out" using unstructurep. interviews with five (5) mathematics teachers. From these it was possible to draw up a detailed structured interview schedule, which was administered to a further seventeen (17) mathematics teachers in senior secondary schools in Umlazi and KwaMashu townships.

Data, about the college mathematics curriculum, was also gathered by means of structured interviews with college mathematics lecturers, in the two colleges of education in KwaZulu, and with graduate teachers with a Secondary Teachers' Diploma in mathematics.

Among the significant findings were:

- Limitations in he college mathematics curriculum in as far as the mathematics content and the methodology courses were concerned;
- Problems with SSC INSET courses such as teaching methods suggested by INSET tutors, timing of INSET courses, group work, etc.;
- Problems with teaching mathematics at school such as the shortage of mathematics textbooks, large classes, inadequate resources, etc.; and
- Problems with incorrect 'overlearnt' rules from inadequate college mathematics textbooks.

The implications of these findings for the SSC were considered. It is suggested inter alia that the SSC should adopt strategies which would emphasize direct contact with the pupils of INSET participants. It is hoped that these strategies will help correct the various problems experienced by mathematics teachers in the schools.

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CHAPTER 1

INTRODUCTION

1.1 Purpose of study

This study focusses on the in-service education and training {INSET) initiative of the SHELL SCIENCE CENTRE {SSC) {hereafter referred to as INSET{*)), and its aim is to investigate senior secondary school mathematics teachers' perceptions of the effectiveness of INSET{*) courses, and the teachers' and college lecturers• perceptions of the mathematics curricula of colleges of education.

There is concern, amongst mathematics teacher educators, for the curriculum for the training of secondary school mathematics teachers which is believed to create a huge gap between what teachers encounter in reality at black schools, and what they are taught at college. This apparent inadequacy may then result in a shortage of good mathematics teachers in black schools who would, given the opportunity, be capable of producing good mathematics results in the final matriculation examinations. Hendricks (1987) investigated "the nature and effectiveness of the pre-service training of secondary school mathematics teachers at colleges of education under the control of

the House of Representatives". The investigation was prompted by his concern about the quality of this training as encountered by himself as a lecturer in a college of education and later as a subject adviser to teachers trained by such colleges.

In this research study, the senior secondary school mathematics teachers (from Umlazi and KwaMashu townships) interviewed and the two colleges of education (Eshowe and Esikhawini) at which they were trained fall under the control of the Department of Education and Culture (KwaZulu).

Hence, this investigation takes into consideration the gap which exists between what black African teachers bring to the teaching-learning situation at black schools and the demands of this situation. This gap appears excessively large due to the inadequate/inappropriate learning histories of the teachers, and INSET(*) was developed as an attempt to close this gap. INSET(*) can therefore be regarded in Vygotskian terms as an external mediator or regulator (Vygotsky, 1978 ; Winter, 1988). According to Vygotsky, the origins of self-regulatory activities (activities which involve self direction of one's engagement) lie in culturally prescribed patterns of control, exercised

initially from without by significant caretakers. Gradually the individual internalizes these outer directed cognitive controls or 'other' regulations, and learns to regulate his/her own behaviour, i.e. the developing individual and the cultural environment of the individual are intrinsically related. Vygotsky's idea of the "Zone of Proximal Development" suggests "mediation" as the mode of connection between individuals or student and teacher when considering individual development. For Vygotsky, the Zone of Proximal Development is:

> ...the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978: 86).

This "adult guidance" is what Vygotsky refers to as mediation. INSET(*) has evolved into primarily being teacher centred, and it is hoped that the consideration of teachers' perception of INSET(*) will allow INSET(*) to evolve into an 'ideal' mediator that will assist black teachers to teach successfully and independently in the learning-teaching situation in schools.

Hence, the SSC designs and implements mathematics programmes/courses in the hope that this will improve teachers' teaching strategies in an environment which is far from being conducive to successful teaching and learning. It is hoped that this study will:

- reveal any shortcomings and/or strengths of the mathematics programmes as perceived by teachers who are involved in the SSC project;
- promote decision-making on alternative courses of action;
- motivate the mathematics staff members of the SSC to examine their work reflectively and critically;
- share information with other similar projects in devising better strategies and approaches to INSET as dictated by the changing South African education scenario.

1.2 The background leading to the implementation of INSET

The SSC started up in 1985 as a compensatory educational intervention project, operating together **with** other similar projects to improve the achievement levels of school pupils from disadvantaged social

groups. The number of black pupils who pass mathematics and physical science in the matriculation examination with exemption, has, over the years, been very low and unsatisfactory. There are various and complex reasons for this state of affairs which is especially evident in black education. One very glaring factor is the inferior and apartheid system of education that black pupils have been subjected to for decades of their lives. Education in South Africa has been used to discriminate against people on the grounds of colour alone, and has been more concerned with protecting those with power, whether political or economic, than sharing the benefits of education in an open, democratic society. According to Hartshorne (1988: 5-6):

> It is .... crucial that there should be an understanding of the historical process **leading to the present educational crisis.** The roots go deep into the past, a past which has been analysed by liberal historians in terms of racial and political discrimination and by Marxist/revisionist historians in terms of class and economic domination: both have been the ideological background of education over the years.

However, the same author concedes that the more immediate background to the present crisis in black education dates from 1948 when the National Party came into power. Black education was placed under strict,

unequivocal central State control and thus began the slow, but destructive process of what was then referred to as "Bantu Education". Christian National Education (CNE) and "separate development" were concepts that formed an ideological foundation for this "Bantu Education". The Bantu Education Act of 1953, once it was fully implemented by the State, contributed to the neglect of black education, thereby, starving it of resources in the years to follow. Buckland (1982) emphasises this point by saying that the Act involved direct State control of all schooling for Blacks in a system designed specifically to discourage political and social aspirations above certain forms of labour. The whole grand design of this Bantu Education has left the present education system with 19 different education structures, viz., the Department of National Education, 5 white departments, one "Coloured", one Indian, and 11 Black. All these departments are tightly controlled within a segregation model in which a discriminatory hierarchy of financing, resources, facilities and outcomes developed, with whites faring the best and blacks by far the worst (Hartshorne, 1988). According to a report by the South African Institute for Race Relations, the 1986/87 per capita expenditure by the State for each white pupil was R2508, as compared to the per capita expenditure for

each black pupil in KwaZulu which was R359. **This** clearly indicates that educational provision for different "population groups" is patently unequal thereby leading to a shortage of resources in Black schools and minimal training standards for Black teachers at colleges.

The education revolt of 16 June 1976, although it was sparked off by issues of language, the basic causes are rather to be found in the policies of segregation and general inferiority of Black education, the obvious discrimination in terms of finance and resources and its ideological direction, all in the context of the social, economic and political position of black South Africans.

In the early 1980's, the schools boycott intensified and spread to "coloured" educational institutions especially in the Western Cape. The problems of black education were becoming too much for the government to handle and consequently in 1980 it requested the Human Sciences Research Council to compile a comprehensive report on the state of education in South Africa. The eagerly awaited de Lange {named after its chairman Prof P. de Lange) Report came out in 1981 and contained a detailed outline for the modernisation of educational

provision for all racial groups, with a heavy emphasis on "career education" and "non-formal" education, both designed to steer pupils away from inappropriate social and occupational aspirations toward more "realistic" career goals (Buckland, 1982). The report indeed cut to the bone of our educational problems racially splintered control and inequality in funding and opportunities. De Lange's insistence on ONE education department for all South African children, with regional bodies to implement policy, was flatly rejected by the Government's 1983 White Paper on the provision of education in **R.S.A.** Instead the government treated it as a "smorgasbord rather than a fixed menu" (Sunday Times July 8, 1990: 23) - picking out certain suggestions that it found feasible to implement, leaving out vital recommendations and suggestions that were supposed to have formed a sound foundation of a new education system. The whole basic spirit of the report was ignored and the new slogan from the Government became "equal but separate" - an impossible concept, and the Financial Mail {January 26, 1990: 32) agreed that separate is not equal and never can be. Further, King {1979) cites the 1954 decision of the United States Supreme Court which outlawed segregation in schools, de jure, by declaring it essentially unequal. Hence, there were no fundamental

changes in the education of black children; the crisis continued and this was exacerbated by the introduction of the tri-cameral system in 1983, which completely excluded black people from voting their own leaders into parliament as if they were strangers in their own country. The resistance in schools and disruption of schooling continued until 1986 when the State saw fit to declare a "state of emergency" in order to control the breakdown of the learning/teaching environment, which was at its worst in the history of black education. Even if it is clear that apartheid education is costing South Africa dearly in economic terms (for example, in the duplication of expensive services and "white facilities" lying unused - over 200 000 vacant places in primary and high schools and about 3 000 in teacher training (Hartshorne, 1988)) it still had to be preserved on ideological grounds. It seems as if the Government would rather retain the unused facilities in white hands, even for non-educational purposes, than hand them over to blacks. Moreover, in **white** residential areas, such facilities would remain idle rather than be made available to blacks for educational purposes.

Hartshorne (1988: 12) records some revealing statistics on matriculation results which must be looked at in the

context of problems that are experienced in black education:

> In 1985, of the 25 584 pupils enrolled in Std 10 at the beginning of the year, 24 231 registered for the senior certificate examination, but only 10 523 took the exams and 4 897 passed (19,1% of the original enrolment). DET enrolments at Std 10 level constituted less than 25% of the total in all black schools, but DET accounted for 70% of the drop-outs during the year ..... For ten years (from 1976 to 1986), over-all passes for black candidates have fluctuated in the 47 53% range, and passes at the matriculation exemption level at between 10 - 13%. (White candidates show about 93 - 94% over-all pass rate with about 45% gaining matriculation exemption.)

The situation in mathematics (and science) passes is even worse. In this regard the Financial Mail (January 26, 1990: 32) says that about 12000 white students pass higher grade mathematics each year whilst, for example, in 1987, 464 blacks did so.

These results show that the State control of education does not only stop at managing the black schools, but even the content of black schooling had to be controlled one way or the other. In **1945**, **J.N.** le Roux articulated the view in parliament arguing that the schools:

> should not give the natives an academic education, as some people are prone to do. If we do this we shall later be burdened with

> a number of academically trained Europeans and non-Europeans, and who is going to do the manual labour in this country? .....I am in thorough agreement with the **view** that we should so conduct our schools that the native who attends those schools will know that to a great extent he must be the labourer in the country. (Quoted in Molteno 1984: 66).

Verwoerd's infamous address to parliament in 1954 also emphasised the point:

> Until now he [the African] has been subjected to a school system which drew him away from his own community and misled him by showing him the green pastures of European society in which he was not allowed to graze. This attitude is not only uneconomic, because money is spent for an education which has no specific aim, but it is also dishonest to continue it. The effect on the Bantu community we find, is in the much discussed frustration of educated natives who can find no employment which is acceptable to them. It is abundantly clear that unplanned education creates many problems, disrupting the community life of the Bantu and endangering the community life of the European. (Quoted in Unterhalter & Wolpe **1989: 20).**

Under such circumstances, it is only logical to conclude that teacher training standards for black people would be low and unsatisfactory. These teachers **were** expected to go back and teach under conditions which were not conducive to good learning. This was the beginning of a vicious circle, since no-one can expect good matriculation results when many teachers were underqualified or unqualified altogether.

According to the Financial Mail (January 26, 1990: 32) Verwoerd further justified his downgrading of black education by asking: "What is the use of teaching a Bantu child mathematics when he cannot use it in practice?" This invariably also led to a shortage of qualified black mathematics and science teachers, due to the lack of facilities and resources in black schools for promoting an improved learning-teaching of mathematics and science. In fact the subjects became known as "hard" subjects, since it was so difficult for black pupils to achieve good passes in the two subjects. Buckland (1982) maintains that by 1980 there was a great demand for skilled manpower because the South African economy was rapidly becoming industrialised. The only way to meet this demand was to "produce" more black pupils with good passes in mathematics and science who could then be trained for the technological explosion that was gripping South Africa in those years. However, pupils' attitudes towards attending technical institutions and technikons were negative, since these were considered as places where people were encouraged to do a lot of "manual labour". To this day, black pupils are placing more prestige on going to universities so that after graduation they will be able to do so-called "white-collar" jobs.

As mentioned earlier on, it became obvious after the de Lange report that the Government was not going to seriously attend to the acknowledged crisis in education. One of the reasons given by the Government was that it did not have enough financial resources to tackle all the problems which were embedded in black education an own admission of the destructive policies of apartheid education. The private sec or was requested to assist in creating and developing programmes to alleviate some of the problems. It was in the early 1980[1]s (after the 1983 Government White Paper), that Shell South Africa made a feasibility field study of where and how it could contribute to the development and enhancement of mathematics, biological and physical science education in South Africa. After initial discussions and consultations with various groups, communities, authorities and other interested parties, it was decided to operate a project for KwaZulu mathematics and science· teach rs. One of the reasons for this decision was that the Department of Education and Culture (KwaZulu) is one of the biggest and most needy departments of education in South Africa. The project, which became known as the Shell Science and Mathematics Resource Centre Educational Trust - in short, the Shell Science Ce!1tre (SSC)

started in 1985, is autonomous and is based at the University of Natal, in Durban. The project is so designed to achieve its aims through inservice training and the professional development of teachers. It is believed that the work of a single teacher may affect the educational progress of hundreds of students taught currently and in the future by the recipient of the educational programmes. The SSC therefore introduced the INSET programme which will be discussed in detail in the next chapter.

CHAPTER 2

THEORETXCAL CONSXDERATXONS

2.1 The curriculum: a problem of definition

As stated in Chapter 1, this investigation will attempt to analyse teachers' perceptions of the effectiveness of INSET(*) for senior mathematics teachers. Since, INSET(*) is seen as trying to contribute to curriculum innovation and/or change, it is important to define the concept of 'curriculum', for its meaning is central to this study and the term has been used very loosely over the years by various people.

Buckland (1982: 168) is of the opinion that the

> notion of curriculum as process rather than as product, means that a curriculum cannot be picked up and examined, but must rather be viewed in historical perspective in its socio-political context. The relationship of the curriculum to the social structure of which it is both co-producer and-product, must be seen in terms of an ongoing dialectic.

This is an important statement since many Government syllabus planners and so-called

"curriculum experts" in Pretoria have been using the term "curriculum" very loosely and it has, for practical purposes, been equated with a syllabus. This results in a reified view of curriculum and ignores the complex relationship between the selection and the organisation of knowledge and the distribution of power in society. Some educationists have also fallen into such a trap (Tunmer, 1981). So, it is important when defining the concept of curriculum, not to resort to an over-simplified and misleading definition. Many educationists have come up with a variety of definitions of the concept (Stenhouse, **1975**; Tunmer, 1981; Buckland, 1982; Taylor & Richards, 1985; Schubert, 1986; Moulder, 1987). one will not try here to pit one definition against the other to show the merits or demerits of each, but an attempt will be made to employ Buckland's (1982: 167-168) more sophisticated, if less tidy, definition of this slippery concept which draws upon the earlier work of Lawton (1973):

> If education is seen as a process of cultural transmission, then the curriculum represents that selection from the culture which is presented to the learner in the school. The selection is made at different levels by a variety of different people in a wide range of contexts, and includes activities

> generated by the school, or by a higher authority for the school. The process includes the inculcation of knowledge as well as the generation of skills and attitudes, which are communicated by teachers, by materials, by other children, through direct teaching, individual learning, informal contact and example. It follows that the selections made from the culture will therefore vary significantly from school to school, class to class and then individual to individual.

Government officials have always insisted that the syllabus document is the core of any official curriculum in schools. The official curriculum must be seen as something that the officials would like to happen in schools, and this must be differentiated from curriculum seen as the existing state of affairs in schools. There are other determinants which affect the curriculum such as the concept of the "hidden curriculum" which may include such learning as how and when to "cheat", as well as what social, political and occupational aspirations would be tolerated. Eggleston (1977) mentions the point that it could be argued that the purpose of the mathematics curriculum is not only to enable pupils to learn mathematics, but also to allow some to understand that they cannot learn mathematics and to acquire a suitable respect for those who can, such as the

teacher and the more able pupils, destined for superior occupational status. According to Buckland (1982; 168):

> In the south African context, the concept of the hidden curriculum is crucial It is even open to question which curriculum, the "formal" or the "hidden", would have most impact on a pupil... in a racially-segregated school with overcrowded classrooms, broken desks and windows .... while within a mile there is a luxurious and half-empty school building to which s/he is denied access because s/he is not classified "white".

Therefore, when officials of the Government claim that everyone is experiencing the same or common core curriculum, whilst implying that the syllabuses in the different education departments are more or less identical, this may suggest, that by just comparing the range of subjects offered, a Zulu-speaking child at a rural school faces the same curriculum, the same selection from the culture, as a white child in Durban. But a glance at other aspects or issues affecting black education, let alone a visit to the schools, should convince anyone that this is not the case. Factors such as the shortage of mathematics and science teachers in black schools, the significantly lower standard of training of the teachers in such schools and the shortage of

facilities from desks, to books, to science laboratories, all these contribute to a significantly different "selection from the culture" available to the individual child on entering school. Although little research has been done in South Africa to determine the nature of the actual curriculum facing the South African child (Buckland, 1982), it is, however, evident that there are huge and significant differences in the "selection from the culture" made available to different pupils in South Africa. Moreover, there is a need to abandon the reasoning which tends to look at culture, or curriculum, or knowledge as something "out there", separate from the socio-political context and historical process. The brief outline of the socio-political background to education policy in South Africa, as expounded in the first chapter, reveals that curricula have provided vastly different experiences and have disadvantaged the majority of the pupils.

2.2 INSET and curriculum change

From the above discussions, it is abundantly clear that major fundamental changes in schooling and especially in curriculum matters, will not take

place without a drastic transformation of the political system of South Africa. There is an urgent need to empower, both politically and economically, the black peoples of South Africa, and for them to be part of every decision-making process, rather than to accept top-down, bureaucratic measures designed to subjugate them. Though the Government has tried to come up with educational reforms, these have been met with resistar e from teachers and pupils alike, hence the National Education Crisis Committee's (NECC) slogan in 1985 of "People's Education for People's Power" (Working Document No.1, 1988). The people wanted fundamental changes and an overhaul of the whole South African education system, not just cosmetic changes as purported by the Government. People's education was put forward by the NECC as a radical, alternative form of education to the "gutter" education which was seen as promoting excellence and superiority amongst whites, and subjugation and inferiority amongst the black pupils. Radical changes were suggested initially for the subjects mathematics, English and history, and commissions were set up to change the curricula of these subjects. Unfortunately the process could not be wholly completed because

since the "state of emergency" was declared by the Government in 1986, many of the NECC members were detained without trial for many months, if not years. Nevertheless, the private sector had already initiated projects or programmes to assist teachers in curriculum improvement, especially those from disadvantaged groups. According to Crossley and Guthrie (1987: 65):

> One of the major perspectives on teachers in developing countries over the last 20 years has been the perceived resistance of teachers to educational reforms. Frequent failures by reformers to change classroom practice has been attributed to the incapacity and unwillingness of teachers to accept self-evident benefits of new teaching materials, new technologies, new curricula, and new teaching styles. To help overcome the unwillingness of teachers to reform, a variety of approaches have been attempted. An important approach has been through the **inservice education and training of teachers (INSET)** (my emphasis).

INSET of teachers relates to the education and training which teachers receive once they are in the teaching situation. A working definition which appears to suit most categories of INSET is that of Thompson (1981, cited in Hartshorne, 1986: 9):

> .... the whole range of activities by which serving teachers and other categories of educationalists may extend

> and develop their personal education, professional competence and general understanding of the role which they and the schools are expected to play in their changing .societies. INSET further includes the means whereby a teachers' personal needs and aspirations may be met, as well as those of the system in which he or she serves.

This definition will be accepted for the purposes of this investigation, though it may be extended for the South African situation, for example, to include affirmative action by some independent INSET projects which are designed to empower teachers to take responsibility for their own professional development.

Greenland (1983) points out with reference to Africa, that the attraction of INSET is its potential to deal with the problems of unqualified but practicing teachers, with teachers facing new tasks such as curriculum innovation, with those holding low qualifications, or with others singled out for promotion. According to Hurst (1978) innovation means the idea of a change in practice or behaviour. Greenland goes on to say that INSET is also seen as a means of revitalising general morale within the profession as a whole. Bot (1987: 60) referring to the South African

situation mentions the fact that:

> In South Africa, with its fragmented educational structure, the standard and qualifications of teaching and teachers vary greatly among the different education departments. Recently, the HSRC Education Research Programme reported that some 200 OOO teachers in South Africa are in urgent need of training and upgrading. There is a drastic shortage of teachers and of qualified teachers in African education especially. In July 1986, a workshop was held under the auspices of the Urban Foundation to look at "possible **ways** of improving the effectiveness of the considerable involvement of the private sector in teacher development programmes".

According to Crossley and Smith {1985: 123), a revealing survey of INSET policy and practice was carried out by Dude and Greenland {1983: 12), and overall, five different types of INSET were identified when classified according to purpose and scale. These were:

- INSET for the initial training of unqualified teachers;
- INSET for upgrading teachers with inadequate qualifications;
- INSET to support the implementation of new curricula;
- INSET to prepare teachers for new roles; and

- INSET in the form of general refresher courses.

It can be argued that in South Africa each of the above types of INSET is of utmost importance because of the problems being experienced in black education, as created by the apartheid system of education. INSET then is perhaps one of the quickest and most direct ways to try and improve South Africa's education system, although the effect of INSET becomes limited unless it is accompanied by other policies to improve the overall quality of education.

According to Hofmeyr (1988) the focus on teachers and teacher education as a means of effective curriculum change arose after the 1976 Soweto uprising. Consequently teacher education was singled out by the public and private sectors as a key factor influencing the quality of education in the classroom.

A lot of INSET work in South Africa is run by independent non-state agencies which are privately funded by major corporations such as Shell, Goldfields, etc. Their spheres of operation are

either national or regional depending on various factors such as financial resources. The emergence over the years of independent **INSET** projects in South Africa should be seen as an attempt by the private sector to get more involved in education and curriculum innovation or change, and "to attempt to redress the educational deficiencies and lack of opportunities in a system which has entrenched unequal and differentiated education for decades" (Shell **S.A.**, 1986: 82). One may equally argue here that some of these big companies started channelling their money into the education of disadvantaged black communities as a way of "buying" credibility in a political atmosphere which was thick with calls for sanctions and for foreign companies to disinvest from South Africa, as a way of forcing the Government to initiate fundamental political changes.

Although it is the function of education departments to conduct INSET programmes, this has been viewed by the private sector as inadequate in serving teachers' needs. Most, if not all, INSET organised by education departments is of the traditional type whereby the officials of the

department solely decide how and in what manner the curriculum innovation will be implemented. The involvement of the teachers in decision-making and the multitude of contexts within which they work, is not problematic as far as the education departments are concerned. The failure of these top-down technicist approaches have been well-documented in studies such as that by Henderson and Perry (1981). After researching traditional forms of INSET activities in Europe and North America they came to the conclusion that there usually is a "mismatch between the needs of the teachers and the content of the course offered" (1981: 2-3). There has always been a need for communication at grassroots level in order to bring about meaningful curriculum change and for the curriculum innovation to succeed. The entry of independent INSET projects into the field of INSET has been to satisfy this need, although they themselves are no guarantee that they will not act in a "centre-periphery/power coercive" manner.

In fact there has been a lot of criticism from various educationists that private sector initiatives are reformist, and unable to bring about any fundamental changes in curriculum

matters. This point is echoed by Jansen in his critique of the Science Education Project when he says that" this project fell into the ide1logical trap which has claimed so many well-intentioned programmes attempting to provide technical solutions to socio-political problems" (1988: 522}. Most independent INSET projects in South Africa are trying to confront massive and deeply entrenched historical forces on a minute scale, and including the fact that these projects perceive curriculum innovation as a politically neutral process, it is then clear why they have not achieved meaningful and fundamental curriculum changes. In this regard Van den Berg argues that to bring about actual improvement of schooling "INSET will also have to be an articulated part of comprehensive strategies for social, economic and political transformation" (1985: 45).

2.3 The INSET model of the SSC

The SSC consists of a group of mathematics and science educationists with support staff and resources. The major focus of change is the senior secondary school mathematics and science teacher in Natal and KwaZulu, and the major area

of development is the INSET activity for these teachers. The INSET programmes have been primarily planned to achieve a number of objectives:

- to update the individual skills and knowledge by assisting teachers to develop their understanding of basic concepts;
- to meet the needs of the matric system by assisting teachers to "train" their pupils more effectively in examination techniques;
- to upgrade teachers with inadequate qualifications;
- to assist teachers in implementing new curricula;
- to conduct refresher courses for experienced teachers; and
- to prepare the group for new roles in a changing society by developing effective leadership skills and changing attitudes.

When the SSC started in 1985, there were only three staff members, viz., the Director, an administrative secretary and a so-called "professional officer", who did not have any background in mathematics (and science) education.

At the time, there were going to be major changes in the syllabuses for mathematics and science at senior secondary schools and they were to be implemented in 1988 for mathematics at Std 9 level. The Department of Education and Culture (KwaZulu), being the second largest in South Africa, was not doing much in terms of providing INSET activities for mathematics teachers. The department has only one in-service training centre with very scarce and limited resources, which were just not enough to manage effectively the INSET programme for all teachers from all schools in the 25 circuits in KwaZulu. Teachers, teachers' organisations (e.g. Natal African Teachers Union: NATU) an schools themselves, did not have the experience and "expertise" to initiate school-based INSET activities and to innovate. Many mathematics teachers in black schools found themselves in a position where they were going to implement a mathematics syllabus containing new topics that they had never seen before, for example, calculus and linear programming. With the given conditions at schools, they could not initiate any curriculum innovation. Hence, the professional officer from the SSC visited senior secondary schools in the greater Durban area to

literally "sell" the idea of the SSC, and it was very appealing indeed to many mathematics teachers. Schools did not have resources to do their work effectively and the SSC was perceived as a place where teachers would be able to "borrow" things such as OHP's, mathematics video cassettes, etc., and be able to make photocopies of past examination papers, and also generally get support through INSET activities.

The previous INSET model of the SSC involved the designing and developing of activities by the professional officer in conjunction with tutors or "experts" appointed by himself. Teachers were drawn out from the schools to a central venue (e.g. hotel) where INSET was conducted over periods ranging from one to three days. Teachers accepted this kind of situation because it provided solutions to the many problems experienced at that time. This approach to INSET mirrored the centre-periphery strategy and was also consistent with the research, development and dissemination (RD&D) model suggested by Havelock (1971) in the sense that the planners at the SSC designed and developed the curriculum innovation, which was then given to the teacher who, regarded

as a rational being, would accept the package if it was seen as an effective solution to the problems being experienced. At no stage were the teachers involved in the process of decision-making and in formulating their own questions and how such questions could be answered. The curriculum innovation invariably "belonged" to other persons other than the "users". As mentioned above, it was, however, not difficult for the planners/developers of the innovation to persuade the "consumers" to accept the innovations. Another dimension that may have entered teachers' minds, was that since Shell was sponsoring the project, it meant that the SSC had unlimited resources which were there for the taking. This is supported by the fact that, at that time, many teachers were requesting the SSC to buy for their schools resources and equipment such as mathematics video cassettes, OHPs, etc. Obviously, these unrealistic expectations were going to cause many problems for the developers and the SSC itself.

This initial approach (1985-1986) to INSET by the SSC was bound not to work in the long term: it had all the ingredients of the power-coercive

approach which used financial and administrative resources to "change" teachers, and this was similar to approaches adopted by many government departments of education. Teachers were not being empowered to take responsibility for their own personal and professional growth or development.

In the period 1986-1988, the SSC began to put together and employ a team of professional staff who had more experience in mathematics (and science) education, especially in black education, than the initial team. This group decided to move radically away from the previous strategies for INSET in the SSC, which in effect assumed that there was something wrong with the teachers and therefore by planning INSET activities for them the "wrong" would be eliminated (Van den Berg, 1987). Many INSET programmes are criticised because they have a lack of direction and at that time, there was really no direction taken by the SSC in its INSET activities. Research has shown that programmes based on some described conceptual model, tend to be more successful (Orlich, 1987). For this reason a conscious decision was made by the professional staff to make decisions in a planned and systematic way, based on a model or

set of basic assumptions about the process of change in teacher behaviour. Consequently, a mission statement was formulated by the SSC containing, inter alia, the following points:

We believe:

- in empowering individuals to overcome the impediments to equality;
- that individuals must take responsibility for their own professional growth;
- in democratic participation of the individuals; and
- that ownership of programmes resides **with** the participant/user (Shell Science Centre, 1988: 1).

What the SSC was conceding here is that fundamental reform comes only through the teacher who must identify and diagnose the need and then proceed **with** innovation development. In this context the professional team were to play a supportive and non-directive role. The formulation of the mission statement coincided with the move made by the SSC to start decentralising its INSET activities throughout

Natal-KwaZulu. Teachers from the strategically-placed geographical rural areas, viz. Newcastle, Greytown, Ladysmith, Port Shepstone and KwaMbonambi (near Empangeni), had approached the SSC for support in establishing these networks or units, as we referred to them. Action Committees onsisting of mathematics teachers were formed in each network. These Action Committees became responsible for identifying teachers' problems, determining their needs and voluntarily seeking help from the professional team who would then act as facilitators in the whole process. Teachers no longer became passive consumers of some finished "product" created by "experts", rather, they were placed at the centre of the action. The SSC saw them as active participants in the process of curriculum change and innovation, and it 'mediated' and encouraged them to initiate and implement the innovation by:

- assisting them to produce their own resources;
- generation of resources;
- consultation;
- doing research and evaluation;
- providing facilities and infra-structure; and
- developing skills and leadership qualities (Shell Science Centre, 1988:1-2) •

This model used by the SSC in its operations is similar to Havelock's Problem-Solving.model which sees the "users" as the agents for the initiation and pursuit of curriculum innovation or change (Havelock. 1971). This involvement of teachers *in* decision-making in the SSC projects does contribute, it is hoped, to some extent, towards curriculum change and innovation. Chapter 4 will deal in detail with an analysis of interviews on teachers' perceptions of the effectiveness of INSET(*) for senior secondary school mathematics teachers in the greater Durban area.

Teachers know the contexts within which they work better than project leaders, hence, when they themselves plan an INSET activity or innovation, they are more likely to adopt and implement in practice the proposed innovations, than when they are told or "instructed" to do so by some "experts". The SSC therefore felt that this was a step in the right direction, as the mobilisation of teachers in this way may eliminate the "mismatch between the needs of the teachers and the content of the course offered" (Henderson and Perry, 1981: 2-3).

The present INSET(*) model therefore focuses on teacher needs and the aim of this investigation is to determine whether there is a match between INSET's attempts to cater for the teachers' needs and the teachers' perceptions of the attempt to attain this goal.

According to an evaluation report of the Natal Primary Sience Project (PSP)(McNaught & Raubenheimer, 1991: 3)

> The perceptions of all people concerned **with** a project are important and must be researched and, where possible, articulated. The interpretations of situations, too, are important even though these are more likely to be dictated by the context than by underlying attitudes.

In the PSP evaluation study, teachers were an integral part of the evaluation, and they contributed to the report by writing and giving their perceptions of the teaching of science before and after PSP was initiated. However, no analysis of this data was done.

In this study revolving around the SSC, the effectiveness of **INSET** courses will be investigated. This will involve considering

teachers' perception of INSET(*), as well as teachers' and college lecturers' perception of the curriculum for senior secondary school mathematics teachers at black colleges of education. Hopefully, this will inform the SSC whether the INSET programmes offered do in fact cater for the teachers' needs. Any shortcomings and/or strengths detected should enable the SSC in planning better and more effective INSET courses for the teachers.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Adopted model of study

The major focus of the investigation involved the use of teachers' perceptions of INSET(*) in order to gauge its effectveness, but did not include observing classes of teachers participating in the INSET before and after the programme. Observation of teachers when teaching must be seen as problematic in black education under the present political atmosphere, since for many decades this has been and is still being used to evaluate teachers by authorities such as inspectors, principals, subject advisors, and so on. At the moment in DET schools throughout the country, teachers, through teachers' unions and organisations, have barred class visits by these officials. Some of the short term demands of the teachers are that the DET should ensure that there are adequate textbooks for all pupils in the schools, more teachers should be appointed so as to decrease the teacher/pupil ratio, more resources and teaching-learning aids should be

supplied to schools, and that schools should be opened to all pupils irrespective of colour, race, religion, etc. A long term demand is that there should be one deoartment of education in South Africa.

Also, we believe that it would be unethical and against the philosophy of the SSC to use tests and/or examination results of pupils of participants of INSET(*), to determine whether there has been any improvement in the pupils' achievements in mathematics, as a means of determining the effectiveness of INSET(*). There are just so many other factors which might affect pupils' mathematics achievements, which cannot be controlled in order to gauge if teachers' changes in behaviour after INSET do indeed pass onto the pupils. It is, of course, the long term aim of the SSC to effect improvement in pupils' mathematics examination results. But the short term aim of INSET must be seen in terms of a mediator between the teacher and the teaching-learning situation, trying to effect curriculum development, teacher behaviour and promoting professional development amongst teachers of senior secondary school mathematics in KwaZulu.

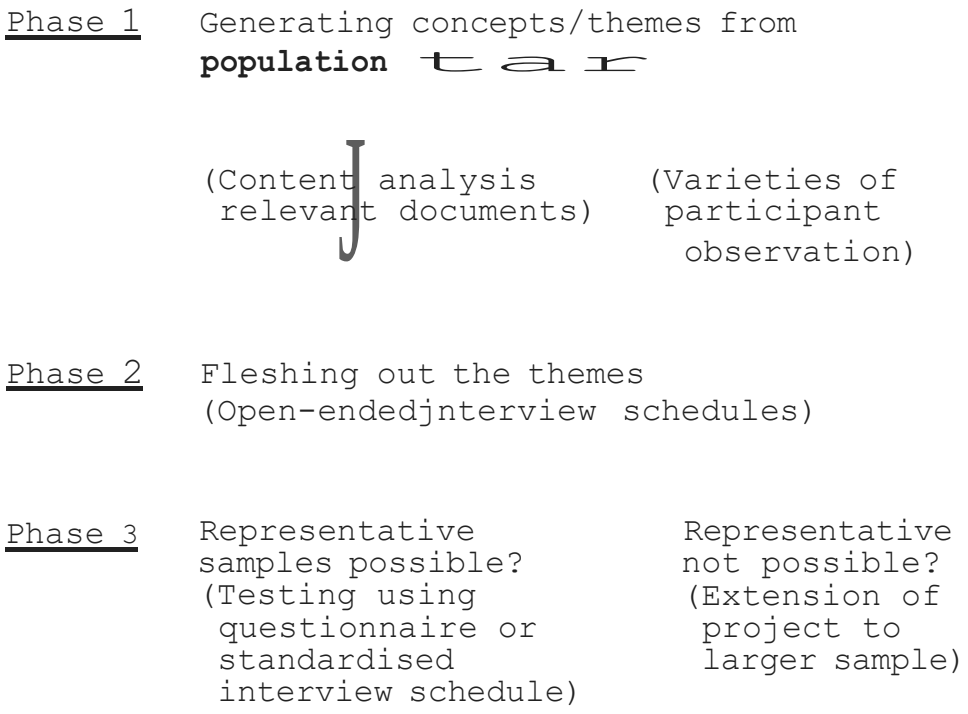
Anyway, even if there was some improvement in the achievement level of pupils taught by participants of INSET programmes, the SSC cannot claim to have solely been responsible for that, since a conglomeration of factors might have accounted for the improvement. And INSET by the SSC, should be recognised as just one of many such factors.

In short, the interviews conducted with teachers who attended INSET courses organised by the SSC were regarded as an adequate information-collection activity, whereby teachers were required to air their views and perceptions about the INSET courses, and without any unnecessary duress of being observed teaching their pupils before and after an INSET programme.

3.2 Research design

The theoretical rationale for the research design in this study is to be found in Simon's (1986) suggested approach, which attempts to break away from the traditional concept of triangulation into a strategy of multiple operationism, and is believed to be suited to the "exigencies" of

peculiar South African research settings. The ideas are summarised in the diagram below (Simon, 1986: 17):



3.2.1 Informal interviews to generate issues

It must be mentioned at this stage that the research investigator is also an implementor of the mathematics programmes of the SSC. Therefore, the investigator has been in a position of being able to meet mathematics teachers in all INSET courses. It was also possible for the investigator, in preparation for this study, to

discuss with teachers both in an informal and formal way many issues of INSET, curriculum innovations and other aspects of mathematics education. As a follow-up to some of these discussions, a few schools **were** visited on an informal basis to discuss **with** mathematics teachers, amongst other things, **ways** and methods of motivating pupils and changing their negative attitudes towards mathematics, especially in the topic of geometry, which has been perceived as one of the most difficult sections in the subject. Three schools were visited regularly over a period of ten (10) weeks - two of these schools were in Umlazi township and one was in KwaMashu township. The schools were chosen for convenience, since the research investigator was also involved in a project called "English for Mathematics" with senior mathematics teachers who attend SSC INSET courses. The project was basically conducted by the English implementor of the SSC at these schools. These visits took the form of participant observations and also formed the context for informal interviewing. Participant observation is described by Simon (1986: 24) as a "research technique whereby the research investigator joins the group he wishes to study and shares in their

day-to-day experiences and activities through genuine face-to-face interaction". The same author argues that such a strategy, if employed, "moves away from the imposi1:ion of categories from above, to a procedure where informal techniques are used in such a way that the target population itself generates the important research issues (crucial concepts)" (Simon, 1986: 14). In this kind of informal interviewing, questions, in connection with the effectiveness of INSET courses, were not asked in any specific order, but the interviewer simply probed certain issues (see Appendix E) which were raised in the course of the interview. The teachers spoken to were basically encouraged to talk at length and their comments were noted thereafter.

From this initial phase it became possible to select those issues (see Appendix E) which repeated themselves to be used in preparation for the second phase.

3.2.2 Semi-formal interviews to "flesh out" themes

According to Simon (1986: 15), the 2nd phase should "represent the 'fleshing out• of the

concepts, using an open-ended interview schedule where respondents are asked to provide 'open-ended' comments on each of the themes". Therefore, in order to eccourage participants to elaborate on the themes and issues generated earlier, the investigator operationalised these themes and issues as free response questions in an interview schedule, as the second stage of the research process (the semi-formal interview schedule appears in Appendix A). These semi-formal interviews were conducted with practising mathematics teachers at senior secondary schools in Umlazi and KwaMashu townships (N = 5). This sample was chosen randomly from a population of twenty two senior mathematics teachers satisfying the following two conditions:

Firstly, the teachers had to be graduates of the two colleges of education in KwaZulu which award the Secondary Teachers' Diploma (STD) in mathematics after 3 years of successful study. Secondly, the teachers had to have attended at least four INSET courses organised by the SSC to qualify for interviewing.

Basically, the policy of the SSC is to offer a maximum of four INSET courses for mathematics

teachers per year over a period of two days (or 10-12 hours of actual teacher contact). Therefore, teachers to be interviewed would have had at least one year of teaching experience to their credit. Such teachers, it is believed, would have more or less felt the impact or non-effectiveness of the SSC INSET courses. It was not at all problematic for the investigator to get a list of teachers satisfying the above-mentioned conditions, since the SSC has a data-base and keeps a comprehensive record on a variety of personal details of any mathematics teacher who attends an INSET activity organised by the SSC. In essence, the second phase generated even more data, themes and issues which could be used for the third phase.

3.2.3 Formulation of formal interview schedule

In the 3rd phase, all informatinn from the first and second phases was used to formulate a much more detailed and structured interview schedule (Appendix B).This interview was extended to the other group of senior secondary school mathematics teachers (N = 17) in Umlazi and KwaMashu townships. The two townships together have twenty two high schools - fifteen (15) in Umlazi and

seven in KwaMashu. In the study twenty two (22) senior mathematics teachers were interviewed, representing fifteen high schools - eleven (11) in Umlazi and four in KwaMashu. Only seven high schools were unrepresented in the study, which is not unreasonable, because in order for teachers to be interviewed they had to have a STD and also attended at least four INSET courses conducted by the SSC. Further, one or two schools have never sent any participants to any of the INSET courses, since attendance is voluntary.

The interview schedule was so designed as to gather as much data as possible concerning, (1) the teachers' perceptions of INSET(*) and its effectiveness, as well as, (2) their perceptions of the mathematics curriculum at colleges of education from which they obtained their diplomas. The reason for the latter is that, it was believed that it was crucial and important, to find out from the teachers themselves, their views and percetions of the curriculum for the training of senior secondary school mathematics teachers, as these findings would impinge on their perceptions of the effectiveness of INSET(*) courses. The reason for this is that INSET(*) is designed so

that, to some extent, the gap between what colleges give and the demands of the school is minimised. If teachers think that this is the case, then they would perceive INSET(*) courses as effective. These perceptions may also help in finding out problems that teachers bring from colleges, problems which INSET(*) must address in order to be an effective mediator.

3.2.4 Conduct of interviews

Having constructed the interview schedules for Phases 2 and 3, the next step to be considered by the investigator, was the problem of gaining access to the schools. It became necessary for the investigator to visit and chat with principals of all the schools where teachers had been identified for interviewing. **The** investigator explained to the principals the aims of the research study and consequently spoke with the relevant teachers. On seeing the teachers, the investigator again explained the purpose of the study and asked them to suggest a date and the time of day to call on them for the interview. By giving respondents this kind of latitude they were somehow elevated to a certain level of importance

and this, it was hoped, would help in making the interviews less tense and more open. All in all, the principals and the teachers were very co-operative with the investigator. The probable reason for this is that the investigator knew some of the school principals and almost all the mathematics teachers, both on a personal and professional basis, hence their willingness to give assistance where it was possible. It must be mentioned that the decision to do this survey by employing interview techniques was based mainly on three reasons:

Firstly, the target population was deemed to be small enough to enable the interviewer to complete the interviews with teachers within a reasonable amount of time, which was four weeks in all.

Secondly, although Umlazi and KwaMashu townships are quite big and the high schools spread throughout the townships, the investigator had the resources to enable him to travel to all the relevant schools, make the necessary appointments, and again return to those schools for the actual interviews at agreed convenient dates and times of the day. Evidently it would have been cheaper to

use postal questionnaires which would include free postage paid envelopes. However, a number of educationists (Simon, 1986; Moser and Kalton, 1971; Thurlow, 1990) seem to agree that the investigator is unlikely to get a 100% response rate using a postal method. Reminders may have to be sent to those who might not **have** yet returned their questionnaires. But even this method, though it may increase response rates, is not a guarantee of a 100% response rate.

Thirdly, the disadvantages of mailed questionnaires far surpass their advantages, and according to Simon (1986: 57), this method gives "no opportunity to correct ambiguities, probe for additional information and clear up misunderstandings as there is with an interviewer present ...[11]. The same author argues that the "probe is one of the most important interviewing tools for soliciting additional information about the respondent" (1986: 39). The investigator used the probing technique quite often in most questions (Appendix B) in order to get respondents to elaborate on their original responses. But, it was at the same time important that the probing technique did not suggest in any way an answer to

a particular question. In this respect, Simon (1986) quotes Babbie (1975: 172) who sums up the neutral role of the interviewer when he says:

> 'he interviewer then, should be a neutral medium through which questions and answers are transmitted. If this is successfully accomplished, different interviewers would obtain exactly the same responses from a given respondent.

When the actual interviews took place in the third phase of the project, the investigator found it necessary to make very minor changes (see Appendix C) to some of the questions after the first 2 or J interviews. Otherwise the rest of the questions and the way they were asked did not pose any difficulties to the respondents. It is, however, interesting to note that although the questions were asked in English, many respondents tended to answer in Zulu mixed with English words. The interviewer had to translate into English whatever was said by respondents. Throughout all the interviews in the last two phases, unobtrusive note-taking was carried out by the interviewer. The investigator believes that this is a richer data-gathering technique in that one can also note environmental settings as these might impinge on the research. The decision not to use a tape-

recorder stemmed from informal procedures used to generate themes and issues from the teachers. Most teachers talked to, hinted that they wouldn't be happy with a tape-recorder in front of them they said they wouldn't be 'free' to respond openly. Somehow talking in Zulu seemed overall to help the teachers express, and respond more openly to, the many aspects and issues in the interview schedule. In other words, this did not become a hindrance to the interviewer who is also a native speaker of Zulu. However, it became important for the interviewer, once the translation had been done and written down, to read it for the respondent so that he or she could make any further comments on the accuracy of the statement. This allowed the investigator to make changes and/or additions where it was necessary. However, it must be reiterated here that bias could have been introduced during the translation of the responses by the interviewer, especially in the choice of words used. The respondents might have agreed to whatever translation done by the investigator in the 'fear' of being embarrassed, for example, for not understanding certain words in English. The word "bias" as used here means the distortion of data or information by a respondent

as a result of certain factors.

Nevertheless, it is unlikely that the information and details that were obtained from the respondents would have been the same had another interviewer with vastly different characteristics to the interviewees been sent to do the interviews. This in fact, must be seen as a problematic situation when doing research studies amongst blacks in South Africa. Crane and Brewer (in Simon, 1986: 38) list such things to be noted in connection with interviewers as the "interviewer's physical appearance, dress, race, accent, socio-economic status and ethnicity". Simon (1986: 38) makes this point even more forcefully when he says that "it would be unwise to send a negro interviewer to interview the Ku Klux Klan wizard; likewise, a South African black to interview a platteland farmer".

Another point worth mentioning is the fact that interviews with the teachers were done at their place of work and this could effect bias on the part of the interviewee because of distractions, noise, time pressures and lack of privacy (Thurlow, 1990). It is suggested that one of the

ways to reduce such biases is to avoid these types of conditions where possible. However, adequate trust and rapport between the respondent and the interviewer is probably the single most important method of reducing bias (Thurlow, 1990). As mentioned above, since the investigator's characteristics matched to some extent those of the respondents, it was not all that difficult to establish rapport and trust **with** the respondents. Further, the investigator had assured the respondents that a copy of a completed report of the research study will in all probability be given to the SSC for its consideration of the recommendations and suggestions. It was therefore stressed that the interview might benefit the respondents in some way or the other. For instance, the way the INSET programme is conducted might be changed to some extent by considering the respondent's views. Basically all the above factors contributed to reducing the bias on the part of the respondents when interviewed when they were at work. In many cases the interviews took place in a library or laboratory of the school, places which the interviewer found quiet and unused at the time of the interviews. However, there were a few instances where the interviews

had to take place in the staff room in the presence of other teachers of that particular school. By moving to a secluded corner of the room, it was possible to conduct the interviews out of earshot of the other teachers, thereby possibly reducing to some extent bias on the part of the respondents.

3.2.5 Interviewing mathematics teacher educators

Another dimension introduced in this research study was to conduct formal interviews with four mathematics teacher educators from the two colleges of education in KwaZulu which award the 3-year Secondary Teachers' Diploma (the interview schedule appears in Appendix D). The main purpose of these interviews was to ascertain the college mathematics lecturers' **views** and perceptions of the college mathematics curriculum. This was a very important exercise for the investigator since many educationists and mathematics teachers at large believe that the standard of training of mathematics teachers at black colleges of education is below average. The SSC also supports this claim, which is why from its point of view, it is absolutely necessary for 'new' mathematics

teachers fresh from college to start attending INSET programmes organised by the SSC. The results from interviews with college lecturers may provide certain recommendations for INSET(*} to take into consideration in order for it to be an 'ideal' mediator.

There **were** no problems of entry into the colleges of education to conduct the interviews with the respective mathematics lecturers. Once appointments had been made telephonically, the investigator was able to travel to the colleges and conduct the interviews. Establishing rapport and trust with the lecturers was not a problem at a1·1. The investigator is fortunate to know all the mathematics lecturers from the two colleges since the SSC is involved in sponsoring and supporting the Association of Mathematics Teacher Educators in KwaZulu/Natal (AMTEK}. The investigator is also the secretary of the Executive Committee of AMTEK.

Therefore the position of the investigator in the INSET programme for mathematics teachers and in AMTEK, has been one of the strengths of the whole study. Moreover, no problems were experienced by

the investigator as a result of his position. Instead, the investigator was seen as someone who wanted to **give** help through the SSC, so the respondents were prepared to give the investigator critical comments. Also, important issues such as lack of resources from the department and inability of the department to supply adequate mathematics textbooks for mathematics teachers, were raised. These, it is believed, would not have been raised had the investigator been an official of the department of education. Everyone interviewed responded to the investigator with much willingness to give whatever information that was required. This indicated that the democratic structures which have been created by the SSC amongst teachers and mathematics teacher educators in KwaZulu have, to some extent, been successful in promoting personal and professional development of those involved in the project.

3.3 Construction of interview schedules

When constructing questions to be used in the interview schedules, the investigator always had to ask himself the following question, "Is it absolutely essential to have this information?"

It was important and crucial to include only those questions in the interview schedule which relate to the research themes. Simon (1986) also offers some hints to be used when constructing questions, and in fact quotes Wiseman and Aron (1970: 39-40) who say the following should be checked:

> Is a question useful? Does it get at the desired information? Is it possible that respondents will have the information necessary to answer the question? Are several questions needed on a specific topic in order to cover it adequately?
> Is the question free from bias?
> Is the wording of the question clear?
> Does it contain difficult words that the average respondent may not understand?

Questions were worded in everyday language and the use of unfamiliar technical terms was avoided as much as possible in the construction of the interview schedules. This was in agreement with Moser and Kalton (1971: 141) who caution that:

> In choosing the language for a questionnaire, the population being studied should be kept in mind. The aim in question wording is to communicate **with** respondents as nearly as possible in their own language. A survey of the members of a particular profession, for instance, can usefully employ the profession's common technical terms, not only are such terms part of the informant's common language, but they also normally have a single precise meaning...

Once the questions for the formal interview schedule for teachers (i.e. Phase 3 of the study) had been completed, the investigator checked this aspect of the research design by doing actual interviews with a few teachers, selected randomly from the actual group with which the study would deal. As mentioned earlier on, there were very minor changes and refinements to the interview schedule, and these were in respect of the wording of two particular questions (see Appendix C). This was in line with Simon (1986: 47) who says that "the pre-test should prove most valuable in demonstrating redundant questions, ambiguity and bias". Backstrom and Hursh (in Simon, 1986: 48) are also of the opinion that "the pre-test is run under actual field conditions on the people in the actual community or population with which the study will deal".

No pre-testing was employed in the other aspects of this research study, which were the semi-formal **interview** schedule for Phase 2 of the study and the formal interview schedule for the mathematics teacher educators. These interview schedules were considered by the investigator to be quite short, precise and to the point (see Appendices A and D).

The actual interviews proved this since no difficulties were encountered with the wording of the questions. Hence, no improvement or reworking of the questions was necessary.

3.4 Data analysis

The comments about INSET(*) courses, as well as the perceptions of mathematics teachers and college lecturers of the mathematics curriculum at black colleges, obtained through interviews must be seen as central to the whole investigation, as these will form the basis for subsequent recommendations. It is unlikely that INSET(*) pa·rticipants would exaggerate or give a totally biased picture about the INSET courses, when they are aware that the programme belongs to them (as the users), and also since they are involved in the programme, through action committees, in determining their needs and thereafter taking necessary action to remedy the situation. The rapport and trust built by the investigator with the INSET participants, who are also the interviewees, is one of aspects that were considered and led to the use of the interview technique in this study. The use of the probing

technique, further allows the investigator to get as much information as possible from the respondent.

In the analysis of the interviews the investigator **will** look for patterns, overlapping points and/or comments, similarities and differences in the opinions of the respondents and on their perceptions of the effectiveness of INSET(*) courses, as well as their perceptions of the mathematics college curriculum.

CHAPTER 4

ANALYSIS OF DATA

The framework for reporting the outcomes of this study is also the result of the analysis of information/data received, which, inter alia, produced the following issues, concerns and themes:

- Limitations of the college mathematics curriculum
- Problems with mathematics textbooks
- Problems with the learning-teaching situation at college
- INSET(*) as bridging the gap between what is learnt at college and what teachers find in schools
- Teachers' perceptions of the nature of teaching methods suggested by INSET(*) tutors
- Problems with the teaching situation in the schools

- Problems with INSET(*)
- Handouts
- INSET(*) compared to other INSET
- Suggestions of previous work covered by INSET(*)
- Focus on pupils
- Pre-service training of prospective mathematics teachers
- Initiatives by mathematics teacher educators towards improving mathematics education
- Mathematics teacher educators' perceptions of the SSC, and how it can improve pupils' performance in mathematics

4.1 Analysis of teachers' perception of the college mathematics curriculum

4.1.1 Introduction

In the analysis of interviews below, the terms 'majority', 'minority', and a 'few' will be used to mean that the number of respondents/teachers was 50%, 25-49% and< 25% respectively.

4.1.2 Limitations of the college mathematics curriculum

During the second phase of the study, i.e. when semi-formal interviews were conducted with mathematics teachers to "flesh out" themes, one of the teachers when asked the following questions: "Did the college prepare you sufficiently for the realities of the school environment?", answered, "No •. When probed for reasons for his answer, he said:

> When it comes to the teaching of mathematics, only Standard 6-10 mathematics was done. You are on par with the pupils you are teaching. I will teach them what I know at the level at which they are supposed to know. What it means, one is teaching Standard 10 whilst one is also having Standard 10 as the highest qualification.

This statement summed up the limitation of the college mathematics curriculum regarding the mathematical content. The investigator decided to

pose the above statement as a question when conducting structured interviews in phase 3 of the research study and the majority of the respondents agreed that they believe that the colleges did not prepare them sufficiently for the realities of the school. What this means, in the above context, is that mathematics teachers find it problematic that the mathematics knowledge they have is at the same level as that of the pupils they are teaching. In this regard teachers can only teach the mathematics content as it appears in the prescribed mathematics syllabus, and this can be detrimental for bright pupils who, sometimes, might need enrichment and advanced work.

Only one of the respondents was not sure whether to say yes or no to the question, but he replied as follows:

> I think with respect to the high school syllabus, I would say what I did at college I am exposed to here at school. There isn't a gap between college and school syllabus, but a teacher must have more knowledge than pupils. What happens is that (at college) in a topic like Calculus, one is not exposed to more ideas.

Although this teacher conceded that teachers

should have generally more knowledge than pupils they are teaching at a particular level, he somehow felt, and was happy with the fact, that the mathematics content taught to him at college **was** the same as that to be taught in the school. The respondent also talked about not being "exposed to more ideas", especially in Calculus, and this may have stemmed from his involvement in INSET courses organised by the SSC. The investigator would like at this juncture to share with the reader some observations experienced in INSET courses with mathematics teachers, and which might **have a** bearing on what prompted the above teacher to make a comment about being "exposed to mo·re ideas".

The matric mathematics (HG) syllabus suggests the following to be taught to pupils when dealing with the section on limits in Differential Calculus:

i) Intuitive approach to the concept of a limit

ii) Determining of $\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$,

where f(x) is equal to k, ax, ax+b, ax^2, ax^2+bx+c and ax^3.

In terms of content, the college mathematics syllabus in black colleges is no different from the matric syllabus, and also specifies exactly the above to be done with student-teachers on the section of limits (although in 1990 a new syllabus structure was implemented). When teachers (approximately N = 50) were invited to an INSET course on Differential Calculus, which was going to look specifically at further ideas on "limits' in the introductory session, they were given the following problem to solve:

> Draw the graph of the following function, and then investigate the "behaviour" of the function at the indicated point:
>
> $$f(x) = \frac{x^2 - 4}{x - 2} \quad , \quad \text{at } x = 2$$

The majority of the teachers who were fresh from college, and were attending the INSET course for the first time, were not able to do the problem properly. They drew a graph of the expression in the numerator (i.e. a parabola), and a graph of the expression in the denominator (i.e. a straight

line) on the same system of axes. Somehow the teachers knew that this was not correct and they were saying so when encouraged to air their **views** on their 'solutions•. A few teachers skipped the first part of the problem, and attempted the second part without success anyway, since their tendency was to substitute the values of x directly into f(x). In this case they got $\frac{0}{0}$ and immediately said that the limit does not exist or that the limit is oo.

What one deduced from this exercise was that the **•new•** teachers from college had not been exposed fully and thoroughly to an understanding of the concept of a limit. To them investigating the behaviour of a given function f(x), at a given point x, meant evaluating the limit of that function at that point, which in turn meant that one must directly substitute the value of x into the given function to find the limit, which is fine if f is a polynomial function. Basically, **what** this means is that the intuitive ideas and approaches to the concept of a limit had not been grounded successfully during teacher-training. The inability to provide proper grounding of concepts is seen by the investigator as one of the

limitations of both the mathematics teacher educators and the mathematics content at black colleges of education. The syllabuses for matric and college mathematics do not elaborate on what is meant by the statement, "intuitive approach to the concept of a limit", hence this is open to different interpretations by mathematics teacher educators, textbook writers, teachers themselves, and so on. At the moment only one or two school mathematics text books (e.g. Classroom Mathematics Std 10, Laridon et al 1985) of the more than fifteen in the market, do the type of exercise **shown above.**

To.further compound the problem, the syllabuses suggest that finding the limit of a function be confined to polynomial functions, functions whose limits will always exist and easily be evaluated by the method of "direct substitution" of the given value of x into f(x).

So, when $f(x) = \frac{x^2 - 4}{x - 2}$,

which is a rational function, teachers run into difficulties in trying to evaluate the limit. Nevertheless most •new' teachers seem to believe that the limit of a function will always exist, a

wrong perception created by the limitations of the college mathematics content. Even more interesting isr-the fact that many teachers have admitted, informally of course, that they were taught at college to use direct substitution whenever they wanted to evaluate the limit of a given function, a method which fortunately, works perfectly well whenever the given function is a polynomial. This is a very serious misunderstanding of the concept of a limit which many teachers from black colleges bring into the teaching-learning situation, and such misconceptions, not only found in the section on limits, are passed on to pupils who eventually may be admitted to universities and this is seen as one of the causes of the high failure rate of first-year students in these institutions especially in the natural sciences.

4.1.3 Problems with mathematics methods

The above problems on the concept of a limit are, however, not difficult to understand when one starts to also have an in-depth and long look at one of the mathematics method textbooks used by lecturers in black colleges. The book is called

Teaching High School Mathematics (Kroeze 1989). It covers the method part of the mathematics syllabi for the Secondary Teachers' Diploma (STD) of the Department of Education and Training (DET), and this department sets the final external examination for the 3rd year STD students at black colleges. On the section "Limits and Gradients", Kroeze (1989), after deducing in previous work that:

Gradient= $\frac{f(x+h) - f(x)}{h}$,

suggests the following:

If h = o, we have:

$$\frac{f(x+h) - f(x)}{h} = \frac{f(x) - f(x)}{0} = \frac{0}{0},$$

which is undefined.

This problem can be solved by using limits: if $f(x) = x^2 + 7$, the value of f(J) could be found by substituting a value very close to 3, for instance, 2,999. It gives: $(2,999)^2 + 7 = 8,994001 + 7 = 15,994001$. We know intuitively that if x=J, then f(x) = 16, because 15,994001 is very close to 16. Such a value that is acquired by getting very

close to, is called a limit. We write

$\lim_{x \to 3} (x^2 + 7) = 16$

In cases such as the one above, limits can be found by substitution.

Any scholar of mathematics who has done university course I mathematics will agree that the above "treatise on an intuitive approach to limits" is nothing else but pure nonsense. What Kroeze is suggesting in his explanation does not in fact solve the problem as he claims it does, since the limit idea solves the problem of $\frac{f(x + h) - f(x)}{h}$ as it does not allow h·to be zero so that we can attempt to divide h into the numerator **(i.e.** eliminate h from the denominator). The book should not have been in the market at all and it is not known how it got there in the first place. Lecturers have been •under undue pressure' to use the book mainly for two reasons, viz.:

- The book is one of **very few** mathematics method textbooks available in the market; and

- The author of the book .i.§ the external examiner of the mathematics method examination for 3rd year

> STD college students. Questions in this final examination paper are based on the use and content of this book, and it stands to reason that the memorandum and answers used for marking the examination paper are likely to be a 'copy-cat' of the contents of the book.

The existence of such a book is another nail into the coffin with respect to mathematics education for black pupils in this country. Unlike colleges of education for Indians and Whites which are attached to tertiary institutions such as UDW and the University of Natal respectively, colleges of education for black students do not have this kind of arrangement resulting in declining and below average standards as far as educational matters are concerned. The Department of Education and Training (DET) in Pretoria which controls black colleges appoints its own so-called "experts" and "curriculum developers" to run black education and make, without any consultation, important decisions affecting hundreds of thousands of black children. In the process, some of these DET officials (mis)use their positions to promote personal interests and unfortunately to the detriment of the black child. "Bantu education" is still alive, as long as fundamental changes and transformation of the socio-

political system in South Africa do not take place.

4.1.4 Problems with the learning-teaching situation at college

The above problems in the learning-teaching situation of black schools highlight the problem of 'overlearning' incorrect rules. Both the teachers and inappropriate textbooks provide the students with incorrect rules which are •overlearnt• by the pupils resulting in their inability to solve mathematical problems successfully and autonomously. Those pupils who then attend black colleges of education (KwaZulu) where these incorrect rules are reinforced, help to create a vicious cycle which is almost impossible to break.

What has been described above is, as noted earlier on, a small but major flaw in the whole curriculum of college mathematics. There are other areas in the syllabuses, e.g. in geometry, where major and fundamental changes have to be instituted in order to have an acceptable curriculum for the training of senior secondary school mathematics teachers in KwaZulu. It is at least good to hear comments that a few mathematics teacher educators **have** also been concerned about the content of the college mathematics

and consequently did something about it, as one respondent said:

> Maybe we were fortunate since it was not only up to Standard 10 work that we were taught. Although our lecturer taught us more than standard 10 work, but he was not following the syllabus straight... especially Calculus. It was not yet in the syllabus but our lecturer did it with us including Analytical Geometry, except Linear Programming.

Although this is an isolated observation and not all the 'new' topics were done by the lecturer, at least the teacher is happy and identifies with the lecturer for having introduced him to the topics of Calculus and Analytical Geometry. This is unlike many of his colleagues who normally would see the •new' topics in the syllabus when they were given it by their principals at the beginning of the year for implementation. In many instances, teachers taught without a syllabus or taught the 'old' syllabus for months without realising that **a 'new'** one had already been implemented, and this has been observed by the investigator on many occasions in INSET .courses. Reasons for this are many and varied: there is generally a lack of effective communication between teachers and principals (in some cases), between principals and circuit offices and between circuit offices and the Department of Education and culture

(KwaZulu); INSET courses for mathematics teachers that are organised by the SSC are voluntary and it is difficult to compile a list of teachers fresh from college early in the year, i.e. at least before the first **INSET** course; some schools are upgraded from being junior secondary to senior secondary, and consequently teachers do not get hold of the relevant syllabuses and/or work programmes and they then rely on textbooks in their teaching. The investigator believes that if the training at black colleges was up to standard, 'new' teachers would have at least been exposed in their pre-service training about cycles for the implementation of new syllabuses, the **INSET** projects and teachers' organisations in KwaZulu where assistance could be obtained regarding resources, syllabuses, work programmes, etc., and ways of communicating with officials of the Department so that they can do their work properly and effectively.

Teachers were also critical of the ignorance among mathematics teacher educators of the problems bedevilling black education and the majority of the teachers interviewed agreed with the opinion that some college lecturers do not know what is happening in black education, making it more difficult for them to adapt to the teaching-learning situation after leaving

the college. The majority of teachers interviewed were supportive of the comments recorded below:

> ...most of the time things taught at college were very artificial. Things were taught which we found impossible to implement in our schools.
>
> It depends whether it is a black or white lecturer. Blacks have ideas about what is happening in black schools whilst the other lecturers do not know.

Other teachers' views on this issue fell into the two above categories using more or less the same wording. The methodology of mathematics forms an important part of the mathematics curriculum for the training of senior secondary school mathematics teachers. However, concluding from teachers' comments, it seems most mathematics teacher educators are either not doing their job properly which is, inter alia, to train the student teachers to teach large classes and with insufficient resources, or they are simply ignorant of the situation in black schools. To emphasise this point further, one teacher interviewed said that white college lecturers "tend to lecture student-teachers to teach in an ideal classroom when in fact they know that it will not be so".

This criticism of mathematics teacher educators must be seen against the background of the whole South African educational scenario where there is a shortage of suitably qualified mathematics teachers with experience in black education. Most colleges in KwaZulu have over the years been forced to take on qualified, though inexperienced personnel fresh from university. These lecturers are then expected to 'produce' good mathematics teachers when they themselves do not have a track record of good mathematics teaching, let alone in black education. This introduces a vicious cycle which cannot be broken since teachers from colleges are also expected to deliver the goods **when** they start teaching, only to find that circumstances and conditions dictate and hence they cannot perform to their full capabilities. In theory, when pupils do not get matriculation exemption in mathematics, that means they cannot gain entry into universities and therefore their other alternative is go to a college of education for a teaching career. Although colleges of education have quite a number of available resources, for example mathematics video cassettes, charts, etc., lecturers seem to 'forget' that many schools in KwaZulu do not have these facilities. Consequently, college lecturers are not making a concerted effort to train would-be-teachers how to manage, improvise and generally cope

with situations of non-availability of facilities, models and equipment in schools. Teachers who after graduation go to rural schools are in a worse situation since the impact of technology is moving at a snail's pace in these areas.

Finally, one teacher amongst those interviewed disagreed with the claim that some college lecturers are ignorant of problems in black education. This is what he said:

> I don't agree fully with this, since lecturers do visit schools when doing criticism of lessons delivered by student-teachers, and so to some extent, they have an idea. We tell them from practice teaching about the situation in the schools.

In this instance, the teacher interviewed believes that the lecturer can understand problems in black education just by attending a few lessons where prospective mathematics teachers are evaluated, and by being told "stories" about the situation out there. It is also of course a fallacy to think that after teaching in black schools for a few months or even years, then one knows what it is all about. It all depends on where and under what conditions one had that kind of exercise. What is, however, important in these 'crit' lessons is

that the lecturers do not get involved in the teaching of the subject, rather they observe and make criticism of certain aspects of the lesson. After the lesson the lecturer discusses with the student-teachers issues arising from the lesson which might need refinement and improvement, but this exercise in itself does not elevate the lecturer concerned to the status of being an "expert" in black education.

4.2 **Analysis of mathematics teachers• perceptions of INSET**

4.2.1 Introduction

As an introduction to this subsection, it must be reiterated that the **views** of teachers expressed here are of those teachers who teach in senior secondary schools in Umlazi and KwaMashu, who have graduated from Eshowe or Esikhawini Colleges of Education with a 3-year Secondary Teachers' Diploma, and have attended at least four mathematics INSET courses organised by the SSC. Therefore their views or perceptions will not necessarily translate into other areas where the SSC runs and conducts INSET programmes, as conditions and circumstances differ quite markedly.

4.2.2 Does INSET bridge the gap between what is taught at college and **what** teachers find in schools?

The majority of the teachers who said in the interview that there was disparity between what is taught at college and what they find in schools, agreed that INSET(*) courses do bridge the gap created by the inadequacy of the college mathematics curriculum, in terms of providing teachers with more content knowledge of mathematics, assisting through the provision of resources such as materials, notes and mathematics videos, and generally giving them ideas about 'new' and alternative methods/approaches of handling the subject in their situations in schools. What is most interesting is that whenever teachers are requested to suggest topics in or aspects of mathematics to be done in the next workshop they want, more often than not, subject matter or content to be covered, as opposed to the methodology of teaching mathematics and curriculum development in mathematics. Teachers believe, and rightly so, that they have not done enough mathematics content at college. They just don't feel confident teaching matric mathematics to pupils when they themselves have never done any mathematics beyond

atric level. The majority of the teachers interviewed were happy that they had been able to attend INSET(*) courses where the subject content went beyond the matriculation syllabus. They said that this affected them in many ways when teaching those particular topics or sections of mathematics to their pupils. Most of them said they felt "more confident" since they were above the level of children and could explain the subject matter better. Another respondent put it succinctly when he said: " ...when something crops up when I am teaching, which requires more information, then I know I have the knowledge to deal with it".

Not all the INSET courses run by the SSC are, in terms of content, above the level of school mathematics and, added to that, the fact that attendance at these INSET workshops is voluntary, it is therefore possible that a minority of teachers might not have had the chance of attending those INSET courses which dealt with enrichment and advanced work in mathematics. Nevertheless, most INSET courses are so designed to allow teachers to explore other ideas, ways and methods of teaching a particular section of mathematics. For example, in geometry an INSET course might require that teachers themselves go through sessions where they have to look at and explore investigative approaches to its

teaching: how they could fold and cut paper to 'prove' theorems, and how they could use mathematical instruments to do constructions which might lead again to a •proof' of a given theorem or statement. Obviously it is important and crucial for teachers (and pupils) to be **aware** that these approaches are only intuitive and not rigorous in themselves, but their importance lies in the fact that they appeal to the practical aspects of the topic. The standard proof for a theorem must be seen as only necessary to convince people without any doubts, that the statement will always be true under the given conditions.

Shandu (1990: 12) maintains that:

> ..... the majority of teachers still find mathematics a difficult subject to teach and tend to rely on letting children work through textbooks without any practical work or discussion. The basic problem is that few, if any, teachers have learned the subject through investigation themselves. There is a great need for INSET which would help teachers to learn mathematics in an active way so that they appreciate the advantages of exchanging ideas ... By this it means, they would become convinced, at first hand, of the value to children of learning mathematics through investigation...

But teachers• attitudes towards the use of investigative methods have been very negative, an

observation made by the investigator in many INSET courses conducted by the SSC, and the results of interviews with teachers on this issue are indicated below in the subsection on "teaching methods". Many teachers tend to equate the way they teach with the way the final mathematics examination paper is set. This paper is set in such **a way** that if a teacher has 'drilled' and trained his pupils very well, then they should be able to do well. There are no questions which require the use of, for example, mathematics instruments for constructions and paper folding or cutting. Most teachers then see no point in using some of these investigative approaches in their teaching of mathematics. Another factor which plays an important role here is that they perceive the mathematics matric syllabus as long and content-packed, prompting them to argue that there is no time at all to do some of these 'innovations' although the benefit of using them are so obvious.

Teachers• perceptions of the nature of teaching methods suggested by INSET(*) tutors

When teachers were interviewed, the issue of teaching methods (including investigative approaches in the teaching of mathematics) suggested by tutors in

INSET(*) courses which are seen as time-consuming, and hence contributory, to some extent, to not finishing of the syllabus at the end of the year, was discussed. In this regard, teachers were divided into three groups:

GROUP 1

The majority of the respondents agreed that "one has to consider the time factor and if a method is time-consuming, hence one cannot apply it". Another respondent in this group said:

> Since methods are suggested, teachers should just select those which will suit their situation and not strictly apply all as this could lead to a waste of time.

Yet another one replied:

> Some of the methods are time-consuming but each teacher must be able to try and "fill" the whole lesson in a period, and therefore should choose a method which enables him/her to finish the lesson.

The above responses.clearly indicate that the teachers are worried about longer, though more effective ways of approaching the teaching of mathematics, since their situations and contexts dictate that finishing the syllabus is a priority. One must remember that in KwaZulu schools, principals, inspectors and subject advisers still do class visits, and teachers are under a lot of pressure to be seen to be finishing the prescribed work within the allocated time.

GROUP 2

A minority of the respondents were of the opinion that it was not important to try and complete the syllabus, whilst pupils have not understood the work. One respondent in this group put it like this:

> I believe that when a method is applied, even if it is slow, as long as students understand it, it is best. It is no use to rush finishing the syllabus and leaving pupils behind.

Another one in the same group said:

> I think there are other methods that can be used even if they are time-consuming. It depends on the circumstances, since if we rush to finish the syllabus, that may not be of help since pupils will not have understood the matter.

Although this is a small group of teachers, it is however encouraging to know that they are concerned about the child learning mathematics in the best way possible. INSET(*) is so designed as to change teachers' behaviour in the classroom. Since no follow-up class visits were done of INSET(*) participants after the programme, one cannot claim complete validity of the information obtained from them, but nevertheless it gives a picture of what they believe are the changes

brought within themselves by having attended an INSET programme. Obviously a lot of courage and commitment from the teachers is necessary to enable them to resist pressure from officials of the department of education in their uninformed insistence to see a teacher doing the work as indicated in the scheme book for a particular week. It is strange to see such officials exerting this kind of pressure on teachers, when they themselves had been teachers for many years, under more or less the same circumstances and conditions. Many officials of the department are former teachers who have since been promoted for one reason or another. They are the people who are supposed to have more 'expertise' in educational matters and problems in education, and should be able to guide teachers rather than subjugate them. Another important factor which teachers believe is a major stumbling block to making the best use of methods suggested in INSET(*) courses in their teaching of mathematics, is the ever increasing number of pupils in schools. When asked to state the largest number of pupils in any class in which they were teaching mathematics, only four responded with the numbers 25, 40, 42 and 46 respectively. The rest mentioned figures varying between 57 and 110 inclusive, with an average of 76 pupils in each class. The lack of facilities and the

shortage of mathematics teachers in KwaZulu schools has led to the above situation where such large classes have now become the order of the day.

GROUP 3

A few of the respondents indicated that they had never attended an INSET course where teaching methods suggested by tutors were seen as too time-consuming to be applicable in their situation. This might mean that the respondents accepted suggested alternative methods and claimed to have implemented them. It must also be remembered that the respondents, although they had attended at least four INSET courses organised by the SSC, might have attended different INSET courses under different circumstances and with a different agenda.

4.2.3 Problems with the teaching situation in schools

On the question of large classes, teachers, when interviewed, mentioned a variety of problems which they experience specifically when teaching such classes:

- Marking homework/classwork exercise books of children:

  The majority of the respondents mentioned this

as a problem, saying that classwork and/or homework exercises in mathematics have to be given to pupils daily. It is, however, very difficult to do all the marking of pupils' work books to see whether pupils have understood the work or not, because there are just too many of them in class.

- Individual attention is not possible:
  Again the majority of the respondents mentioned this problem, and said that there were too many pupils and teachers find it almost impossible to attend to each individual pupil's problems.

- Problems of discipline/control of the class:
  A minority of the respondents mentioned this problem, saying that the situation in schools is now almost out of the teachers' control. It was revealed that many pupils come in and go out of class as they like. Teachers cannot use any kind of punishment since pupils simply refuse to be punished under any circumstances, and teachers do not in any case want to take unnecessary risks with their lives.

- Negative attitude towards mathematics:

A few respondents mentioned this problem. They said that many pupils hate the geometry section, and as a result it becomes difficult to teach this particular section since pupils somehow believe that they will never be able to understand it.

- Lack of background:

  A few respondents mentioned this as a problem, where many pupils who come from junior secondary schools in the surrounding areas to do matriculation are found to be, in most cases, at different levels in their standard 8 mathematics content, with some having not done certain topics and others still, having not completed the syllabus in the previous year. Consequently, it becomes extremely difficult to provide good grounding of mathematics concepts, and reteaching of work which would normally have been covered the previous year takes a lot of teaching time.

- Shortage of books:

  A few respondents mentioned this as a problem. They stated that the department of education and culture of KwaZulu does not supply enough textbooks for all the pupils, and this makes teaching mathematics difficult since even if

pupils share a book in class, they cannot share it when they have homework exercises (at home).

- Pupils copy from each others' exercise books
  Finally, a few respondents mentioned this problem, and they said that many pupils copy answers from a few pupils who are known to be good in mathematics. This cheating is done even during final examinations, and a few teachers also commented that they have heard rumours that some teachers are sometimes forced to tell pupils the answers to certain questions in the examination paper.

These are difficulties and problems which mathematics teachers experience daily in their contexts, and the big question is, "Does INSET work offered by the SSC address the problems in any way?". The majority of the respondents said •no', and the rest said •yes'. Some of these problems fall outside the control of the SSC, for example, the shortage of books, which are supplied by the department of education. However, all teachers were unanimous that they themselves and/or through the mathematics action committee were responsible for determining what topic(s) in, or aspect(s) of

mathematics would be dealt with in a particular workshop. Although the SSC encourages the participatory approach to INSET and employs democratic principles in its involvement with teachers, what is emerging from the above results is that either teachers do not as yet have the skills to articulate their specific problems related to the teaching-learning context or if they have such skills, then the SSC has not been successful in helping them to overcome the difficulties outlined above. However, teachers still need facilitators to guide and initiate critical thinking and discussion among themselves, and this should be the case when they have to discuss and suggest issues that should be treated in a particular INSET. But this is no guarantee that if teachers develop these skills, then the SSC will be able to solve their problems in the schools. For many years teachers have got used to being told in a top-down approach by the bureaucrats and officials of the department. The bottom-up strategy used by the SSC is therefore in conflict with this and hence they still have difficulties in trying to deal with this new kind of reality which to them is like a complete overnight change which has yet to sink in.

4.2.4 Problems with INSET(*)

Group **work in INSET courses**

As mentioned earlier, for many teachers an INSET course means doing the subject matter or content e.g. linear programming, whereas, according to the investigator, sessions could be built into the course where group discussions amongst the teachers can take place to look at the more subtle issues of mathematics education such as the problems which most teachers are experiencing in their schools. Just exchanging ideas among colleagues helps one to think back and reflect critically on how a particular problem or situation can be handled and managed effectively.

This is one of the reasons for encouraging mathematics teachers to work collaboratively in groups when discussing problems and/or exercises, in most INSET courses run and conducted by the SSC. However, a minority of the respondents interviewed criticised this method and agreed that most of the time only one person in the group does everything and the others do not contribute anything. They then suggested that groups should be smaller and should consist of a maximum of three persons in order for group work to be

more effective.

Only one teacher saw the question of group work differently, and he commented that:

> It depends on the topic; there are sections where the same teacher cannot dominate the group. Domination can be from one teacher to another depending on the topic since a teacher cannot be that good in all the sections.

What was interesting however, was that the majority of the teachers interviewed said that they prefer to let their pupils in a mathematics class work individually, although the teachers themselves had overwhelmingly agreed to using group work in INSET(*) courses. They mentioned large classes as a stumbling block to effectively using groups in class and also problems with regard to controlling and monitoring the groups. These made it difficult for the teachers to see whether there was any progress made by the groups.

Timing of INSET oourses

Another important aspect of INSET(*) is that it is difficult for the SSC to organise and run courses for mathematics teachers just before they commence the teaching of a particular section of mathematics, and

interviews highlighted this problem. One reason for this is that there is a limit to the number of INSET courses that can be.offered by the SSC in any one year. Another reason is that most teachers do not strictly follow the work programme prescribed by the Department of Education and Culture (KwaZulu). Teachers were then divided into two groups on this issue:

Group A

The majority of the teachers interviewed belong in this category. These teachers pointed out the fact that the order of the topics in many parts of the work programme is problematic and just doesn't make sense. An example of such a case is that the work programme, according to the mathematics teachers, firstly involves the "graphical representation of the functions defined by $y = ax^2 + bx + c$ $(a \neq 0)$", and later on the "theory of quadratic equations".

Other teachers in this group maintained that once they start teaching a particular section, e.g. trigonometry, then they like to teach it until it has been completed, whereas the work programme suggests a little bit of trigonometry, followed by say geometry, then algebra, and the cycle begins again until all the topics in these sections have been completed or covered.

Group B

A few teachers admitted that they follow the work programme strictly and they cited the point that "pressure is exerted by inspectors who want to see the work programme followed as it is". Unfortunately no probe was done with this group of respondents to see how they would handle the problem mentioned above concerning the order of the topics in the work programme, as it clashes with common sense for many mathematics teachers. It is possible, however, that those teachers who follow the work programme as it is given to them, do not have heads of department (mathematics), who would under such circumstances rearrange the order of topics in the work programme, to suit their particular needs. The availability of the mathematics subject advisor in such instances would be of immense assistance to the mathematics teacher, but his programme may be such that it could be a long time before he could visit that school, unless there was really a major crisis.

Consequently, the majority of the teachers interviewed, indicated that they have in the past

attended at least one INSET course organised by the SSC whereby topics covered were topics they had already taught in their classes. Quite interestingly, teachers said such instances were very useful to them since they were able to reflect and think critically as to how they themselves had handled the topic. These are some of their comments:

> It is helpful since one learns mistakes one may have done whilst teaching that topic. If there is time, one goes back and emphasises those points which might have been overlooked.

> I gained a lot, since on that course I found some new approaches I could have used rather than the approach I was using.

> If that course had been done before I taught that topic, I found that I would **have** treated that topic better. Things came out which I hadn't done in class.

The majority of other teachers mentioned that besides learning other new approaches and methods of teaching a particular topic, the INSET(*) materials had extra

problems and exercises other than those in the textbooks, and they could use these during the revision of that topic **with** their pupils.

Further, all the teachers interviewed indicated that they had also attended at least one INSET(*) course where the topic treated **was a** topic they were still going to teach in their classes. They agreed that the workshop on that topic helped them quite a lot with techniques when they had to teach the topic to their pupils. They said that they felt more confident and fresh from the experience of having attended the **workshop.**

one teacher put it like this:

> It builds confidence. When you go to class you know you have done this topic and it makes teaching of the topic easier.

Yet another one mentioned that:

> The tutors armed me with proper teaching skills to tackle those sections and showed me how to approach them. They showed me which topics I had to do first before doing that topic.

4.2.s Handouts

The reference by the majority of the teachers interviewed to handouts given to participants of an INSET(*) course deserves further attention, since handouts form the backbone of that INSET. One teacher said:

> There were some handouts given which I used with my pupils when teaching those sections....

Another one commented:

> When the time comes for me to teach that topic, it was easier for me to teach it using the materials and notes obtained from the INSET course, especially in sections I am not so clear **with**.

Handouts are widely used teaching aids in the INSET(*) courses as well as in other frameworks of teaching-learning. In the mathematics INSET programme they are of special importance for the following reasons:

- They help in the process of teaching in the INSET course since tutors do not necessarily have to **write** down everything that they teach and participants are also saved the trouble of taking notes. In this way the participants are more likely to involve themselves in listening

critically to the tutors and hence initiate discussions.

- The participants are enabled to review the content of the course and to discuss details with peers (colleagues). The input from participants into the content of the course is of great importance to the tutors and developers of the course.

- The participants are enabled to establish a collection of resource materials which might be of some assistance to better and improved teaching of mathematics in class.

- The mathematics textbooks do not contain the "new" material which is sometimes presented in a course to the participants. As indicated earlier, some of the notes used in a specific course may contain advanced content not prescribed in the matriculation mathematics syllabus.

4.2.6 **INSET(*) compared to other INSET**

Still on the question of materials, and resources in general, the majority of the teachers interviewed said that they had previously attended one or two

mathematics INSET courses organised by the Department of Education and culture (KwaZulu). They were asked to point out any major differences between their experiences of having attended INSET courses organised and run independently by both the department and the SSC. The following comments from some of the teachers were noted:

> In courses organised by the department, we were only given modules to work out and no actual tuition was done as the case with courses organised by the SSC.
>
> Departmental courses were organised and run by people who were not good in communicating with us. Most of them were Afrikaners from the University of Orange Free state. Modules had to be finished and problems (probably teaching-learning problems) I had could not be solved. Most of the time I was passive whereas self-activity is involved in courses organised by the SSC. The SSC also gave us materials which were more than enough and one can even borrow resources from the SSC such as mathematics video cassettes, overhead projectors, etc. In departmental courses you get only the modules and no resources are offered by the department.
>
> The SSC sometimes invited examiners for mathematics, and one gets a lot of guidance and information from the horse's mouth. At the course organised by the department only one person conducts the course, whilst the SSC has different tutors for the same course and even teachers sometimes lead a few sessions.
>
> In departmental courses, there is no practical work. Sometimes there are no worksheets or other materials, so we have nothing to give to and use with pupils in our classrooms. The SSC courses are also more regular than those organised by the

department.

> In departmental courses, teachers become recipients... they (lecturers) gave us modules to work on our own and at the end of a module one had to write a test. No resources are supplied whilst one can borrow from the SSC many resources.

From the above and other similar responses from the teachers, it is clear that they are not satisfied with the way INSET is organised and run by the department of education (KwaZulu). Teachers were very critical of the top-down approach to INSET as used by the department. Basically, these mathematics INSET courses were run by MATIP (Mathematics Teacher In-service Programme) of the University of the Orange Free State, which was commissioned by the department to run INSET in KwaZulu from the early 19S0's. The only local venue for the courses for all KwaZulu circuits was the Umlazi In-service Training Centre. The participatory approach to teacher development as used by the SSC seems to have been well accepted by the teachers, since they are able to do and initiate things mostly on their own, and are not as passive as they appear to be in departmental courses. To make matters worse, departmental courses are not voluntary, and the teachers mentioned that someone decides for them the topics to be covered without consultation. Attendance is compulsory. Whether the teacher needs or does not need the INSET is

irrelevant as far as the Department of Education and Culture (KwaZulu) is concerned.

It is crucial that teachers are empowered to take responsibility for their own professional development, and the SSC is doing this through INSET(*) where teachers are actively involved in organising and running INSET courses. The technicist approach to INSET and to education generally, as purported by the Department of Education and Culture (KwaZulu), must be seen as problematic, since the teacher has the power to veto any innovation in which he was not actively involved in developing.

It is interesting to note that only one teacher mentioned the state of accommodation as unsatisfactory in courses organised by the department. In the past the SSC has had to contend with unfounded implications from the Department of Education and culture (KwaZulu) that the SSC was using hotel accommodation to attract teachers to INSET courses. As a result, some officials insinuated that teachers were no longer interested in attending INSET courses organised by the department. However, from this analysis, it is clear that teachers do not see hotel accommodation in SSC INSET courses as a major difference to the hostel type of accommodation offered by the department. But what is important for

the department to note is that teachers want to be treated as adults and as professionals in their own right. To insist that teachers must use hostels - as is the case in INSET centres in KwaZulu - where there are no hot water facilities or privacy or decent food is indeed an insult in the extreme. Obviously teachers under such circumstances are bound to reject with contempt anything that will place them in such a situation.

4.2.7 suggestions of previous work covered by INSETC*1

Finally, teachers were questioned as to why they usually tend to suggest subject matter or content previously done in some other workshop to be covered in the next INSET(*) course. Most teachers pointed out that due to limitations of time, topics are not taught in sufficient depth or that sometimes too much work is covered during the short time of the courses. One respondent **said:**

> It was not clear enough for me in the previous workshop and I felt that it (the topic) had to be re-addressed.

Another one mentioned that:

> I had still some problems with the topic. There were gaps I felt had to be filled in.

Another teacher stated:

> Most probably in a topic one cannot grasp the content very well at one go. So, doing it again helps one in understanding that topic better.

Yet another one simply pointed out that:

> I didn't gain sufficient expertise and knowledge in that particular workshop. We were limited by time and tutors could not cover everything.

Mathematics INSET(*) courses are run over a period of two days with between 10 and 12 hours of actual contact with teachers. There are however, many constraints which prevent the SSC from conducting as many INSET courses as required, and over longer periods. The department can only give teachers a limited number of school days per year to attend INSET courses, otherwise there would be disruption of classes at school if teachers were to be out of class more often. The feeling of many teachers as seen above is that they would be happy to have more time to attend INSET(*) courses, and one can understand their difficulties when one looks at the number of topics in mathematics which they normally suggest should be done in the next workshop. The action committee and developers of INSET(*) have no choice but to select priority topics,

and with the number of INSET(*) courses limited to four (4) per year, it is impossible to cover all the work prescribed in the mathematics syllabus.

4.2.8 Focus on pupils

All the teachers interviewed think that the SSC can help improve the performance of pupils in mathematics in their schools through the organisation of Saturday mathematics classes for their pupils, and by giving teachers worksheets, notes and materials which could be used directly by pupils. The latter point is a very valid one, when one considers that in most INSET(*) courses the focus is on the teacher, who is a participant at the INSET programme. Handouts given at these INSET(*) courses are basically used by teachers in their teaching of the subject. However, in most black schools, because of the shortage of resources, pupils sometimes find themselves without a mathematics teacher and/or good mathematics textbooks. It becomes difficult for the pupils to learn mathematics in such situations, and this is when worksheets and notes could become useful provided that these materials are designed and presented in such a way that they contain detailed explanations, worked-out examples and a variety of exercises.

The other point stems from the fact that previously the SSC used to run Saturday mathematics classes for matriculation pupils. That programme was known as the Matriculation Examination Preparation Programme (MEPP) and was so designed to assist those pupils who were preparing for their final mathematics e amination. Revision of mostly past mathematics examination papers was done in this programme, and sometimes even reteaching of certain topics was carried out by the tutors responsible for those Saturday classes. Teachers seem to believe that the programme really helped their pupils, and should be reinstated. The programme was stopped for financial reasons and, unfortunately, without the consultation of the teachers and the communities within which the SSC was working.

The teachers also stated categorically that they would love to get follow-up support from the SSC after an INSET course. This, they said, should be in the form of tutors who should visit and help them with their actual teaching in the classroom. At the moment the SSC does not have the manpower and the financial resources to do this. But this must be seen as impinging on the effectiveness of INSET(*) courses. It seems, from the information obtained through interviews

and from the investigator's experience in INSET(*), that many teachers are now "sick and tired" of listening to the theory in an INSET course, rather they would like the tutors of the INSET to come to their scA1ools and show them in actual practice how "it should be done", i.e. the teaching of a particular section in mathematics.

4.3 AD analysis of the mathematics teacher educators• perceptions of the college mathematics curriculum

4.3.1 Introduction

In 1990 a new syllabus was implemented in black colleges of education, under the control of the Department of Education and Culture (KwaZulu). However, it must be remembered that all black colleges in South Africa get their syllabuses from the Department of Education and Training (DET), which is also responsible for the external final Secondary Teachers' Diploma (STD) examinations.

Prospective mathematics teachers who began their training last year (1990), when the new syllabus was implemented, are now in their second year of study at the colleges. In other words, prospective mathematics teachers who are in the third year of study this year (1991), are still being taught through the old syllabus. The major difference between the 'old' and the •**new**' syllabuses is that the mathematics content in the old syllabus ranges from standard 6 to matriculation school mathematics, whilst in the new syllabus, the mathematics content goes beyond the matriculation level, and almost reaches one and a half years of university mathematics.

4.3.2 Is the pre-service training of prospective mathematics teachers adequate?

All the mathematics teacher educators interviewed (4) agreed overwhelmingly that the pre-service training of mathematics teachers was far from satisfactory. **Two main reasons** were cited by the mathematics lecturers, viz.

Pirstly, they were highly critical of the quality of their intake of prospective mathematics student teachers, whom they said, in most instances, had very poor matriculation mathematics results. The investigator was informed that it was very rare to get a student at college with a D symbol in mathematics **(HG). A** typical student teacher has a matric mathematics symbol of E (40-49%) in standard grade. Such students, according to the mathematics lecturers, lack a lot of background and basics in mathematics, and lecturers are compelled to do more mathematics content in their teaching, rather than the methodology of teaching mathematics. Further, the mathematics lecturers **were** of the opinion that it was quite a tall order to expect them to train this type of student to be a competent mathematics teacher at senior secondary

schools. One of the lecturers said that the "quality of the output (product) is dependent on the quality of the input, and should the colleges become more selective, then they would end up with empty mathematics classrooms".

Secondly, the mathematics lecturers criticised the DET mathematics curriculum as inadequate and narrow. The old syllabus was perceived as undemanding on the part of the student, who didn't have to do any mathematics content beyond matriculation level. However, although this was the case, the lecturers felt that at least the weaker students were able, to some extent, to handle and follow the content in the old syllabus.

Now the new syllabus has quite a lot of post-matric work and the lecturers, though happy with this aspect, maintain that because of the lack of a good mathematical background, in students that come from schools, they (the student teachers) are having difficulties in following some of the work or content. To make matters worse, there are no recommended mathematics textbooks which deal with all the topics and/or sections that are especially 'new' *in* the syllabus. This forces the lecturers to select from various advanced maths textbooks topics such as

numerical integration, numerical methods, statistics, and so on, so as to make photocopies for their students. Consequently, it becomes difficult for them to know how deep and wide a particular topic should be treated.

The above two important points are further compounded by the standard of the external mathematics examination, which is set by the DET. All the mathematics teacher educators said that the standard of this paper is very low, and that it was not even comparable to the matric mathematics (HG) paper. This state of affairs ensures that most students pass the STD, and then go out to teach mathematics at senior secondary schools. One of the lecturers said that some pupils at matric level could easily pass the third-year STD maths paper.

Practice teaching and related problems thereof

As part of the pre-service training of prospective mathematics teachers they have to do practice teaching in the two major subjects of their choice. This spans over two weeks each year, and student teachers are expected to teach five (5) lessons in each of the two subjects.

Lecturers were however not happy with this kind of arrangement, since student teachers cannot be expected to do their best in such a short period. Various problems were mentioned by the lecturers which student teachers encounter during practice teaching:

- lack of discipline amongst pupils in schools where practice teaching is being conducted;
- lack of teaching aids in schools;
- little or no assistance from the subject teachers in the schools;
- lack of continuity in topics, which student teachers find being taught in schools when they have to start their practice teaching; and
- difficulties in handling pupils who have no background in a topic that has to be taught.

Only one lecturer said that a whole week is usually spent with student teachers discussing their problems, which they encountered during practice teaching. The other lecturers admitted that because *ot* the time factor, and the pressure to finish the work by the end

of the year, little help, if any at all, is given regarding the above-mentioned problems.

They (the lecturers) pointed out that, in most cases , they have to fill in forms, which are used to evaluate and criticise the lessons conducted by the student teachers. However, it is not possible to give immediate feedback to the student teachers since they have many other lessons (where student teachers are evaluated), that they have to attend in any one day.

4.3.3 Initiatives by mathematics teacher educators towards improving mathematics education

Although the mathematics lecturers were critical of the college curriculum and generally, the pre-service training of mathematics teachers, they all pointed out that they do their best to promote an interest in mathematics education amongst the student teachers. Lecturers from one of the colleges commented that they have, on a few occasions, invited mathematics lecturers from other colleges and universities, to come and address the students on aspects of mathematics education. In the same college, student teachers have also undertaken educational tours to other colleges and/or universities, and this , it was hoped, would assist in developing within the student teachers

motivation and more interest in matters and issues of mathematics education. However, one lecturer from another college mentioned that the majority of the mathematics student teachers are so weak in their English that they cannot read an article, let alone a mathematical article. The same lecturer said that this in itself makes it difficult for the students to follow instructions, and hence, to extract relevant information from books and journals in mathematics education for assignments and group project work.

When the mathematics teacher educators were questioned as to what major aspects of mathematics education should be included in the present curriculum, in order to 'produce' good mathematics teachers, they complained about the method course, which they perceived as unsatisfactory, since the number of periods allocated for it were inadequate to cover all the aspects of mathematics. All the mathematics lecturers hinted that the STD should be a four-year course, the first year to be used to build up the necessary confidence and background in mathematics to a level which would be satisfactory, and enable the students to cope with the present, but very demanding subject content.

Black colleges in KwaZulu do not provide any INSET

courses for practising mathematics teachers. However, three of the lecturers interviewed maintained that they do give support and assistance, on an informal basis, to mathematics teachers in the schools which fall in the immediate surrounding vicinity of the college. Some of these lecturers claimed that they have in most cases, been invited by teachers who were former students of the college, to come and help with afternoon, Saturday and winter school classes. The lecturers concerned thought that it was good to be able to give this kind of help since they, to a certain extent, keep tabs on what is happening in schools, and in the process are able to develop teaching methods which could be useful for their student teachers.

The above initiatives, as undertaken by mathematics teacher educators in the hope of improving mathematics education, though commendable, seem, however, to be done on an ad hoe basis, without direction and good planning. There is definitely a need for a co-ordinated effort among the mathematics departments of the colleges of education in KwaZulu and support from other interested organizations, if such initiatives are to have an impact on the learning and teaching of mathematics.

4.3.4 Can the SSC help in improving pupils' achievements in mathematics?

Finally, the mathematics teacher educators came up with some interesting points as to how they perceive the SSC improving the performance of pupils in mathematics:

- Saturday classes and winter schools should be revived as these give help directly to pupils;

- follow-up support should be done by the SSC to assist mathematics teachers in their situations and contexts for more effectiveness;

- the SSC should start working with primary mathematics teachers, since it is at this level where a good background in mathematics can be fostered and effected in pupils;

- notes and materials should be compiled by the SSC to assist the mathematics teachers, since most of them tend to use inadequate maths textbooks.

The above suggestions indicate a need for the SSC to reach out to the pupils who are supposed to benefit from the teacher's attendance in INSET courses. An

implicit assumption here is that most of these benefits are not passed on to the pupils for one reason or another, which has been indicated by the majority of the teachers who felt that the SSC has not yet been successful in solving their problems in the classroom. The suggestion to work with primary mathematics teachers is indicative of the mathematics lecturers' perception of the importance of numeracy and primary education in general. The SSC is seen as having the "expertise" to make some contribution toward improving the present crisis in mathematics education, and it is believed that one of the **ways** to do this is by giving assistance to primary mathematics teachers, rather than concentrating all efforts at senior secondary level.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

The following recommendations and suggestions are based on the analysis of data (in the previous chapter) consisting of comments made by INSET(*) participants, as well as mathematics teacher educators:

5.1 Limitations of the college mathematics curriculum

Both the mathematics teacher educators and the mathematics teachers interviewed, contended that the college mathematics curriculum was unsatisfactory and inadequate, as far as the mathematics content and the methodology courses were concerned.

The mathematics teacher educators also partly blamed their intake of prospective mathematics teachers, and pointed out that their matric mathematics knowledge leaves much to be desired. This evidently aggravates the teaching-learning situation at colleges, since it would be difficult for the colleges to 'produce' good and competent mathematics teachers under these circumstances.

However, the mathematics teachers maintained that by attending INSET(*) courses, in conjunction with the Action committee, which consists of mathematics teachers, the gap created by this inadequate college mathematics curriculum is, to some extent, minimised.

RECOMMENDATION

It is recommended that the SSC should continue its sponsorship of the Association of Mathematics Teacher Educators in KwaZulu (AMTEK), since it is through this channel that mathematics teacher educators can exchange informative ideas, discuss prevailing problems in mathematics education and ways of improving the college mathematics curriculum, and generally act as a unified voice and independent body with the objective of promoting an interest in mathematics teacher education.

It is also suggested that the SSC should continue in its mediator capacity of conducting INSET courses, and providing resources for senior secondary school mathematics teachers.

But these should be planned collaboratively with the teachers concerned, so as to provide them with opportunities to innovate, to show problem solving, self motivation and self confidence. These factors should, hopefully, lead towards personal growth and professional development of the mathematics teachers. The crucial point here is that bottom-up stategies for INSET are more likely to succeed, since the teacher has the ultimate and final say, whether (s)he will or will not implement any innovation in the classroom (Van den Berg, 1987).

It is further recommended that project coordinators should, as far as possible, act as facilitators in guiding the teachers in articulating specific problems that they encounter in their school contexts. The suggestions of the Action committee, the experience accumulated by staff members during a particular INSET session and from one INSET session to another, and the information obtained from the "evaluation" of a particular INSET session, should all be utilised and considered in providing mathematics teachers with a programme that will cater for their needs.

5.2 Problems with teaching methods suggested by INSET tutors

The majority of the mathematics teachers interviewed admitted that when teaching matriculants, more often than not, they are under pressure to finish the prescribed syllabus and prepare their pupils to write the final matriculation examination. This examination is the only external examination written by any pupil in his/her 12 years at school, and is consequently the most important for the pupil, as it determines the fate or future of that pupil. As a result teachers find it extremely difficult, at times, to apply in the classroom, certain teaching methods/approaches (e.g. problem solving and investigative approaches), although they do recognise that in the long term, the use of such methods would greatly benefit the pupils.

Another problem is that many mathematics teachers see mathematics as a body of rules and definitions, to be transmitted to the pupils, who then should reproduce these in tests/examinations, or whenever the knowledge is required. This "banking" concept, concerning the philosophy of

mathematical knowledge, is unlikely to change as long as the present examination system exists, which invariably dictates how the teacher delivers the subject matter in class {Ernest, 1991).

RECOMMENDATION

A good background and solid foundation in mathematics can only be effectively achieved when the pupil also contributes meaningfully his/her ideas through a constructive approach to the learning of mathematics.

Hence, it is suggested that the SSC should investigate the possibility of involving primary and/or junior secondary school mathematics teachers in the INSET(*) programme.
Investigative approaches, problem solving with the pupil creating his/her own problems, and process aspects are other **ways** of making mathematics more meaningful and accessible to the pupil. The investigator believes that these ideas can be successfully implemented at primary or junior secondary levels, where there is no undue influence of any external examination on either the pupil or the teacher.

This involvement can be gradually integrated in the overall INSET(*) programme, starting with standard 8 mathematics teachers, and then on a periodic basis (say, after 2-3 years), standard 7 mathematics teachers would follow suit. This would also allow for an evaluation of the programme, and to make refinements and improvements, where necessary.

There is also a need to make teachers aware of the nature of mathematics. A teacher's philosophy of mathematics will affect the way he/she teaches mathematics. Many -c.eachers' philosophy of mathematics involves a **view** of mathematics as a final, absolute product. They must be made aware of the fact that mathematics is a human invention, and that mathematical knowledge is continually changing and evolving, and is not a finished product (Ernest, 1991; Craig & Winter, 1991). This 'dual' nature must also be made explicit to the students.

5.3 Problems with teaching mathematics at school

Teachers interviewed mentioned that although the INSET(*) courses provide them with the knowledge or subject content they need to be able to teach with more confidence, there exist, however, problems in their school situations which INSET has not been able to solve, such as "how to mark pupils' homework exercise books", or "how to give individual attention to pupils' problems", when in each class there is an average of 76 pupils.

Although the SSC employs bottom-up strategies to INSET, by way of involving the teachers in decision-making, in determining their needs and in designing and developing an INSET programme that will cater for these needs, there is no guarantee that such an approach will always succeed. This must be seen as a major disadvantage of a school-focussed INSET strategy, as opposed to a school-based INSET strategy, whereby the teacher is given help at his/her own school context, and in most cases, the INSET is initiated by the teacher(s) within that particular school as a result of a specific need that has to be fulfilled.

RECOMMENDATION

It is therefore suggested that INSET(*) courses should be followed up with class visits where possible, by INSET(*) tutors in order to observe, and examine their effect on teachers' performance and changes in teacher behaviour. Such visits may also have three other objectives, **viz.** :

- To supplement the knowledge which teachers gained in the course;

- To refine and improve the INSET programme; and

- To **give** firsthand assistance to teachers **with** problems they encounter in their school context/situation.

5.4 Handouts

The majority of the mathematics teachers interviewed commented that the SSC INSET courses provide them with very useful handouts, which they claim to use in their teaching of mathematics in

the classroom.

However, most of these materials can only be used and understood by the teacher. This has certain limitations, since the SSC always hopes that the benefits of an INSET course will be passed on to the. pupils by the INSET participant. This 'multiplier effect• is a theoretical wish of INSET developers, but whether it happens in practice is another matter, since no school visits are done to observe any actual changes in teachers, and perhaps also in pupil behaviour.

RECOMMENDATION

It is therefore suggested that over and above school visits, there is a need to revive pupils' programmes, such as winter schools and Saturday classes, as these provide direct assistance to pupils. Failing **which**, the SSC should then design and develop notes, materials and worksheets which could be used by pupils so as to supplement the shortage or inadequacy of mathematics textbooks, resources and/or teachers.

5.5 Problems with inadequate mathematics textbooks and overlearnt rules

The mathematics textbooks used by the mathematics teacher educators at colleges, and by mathematics teachers in the schools, have been criticised as inadequate and insufficient in some of the sections/topics of mathematics.

A typical example, which tries to explain addition and subtraction of 'like' and •unlike' terms, and which appears in many mathematics textbooks used by mathematics teachers and by mathematics teacher educators (Kroeze, 1989: 91), is shown below:

> Another way of explaining the addition and subtraction of like terms is the famous story of the apples:
> 2 apples+ 3 apples= 5 apples and hence
> 2a + 3a = 5a.
> As apples and balloons cannot be added,
> 3 apples+ 2 balloons remains as it is, and
> hence Ja+ 2b = 3a + 2b.

The above explanation shows the bankruptcy of using the algebraic symbols "a" and "b" as objects, rather than as standing for numbers.

What the authors of these mathematics textbooks are overlooking is the fact that mathematical operations such as 11+ I X" and II,;_II cannot

operate on anything else but numbers. Hence, the symbols used in algebra must be seen as "standing for unknown numbers". Therefore, this implies that the algebraic expression "Ja+ 2b" can be computed once it is known which numbers are represented by "a" and "b". In other words, to say that "Ja" cannot be added to "2b", since we have the so-called "unlike terms" or because we cannot add apples to balloons is incorrect; all that can be said is that the expression "Ja + 2b" cannot be simplified further.

The confusion in the textbooks is further complicated by the use of the words "like" and "unlike" terms, which, according to the investigator, must be avoided at all costs when introducing algebra to pupils. The reason is that pupils are misled into believing and thinking that the algebraic symbols stand for objects (although they can be applied to objects), whereas in fact they represent numbers as yet unknown to the pupils.

Unfortunately, the above problems lead to an •overlearning' of incorrect rules by pupils in schools, and by prospective mathematics teachers

at colleges (Winter, 1988; Craig & Winter, 1990). This in turn creates a vicious cycle whereby the whole process of overlearning these incorrect rules is perpetuated.

RECOMMENDATION

It is suggested that INSET(*) courses should be designed so as to identify as many of such 'overlearnt' but incorrect rules as possible amongst the mathematics teachers, in order for INSET(*) to be a more effective mediator. By developing appropriate INSET worksheets, it should be possible to discover such rules and develop ways to dislodge them, and thereby remedy, to some extent, the situation (Winter, 1988; Craig & Winter, 1990). Where possible, mathematics teachers should be guided in selecting 'good' and self-sufficient mathematics textbooks.

5.6 Problems with INSETl*)

Quite a number of mathematics teachers interviewed indicated that they have had a few problems with certain aspects of INSET(*) courses, such as:

- group work in INSET courses;
- timing of INSET courses; and
- INSET courses are too short.

RECOMMENDATION

It is suggested that the SSC, as indicated earlier on, should work closely with the mathematics teachers or Action Committee, through a participatory and democratic approach. It is only through open discussion **with** the teachers that a successful programme for a particular INSET can be designed and implemented. Teachers pointed out that group work in INSET courses is very helpful in discussions and exchanging ideas; however, such groups must have a maximum of three persons. This obviously nesessitates more tutors, depending on the number of INSET participants, in order to observe and guide progress in all the groups, and to give optimal individual assistance, where it may be needed.

With respect to the issue that INSET courses are too short , it is recommended that the present

structure of INSET, which is usually conducted over a period of two days (or 10-12 hours of actual contact **with** teachers), be extended to three or four days, so that topics can be taught in sufficient depth, rather than covering too much work (which sometimes is the case) during the short time of the INSET courses. Presumably this also implies some form of negotiation with the Department of Education and Culture (KwaZulu).

CONCLUSION

As stated in the introduction to Chapter 1, INSET (*) can be regarded as an external mediator, whose primary concern is to narrow the excessively large gap which exists between what black African teachers bring to the learning-teaching situation at black schools and the demands of this situation.

Through a consideration of teachers' perceptions of INSET(*), many problems have been identified (INSET courses are too short, timing of INSET courses, group work in INSET courses, teaching methods suggested by INSET tutors, etc.). These perceptions have pointed the way to possible adjustments of INSET(*). Of primary

concern to INSET(*), revealed through the mathematics teachers' and college lecturers' perceptions of the college mathematics curriculum, is the vicious cycle created by the perpetuation of incorrect rules for doing mathematics, which is preventing teachers from teaching independently and successfully, and preventing pupils from engaging in mathematical problems effectively and autonomously (Winter, 1988; Craig & Winter, 1990; Craig & Winter, 1991). It is, therefore, the task of INSET(*) to attempt to break this cycle, by discovering these incorrect rules through the analysis of mathematical textbooks and the mathematics curriculum in black colleges of education, as well as analyzing teachers' attempts to solve mathematical problems. This analysis may allow INSET(*) to develop materials that would dislodge these taken-for-granted rules, and these materials would be of benefit both to teachers and pupils whom they teach.

It is hoped that this investigation, which focusses on teachers• perceptions of the effectiveness of INSET(*), will allow for the evolution of INSET(*) into the 'ideal' mediator, that would contribute to the narrowing of the excessively large gap, which exists between what the teachers bring to the learning-teaching situation at black schools and the demands of

this situation, by promoting more independent and successful teaching.

APPENDIX A

SEMI-FORMAL INTERVIEW SCHEDULE (MATHEMATICS TEACHERS)

1. Did the college prepare you sufficiently for the realities of the school environment? (Probe: in what way?)

2. Why do you attend INSET courses organised by the SSC?

3. In what way(s) has the INSET programme of the SSC answered your needs?

4. Describe an issue(s) in which the INSET programme of the SSC did not answer your needs.

5. There are opinions that too much work is covered during the short time of the INSET courses. What is your reaction to this? (Probe: in what way does this affect teaching of that particular topic?)

6. There are also opinions that due to the limitations of time, topics are not taught

sufficiently indepth. What is your reaction to this claim? (Probe: how does this affect teaching of that topic?)

7. Is any follow up made by tutors to your class in school after an INSET course?

8. If no to question 7 above: would such follow up be of any help to you and your pupils? (Probe: in what way, if any?)

APPENDIX B

FORMAL/STRUCTURED INTERVIEW SCHEDULE (MATHEMATICS TEACHERS)

1. In your opinion, can you give three reasons why pupils perform very badly in mathematics in your school?

2. For each reason stated above, can you suggest a possible solution?

3. Have any of the mathematics INSET courses organised by the SSC addressed any of the prob ms mentioned in response to question 1 above? (Probe: how or why not?)

4. Do you think that the SSC can help in improving the performance of pupils in mathematics in your school? (Probe: if 'Yes', how?)

5. In your teaching of mathematics do you strictly follow the work programme prescribed by the Department of Education and culture of KwaZulu?

(Probe: why?)

6. Have you ever attended a course organised by the SSC whereby the topics covered were topics you had already taught in your class?

7. If 'Yes' to question 6 above, were you happy with this INSET course? (Probe: why?)

8. If 'No' to question 6 above, in what way did that workshop help you when you had to teach that topic in your class?

9. Who is responsible for determining what topic(s) in or aspect(s) of mathematics will be dealt with in a particular INSET course?

10. Do you have any input into this process of decision-making?

11. What do you think should be the role of the teacher in the mathematics programme of the SSC?

12. Do you regularly attend mathematics INSET courses organised by the SSC? (Probe: why?)

13. Have you ever attended a mathematics INSET course organised by the Department of Education and Culture of KwaZulu?

14. If 'Yes' to question 13 above:
    14.1 What do you think are the main differences between INSET courses organised by the Department and those organised by the SSC?
    14.2 What do you think are the main similarities?

15. What kind of follow up support do you get from the SSC after attending an INSET course?

16. If 'None' to question 15 above, would you be willing to get assistance from the SSC by way of follow up school visits after an INSET course?

17. In what way would such follow up visits help you and your pupils?

18. In your opinion, do you think that the SSC INSET courses are effective or not, given the present state of black education? (Probe: in what way?)

19. some teachers say that there is a mismatch between what is taught at college and what they find in

schools. Do you believe that the college prepared you sufficiently for the realities of the school environment? (Probe: if not, how?)

20. If 'No' to question 19 above, would you say that SSC INSET courses bridge the gap created by the college curriculum? (Probe: in what way?)

21. There are also opinions that some college mathematics lecturers do not know what is happening in black schools, and it becomes necessary to adapt to the situation when one starts teaching after graduation. What is your reaction to this claim?

22. Are there any INSET courses organised by the SSC where the subject content covered goes beyond the syllabus restrictions?

23. If 'Yes' to question 22 above, in what way does this affect your teaching of that particular section to your pupils?

24. What is the largest number of pupils in any class in which you are teaching mathematics at standard 9 or 10 level?

25. What specific problems do you encounter when teaching mathematics to this group of pupils?

26. Has any SSC mathematics INSET course ever addressed the problems you have just mentioned above? (Probe: how or why not?)

27. When you suggest topics in or aspects of mathematics to be covered *in* the next workshop, have you ever suggested subject content and/or topics which have already been dealt with in a previous workshop (say, in the previous year)? (Probe: if 'Yes', why?)

28. In most courses conducted by the SSC, teachers are encouraged to work collaboratively in groups when discussing exercises and/or problems. Someone has criticised this method, saying that most of the time only one person in the group does everything, and others do not contribute anything. What is your reaction to this statement?

29. Do you encourage any group work in your mathematics class, or do you prefer to let pupils work individually for fear, for example, that they

might copy from each others' exercise workbooks?

30. On many occasions tutors in SSC INSET courses have suggested certain teaching methods, which could be used by teachers in class, so that pupils can understand and perform better in mathematics. However, teachers have indicated that some of these methods are time-consuming, and hence they cannot use them, since they might not finish the prescribed syllabus in time. What is your reaction to this statement?

31. Are you a (paid-up) member of any mathematical association or society? (Probe: if 'Yes', which one?; if not, why?)

32. Have you ever done, or are you presently doing any (further) studies in mathematics (education)?

33. Besides providing INSET programmes and resources for mathematics teachers, in what other way(s) do you think the SSC can improve mathematics education in schools?

34. Does the SSC provide any materials, worksheets or notes which could be used by your pupils?

35. If 'No' to question 34 above, do you think that these would help in improving the performance of pupils in mathematics?

APPENDIX C

AMMENDED QUESTIONS

25. Original question: What specific problems, such as using bad rules in Algebra, Trigonometry and Geometry, do you encounter when teaching mathematics to this group of pupils?

Re-worded question: What specific problems do you encounter when teaching mathematics to this group of pup-ils?

In this case the difficulty was that teachers were not able to articulate actual and specific common errors made by pupils whereby they would use non-existent rules such as that:

$(\log A)/(\log B) = \log (A - B)$, which is confused with the correct rule, viz. $\log(A/B) = \log A - \log B$.

Teachers tended to mention general problems, such as, "not being able to give individual attention to all the pupils".

32. Original question; Are you presently doing any further studies in mathematics (education)?

Ra-worded question: Have you ever done, or are you presently doing any (further) studies in mathematics (education)?

The problem with the original question, when interviews were conducted, was that there were some teachers who responded that they had before been doing some studies, although these had been discontinued at the time of the interviews.

APPENDIX D

FORMAL/STRUCTURED INTERVIEW SCHEDULE (MATHEMATICS TEACHER EDUCATORS)

1. In your opinion, are you satisfied with the pre-service training of mathematics teachers in this college?

2. Many teachers in Umlazi and KwaMashu, who are teaching mathematics at senior secondary schools, have openly criticised the college mathematics curriculum, saying that it is inadequate and generally that the college did not sufficiently train them for the realities of the school environment. ihat is your reaction to this claim?

3. Can you make a comment on the quality of your intake of prospective mathematics student teachers?

4. Do you give any kind of support to practising mathematics teachers in this area? (Probe: if yes, in what form?)

5. In what way do you promote an interest in mathematics education amongst your student teachers?

6. Which major aspects of mathematics education should be included in the present mathematics curriculum in order to 'produce' good mathematics teachers?

7. Some college mathematics lecturers believe that the standard of the DET maths examination for third-year student teachers is below average. What is your comment?

8. When student teachers do practise teaching, they more or less get a taste of what is in store for them when they commence actual teaching after graduation. What specific problems do they convey to you when they return from such practice teaching?

9. In what way do you assist your student teachers in alleviating these problems when they have to do practice teaching again, or when they have to actually go and teach after graduation?

10. The SSC is involved with mathematics teacher educators through the Association of Mathematics Teacher Educators (AMTEK), and with senior secondary school mathematics teachers through INSET. Besides this involvement, how do you see the SSC helping to improve the performance of pupils in mathematics?

APPENDIX E

ISSUES WHICH WERE PROBED, AND ALSO FOUND TO REPEAT THEMSELVES

- Inadequate college mathematics curriculum.
- Assistance in schools by the SSC is needed.
- INSET courses are too short.
- INSET is very useful since it provides materials, notes and handouts for teachers.
- No time to apply investigative teaching methods in the classroom.
- Winter schools for pupils should be reintroduced.
- Shell **(SA)** should continue sponsoring the project.
- Teachers must be involved in determining topics that will be treated in INSET courses.

- SSC INSET is much better than departmental courses.

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