THE PRE-SERVICE PREPARATION OF SECONDARY SCHOOL MATHEMATICS TEACHERS - A CASE STUDY OF CURRICULUM EFFECTIVENESS

DUMILE DENNIS MSOMI

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DECLARATION

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

D.D. MSOMI
January 1995
Durban

DEDICATION

This thesis is dedicated to my late parents,

Richard Sgekle and Lizzie Nomagqirhana.

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ABSTRACT

The quality of education in most historically black schools is a source of concern for many people. The high failure rate in mathematics in particular, is believed to result in part, from the inadequacy of the teacher preparation programs at many of the colleges of education in the country. Esikhawini College of Education in KwaZulu-Natal is one of the colleges which is involved in the preparation of secondary school mathematics teachers. The appropriateness of the mathematics curriculum of this College was the subject of the study.

In particular, the study aimed at the following :

(i) To analyse aims and philosophies underlying the prescribed mathematics curriculum of the College.

(ii) To establish the teacher educators' and student teachers' perceptions of the appropriateness of the curriculum in general.

(iii) To establish the teacher educators' and student teachers' perceptions of the mathematics curriculum content and processes.

(iv) To establish the quality of available materials used at the College for realisation of the curriculum goals.

(v) To offer proposals and recommendations for the improvement of the education of prospective secondary mathematics teachers.

Data about the perceptions of the appropriateness of the mathematics curriculum was gathered through a questionnaire which was administered to one hundred and one student teachers. The issues that arose from the questionnaire study were followed up by an interview study. The interview schedule was administered to a sample of fourteen student teachers and all six mathematics teacher educators in the College. In addition, a survey of mathematics materials available at the

College library and in the mathematics department was carried out to collect further data.

Some of the significant findings of the study were :

- Limitations in the College mathematics curriculum in as far as the curriculum content and processes were concerned.

- Inadequacy of mathematics curriculum materials that were available and used at the College.

- Low attainment in mathematics at matriculation level of most of the student teachers.

- Widespread dissatisfaction with the curriculum, especially that of Mathematics Didactics.

The implications of the findings for the College were considered. Amongst other suggestions is the suggestion that the College introduces a preliminary STD course in which prospective student teachers' mathematics background is enriched to enable them to cope with the demands of the College curriculum.

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CHAPTER 1

INTRODUCTION

1.1 The Context of the Study

The state of black education in South Africa has long been a source of concern. This concern emanates from, amongst other things the high failure rate in schools. Christie (1991 : 1) gives the following statistics about the failure rate of black pupils:

Of every 10 000 black pupils who start school in Grade 1:

only about 1 300 pass Standard 9;
only 270 go into their matric year;
of these, only 113 pass;
27 get matric exemption;
and ONE gets a matric exemption in mathematics and science!

The quality of the teaching done in black schools is questionable. Pre-service teacher education is one of the areas in which endeavours should be made to improve the quality of education in South Africa. This view is supported by the de Lange (1981 : 7) report:

> "The co-ordination of courses and standards of training merits close attention because the quality of service rendered is directly related to the quality of training."

This thesis is concerned with the quality of mathematics teacher education in particular. A number of suggestions have been made by educationists concerning the means by which the quality of pre-service teacher education can be improved in general and in mathematics in particular. The Cockcroft (1982 : 208) report recommends that the level of content knowledge in mathematics teacher training should be developed substantially beyond the level at which the students will be teaching. This view is echoed by Webb (1985,27) in his claim that mathematics teachers should essentially be mathematicians themselves. This, he contends, will enable the teachers to analyse the possibilities inherent in a mathematical situation

which their pupils are studying and to maximise their learning experience. The "Standards for Professional Development of Teachers of Mathematics", which are proposed by the American National Council of Teachers of Mathematics (cited in Billstein and Lott 1991 : 6), also emphasise the importance of content knowledge of mathematics for prospective teachers. For the mathematics teacher educator the minimum qualification, in academic mathematics, is recommended in Van den Berg's (1976 : 33) report to be an honours degree.

In view of the low attainment in school mathematics of many prospective black teacher-trainees, a question arises concerning their readiness to cope with an advanced course. Christie (1991 : 8) is strongly against beginning with the study of advanced (tertiary) mathematics at Colleges of Education at present, because the majority of students will have insufficient background knowledge to cope successfully with the work at that level.

The problem of the shortage of mathematically informed and able prospective recruits to the teaching profession is compounded by the fact that the profession offers less attractive conditions of service than industry and commerce. This problem is not peculiar to South Africa. In Turkey, for instance, out of 200 000 students who enter tertiary institutions each year, only 600 students choose to become secondary school mathematics teachers (Aydin 1990 : 475).

The selection of prospective teachers on the basis of academic aptitude only, may be educationally unsound. Commitment to teaching and concern for the welfare of children are important traits worthy of favourable consideration for entry into the profession. The de Lange (1981 : 8-9) report puts this across very clearly.

> "If teaching were an activity merely directed at the intellectual abilities of the pupil, thus recognising the child as a cognitive being, the teacher's task would be reduced to that of a distributor of knowledge who is not concerned with the development of the child into an adult. This idea is not in accordance with the view that the teacher is primarily an educationist..."

Matriculation results in particular do not seem to be a reliable predictor of tertiary success rate. A study cited in White (1982 : 93) of 1 500 black university students shows that the correlation between their university academic achievement and their

senior certificate examination results is seldom higher than 0,2 or 0,3. Research in the USA as well (also cited in White, 1982, 93) has shown that school leaving examinations have a limited predictive value. Implicit in these studies, is the fact that in spite of low achievement in school leaving examinations, it might be possible for student teachers to be trained to become effective teachers.

This raises the question of how a programme of teacher education can be designed for positive results. The suggestions to this end are many and varied. Many of them are in connection with more realistic balance in the curriculum between theory and practice. The NFER survey (1980) cited in Cockcroft (1982 : 204) reports a general wish on the part of teachers for greater emphasis on the more practical elements of the course. They felt that the relevance of education theory had not become apparent by the end of their initial training. Moodley (1985 : 6) confirms this disparity in pre-service training of mathematics teachers. He suggests handling of theory and practice as an integrated unit as one of the ways in which a course in mathematics can be made to be more meaningful. Also, Christie (1991 : 6) contends that duplication of content across subject barriers in existing professional studies courses has been a source of complaints from students for a long time. In summary, a way needs to be found to make the curriculum of prospective mathematics teachers to be more meaningful and effective.

1.2 Purpose of the Study

As a mathematics educator himself, the researcher is concerned about the high failure rate in mathematics in the country. The previous section (1.1) of this report has highlighted the fact that the quality of teaching plays an important role in the determination of success at school mathematics. Although other factors may play a role, it is the researcher's belief that teacher preparation programs offer an important point of leverage in addressing the problem.

Having spent a considerable part of his professional life as a mathematics teacher educator at Esikhawini College of Education, the researcher has formed the opinion that all may not be well with the mathematics curriculum followed at the college. The low achievement of black pupils in mathematics at matriculation level may result in part from inadequacies in the mathematics curriculum at Esikhawini and other colleges of education.

The purpose of the research is, generally, to study the appropriateness of the pre-service curriculum for secondary mathematics teacher education at Esikhawini College of Education. In specific terms the purpose of the study is:

(i) To analyse aims and philosophies underlying the prescribed mathematics curriculum of the college.

(ii) To establish the teacher educators' and student-teachers' perceptions of the appropriateness of the curriculum in general.

(iii) To establish the teacher educators' and student teachers' perceptions of the mathematics curriculum content and processes.

(iv) To establish the quality of available materials used at the college for realisation of the curriculum goals.

(v) To offer proposals and recommendations for the improvement of the education process of prospective secondary mathematics teachers.

1.3 Possible Values of the Study

The following is a list of possible values of the study:

(i) Contributing to the record of current practices in the education of prospective secondary mathematics teachers.

(ii) Bringing about a general awareness amongst teacher educators as to the state of current practice in mathematics education.

(iii) Inspiring curriculum planners to heed some of the issues raised in the study in the planning of the future curriculum.

Should the study influence any section of the mathematics education community, no matter how modestly, it will be regarded by the researcher as having been a success and a worthwhile exercise.

1.4 The Layout of the Study

The next chapter in this report (Chapter 2) will give background to the study through a review of literature.

Chapter 3 will discuss methods, techniques and instruments employed in this study.

Chapter 4 will report the results of the study.

Chapter 5 will summarise the study and offer proposals and recommendations based on the results.

1.5 Definition of Terms

Unless otherwise stated, the following terms shall be construed as shown:

College shall mean Esikhawini College of Education.

Teacher educator shall mean a person who is a teacher by profession and teaches mathematics or its didactics at the College. Teacher educator shall be used interchangeably with lecturer.

Teacher trainee shall mean a person who is following a college programme to become a secondary mathematics teacher. Teacher trainee shall be used interchangeably with student teacher.

STD shall mean a Secondary Teachers Diploma course which is followed by all prospective mathematics teachers at the College.

Matriculation shall mean the final year of school in South Africa. It is a gateway to tertiary education.

DET shall mean the Department of Education and Training, a South African government department with the responsibility of validating and certifying black teachers' training programmes.
It is in the process of being abolished, as the old, segregated departments become unified under the new dispensation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

It is generally believed that the quality of an education system is directly related to the quality of its teachers (see Luthuli,1992, 1). Thomas et al (1993) confirm this belief and emphasise the role of teacher training :

> "... while the quality of any educational system is determined by the quality of its teaching force, ultimately it is the quality of how that teaching force is trained and educated that really matters." (Thomas et al,1993,1).

Beeby (1966) postulated that an educational system in developing countries must necessarily pass through the following stages:

Stage 1 The Dame School Stage.
At this stage teachers are neither trained nor educated. Presumably the possession of a pair of soft hands was a token that the owner did not earn his living by manual labour. This was often all the qualifications a man needed to be a teacher.

Stage 2 The Stage of Formalism.
This is a stage at which the teachers are trained but poorly educated.

Stage 3 The Stage of Transition.
This is a stage at which the teachers are trained and better educated, but still lack full professional competence.

Stage 4 The Stage of Meaning.
At this stage the teachers are well trained and well educated.(Beeby,1966,58-66)

According to Beeby's teacher development scheme therefore, Stage 4 is the ultimate stage at which all teacher education programs should aim. As a result of the apartheid legacy in South Africa, it is likely that most black teachers can be

located at no higher than the Stage of Formalism. Statistics of black teacher qualifications (see Edusource 1994, 7) give testimony to this.

This chapter discusses different aspects of teacher preparation programs in mathematics education. The aspects include discussion of the ideological foundations of the curriculum, and discussion of the definition and concept of the curriculum. This is followed by a discussion of the philosophy and nature of mathematics and mathematics education. Finally, curriculum issues in the preparation of secondary mathematics teachers are discussed.

2.2 The Ideological Foundations of the Curriculum

Ernest (1991, 111) suggests that a consideration of ideology is necessary in the investigation of philosophies that underpin the mathematics curriculum. Ashley (1989, 21) concurs with this view on the importance of the examination of ideology.

> "The nature of any curriculum is clearly very heavily influenced by ideological factors, and in the case of South Africa, it displays certain characteristics which clearly had their origins in the Christian National outlook".

Concerning the meaning of 'ideology' Meighan (cited in Ernest,1991,111) sees it to mean an overall, value-rich philosophy or world-view, a broad inter-locking system of ideas and beliefs. On the other hand Marxism views education ideologies in particular, as beliefs and theories about education which serve to obscure the nature of social reality from pupils, parents and teachers, and serve the interests of the ruling class (Ashley,1989,2). It is clear that central to the definition of 'ideology' are values and belief systems held by particular groups. Ashley (1989, 2) argues that formal schooling, as an important component of education is profoundly affected by ideological considerations.

For South Africa in particular, Christie (1991, 7) observes that Christian National Education (CNE) has been the official ideological position of Afrikaner Nationalists and has been an educational expression of apartheid since 1948.

Consequently the ideology has had a very important impact on different aspects of the curriculum, including syllabus determination and text-book prescriptions.

Ernest's (1991) and Christie's (1991) views on ideology as central to curriculum design in education are corroborated by some of the speeches of Afrikaner Nationalist leaders. One such is reported to have said::

> "[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..." (J.N. Le Roux, quoted in Molteno,1984,66).

On mathematics education in particular Dr H.F.Verwoerd during his term as Minister of Native Education had the following to say:

> "What is the use of teaching the Bantu child mathematics when it cannot use it in practice? This is quite absurd" (cited in Financial Mail,1990).

The recently released Draft White Paper acknowledges ideological manipulation of education in South Africa, which used education as an istrument of propaganda and indoctrination by the State (see Draft White Paper, 1994, 9). In addition, the Paper charges that the State's official policies on examinations and teaching methods have encouraged memorisation of large amounts of information and discouraged teachers and students from developing their initiative or critical thinking.

2.3 The Curriculum - A Problem of Definition

Examining the literature on the definition of curriculum reveals a wide variety of conceptions. The conceptions range from the notion of curriculum as syllabus, to wider more all embracing notions. On these notions, Young in Luthuli (1991,1) is reported as saying:

> "There is widespread tendency in South Africa to equate 'syllabus' with 'curriculum'. The latter, if understood at all, is invested with abstract connotation, the preserve of theorists, while syllabus, a prescriptive inventory of items taught to meet annual examination deadline, is dominant to the exclusion of all else" (Young,1986).

Tunmer (1981,30), for instance, conceives of a curriculum as "...the range of compulsory and optional activities formally planned by a school". Hawes cautions against this conception of the curriculum (Buckland,1982,170). He suggests that the syllabus is only one of a number of instruments which express the official curriculum. Buckland (1982,167) is more forthright with his criticism of Tunmer's conception of a curriculum. He criticises it on the grounds that it ignores sociological and ideological dimensions of the curriculum and professes the notion that it is based on a set of universally valid realms of meaning or selection of subjects. Instead of Tunmer's conception, Buckland (1982, 167) proposes the following notion which in his own admission, is not as tidy as most definitions:

> "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" (Buckland, 1982, 167).

Giroux and Denna (cited in Salmon and Woods, 1991, 55) concur with Buckland in advocating a broad view of the notion of curriculum. They believe that sociopolitical forces strongly influence the day-to-day classroom pedagogical practices.

Luthuli (1991) offers a more pragmatic view of curriculum:

> "... any working definition of the curriculum must offer much more than a statement about knowledge content and course activities. It must go beyond activities or experiences that knowledge is likely to have, or is intended to have, on its recipients. Furthermore, the curriculum should embody statements of methods through which its aims are most likely to be achieved and lastly a means by which the programme and its participants can be assessed" (Luthuli, 1991, 62).

Fey (1980, 393) offers a simple but useful view of the notion of the curriculum. In his view the curriculum comprises of three aspects:

i) The selection and structure of ideas;

ii) The presentation of the ideas to students, and

(iii) The evaluation of program effectiveness and student achievement.

Similarly Howson et al. (1981, 2) believe that the curriculum should have the following aspects:

aims
content
methods
evaluation procedures.

Although the literature discussed above offers valuable insights into the conception of the cuurriculum, it does not reveal the 'hidden' element of the curriculum. This element is not explicit in the design of the curriculum but is crucial for a meaningful analysis. The hidden curriculum plays an important role in the total experience of the learner as the formal curriculum does. For this reason it needs to be taken into consideration in any discussion of the concept of a curriculum.

2.3.1 Concepts related to Curricula

The Mathematical Sciences Education Board of America (1990) notes that a number of curricula are communicated in discussions on the curriculum. The curricula are:

An Expected curriculum.
This type of curriculum represents future needs of employers and the discipline.

An Available curriculum.
This is the curriculum that can be taught with existing teaching materials and currently trained teachers.

An Adopted curriculum.
This is the curriculum that authorities say should be taught.

An Implemented curriculum.
This is the curriculum that teachers actually teach.

An Assessed curriculum
This is the tested curriculum.

An Achieved curriculum.
This is the curriculum that learners actually master.

(MSEB,1990,35).

Another important type of curriculum is the hidden curriculum. This is a covert curriculum which is not communicated explicitly by the curriculum developers. One example of the hidden curriculum is provided by Salmon and Woods (1991, 55) in their study of the Colleges of Education. They cite the organisational nature of the colleges, the structure of the syllabus, its implementation and teaching styles as socialising staff and students to internalise values which stress a passive respect for authority, compliance and conformity. Eggleston gives another interesting example of the functioning of the hidden curriculum (Buckland,1982,168). He argues 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. This helps them to acquire a suitable respect for those who can, such as the teacher and the more able pupils possibly destined for superior occupational status.

Understanding of the different types of curricula, helps to uncover a number of myths such as that of 'national curriculum'. This is a myth in that it depends upon individual teachers and students, their understanding and interpretation of aims and texts (see Howson, et al.,1981,2).

Eggleston in Tunmer (1981, 38) suggests variables that come into operation in curriculum development. The different curricula according to the variables are:

Traditional or futuristic

The traditional curriculum is characterised by the retention of long established curricular patterns, whereas a futuristic curriculum constantly changes to meet changing interpretations of relevance.

Determined or Innovatory

A determined curriculum is coherent and rational, with traditional subject divisions, whereas an innovatory one stresses integrative approaches towards knowledge. Themes and problems are initially raised by the learner and explored in directions determined by spontaneous questions as they arise.

Commitment-based or Contract-based

A commitment-based curriculum sees the pupils accepting, without question, a view of knowledge to which they must aspire. This is done through appropriate instruction. A contract-based curriculum is one that is open to negotiation. The negotiating parties may be the teacher and the pupils.

Consequential or causal decisions

A curriculum based on consequential decisions is made on the assumption that it reflects society as seen by the small number of curriculum designers. A curriculum based on causal decisions is based on the assumption that schooling can change social structure. (Eggleston cited in Tunmer,1981,38)

Each pair of variables, e.g. 'traditional', 'futuristic', that are suggested above by Eggleston represents extreme cases of the process of curriculum development. The left-hand variable of each pair implies curriculum development in a traditional and less progressive manner than the right-hand variable of each pair.

2.4 Aims and Philosophies of Mathematics and Mathematics Education

> "One's conception of what mathematics is affects how it should be presented. One's manner of presenting it is an indication of what

> one believes to be most essential in it ... the issue, then is not, What is the best way to teach? But, What is mathematics really all about?" (Hersh in Thompson, 1992, 127).

The above quotation illustrates the need for examining conceptions of mathematics, in understanding how mathematics is taught.

Discussion on the aims of mathematics and mathematics education inevitably involves discussion of the broader aims of education. Because mathematics and mathematics education on the one hand and education on the other are so closely knit, it becomes useful to discuss briefly the broader aims of education.

Hirst (cited in Ernest) conceptualises the aims of education in technical and normative terms. He sees them as a means to rational curriculum design and as a means of specifying what the curriculum should be (Ernest,1991,121).

Carr and Kemmis (1986, 77) see educational means and ends as inseparable. They see the aims of education as expressions of the values which can be bestowed on or withheld from the learners by the educational process.

Ernest (1991, 123) emphasises the social perspective in the consideration of the aims of education. He believes that the aims of education are not universally shared by all persons or groups. He sees different social groups having different educational aims which relate to their underlying ideologies.

Ernest's view that the aims of education may not be shared by all groups in society is exemplified by the education system in South Africa. On the one hand, Bantu Education was believed by the ruling Afrikaner nationalists to be a means of subjugating the African masses and on the other hand, it was believed by the African people to be a means of emancipating themselves.

2.4.1 Aims of Mathematics Education

Ernest (1991, 124) believes that the aims of mathematics education are the intentions that underlie it and represent one component of the general aims of education. The Mathematical Sciences Education Board (1990,7) suggests that

mathematics is taught to reflect the diverse roles that it plays in society. Some of the aims they suggest are:

- To help individuals solve problems of everyday life (practical goal).
- To enable citizens to participate intelligently in civic affairs (civic goal).
- To prepare students for jobs, vocations or professions (professional goal).
- To impart a major element of human culture (cultural goal).

The civic goal includes satisfying the need for society to understand data presented in a variety of formats, e.g. percentages, graphs, charts, tables and statistical analyses. Such data is commonly used to influence societal decisions (Ibid, 8).

The professional goal relates to mathematics being increasingly used in other disciplines and in technology. The increase in the number and variety of problems, calculators and computers, for instance, have significantly increased the need for mathematical knowledge (Ibid, 8).

In addition to the above aims of teaching mathematics, Cockcroft (1982, 2) believes that mathematics provides a means of communicating information concisely and unambiguously through symbolic notation. However, it is regretted that this power of mathematics is also the source of difficulty for most people.

The report by Her Majesty's Inspectorate (1985) also suggests the following aims of teaching mathematics (Ernest,1991,124):

- Mastery and appreciation of mathematics as an essential element of communication.
- Development of appreciation of the structural relationships within mathematics.
- Development of personal qualities of working in a systematic way.

Ernest (1991, 124) criticizes these aims, as put forward by the HMI, on the basis of their assumption that the aims are not controversial or problematic and are universal. He believes that different social groups will have different aims of teaching mathematics and the aims cannot be universal.

2.4.2 Philosophies of Mathematics

The question around the aims of teaching mathematics is closely related to the philosophy underlying mathematics and its teaching. It is through the understanding of one's personal philosophy of mathematics that one is able to clarify the aims of teaching mathematics.

The Perry Theory has been used by a number of researchers as a framework into which different philosophies and sets of values can be fitted (see Ernest,1991,112 and Thomas et al., 1993,132). This is a psychological theory concerning the development of individuals according to different epistemological and ethical positions. The theory describes a number of levels of development of personal philosophies about mathematics. Below, is a brief description of these levels (Ernest,1991,113):

Dualistic view

The dualistic view of mathematics regards it as concerned with facts, rules, correct procedures and simple truths. Mathematics is seen as fixed and exact with a unique structure. Doing mathematics is following set rules.

Multiplistic view

This perspective also views mathematics as an unquestioned set of facts, rules and methods. It does not, however, perceive the choices and uses to be absolutely determined by authority. It accepts plurality of answers according to the belief-holders' preference, or on pragmatic and expedient grounds.

Relativistic view

This view acknowledges multiple answers and approaches to mathematical problems, the evaluation of which depends on the mathematical system or its overall content. Mathematical knowledge is understood to depend on the mathematical system or frame adopted.

Skemp (1978) proposed a different view to the nature of mathematics which he calls 'instrumental mathematics' and 'relational mathematics' (Thompson,1992,133).

Instrumental knowledge of mathematics is knowledge of a set of 'fixed plans' for performing mathematical tasks. A characteristic of these plans is that they prescribe a step-by-step procedure to be followed in performing a given task, with each step determining the next.

On the other hand, relational knowledge of mathematics is characterised by the possession of conceptual structures that enable the possessor to construct several plans for performing a given task.

A similar analysis of the philosophies of mathematics is provided by Ernest (Ibid, 132). Three views of the nature of mathematics are:

The Problem Solving View

Mathematics is conceptualised as a continually expanding field of human creation and invention in which patterns are generated and then distilled into knowledge. The implication of this view is that mathematics is a process of enquiry, and not a finished product.

Platonist View

This view, in contrast with the problem solving view, sees mathematics as a static but unified body of knowledge, a crystalline realm of connected structures bound together by logic and meaning. One implication is that mathematics is discovered but not created.

Instrumentalist View

This view of mathematics links with the view identified by Skemp (1978) above. To explain this view Ernest (1991) uses the metaphor of a bag of tools which can be used by trained artisans skilfully in the pursuance of some external end. The bag is made up of an accumulation of facts, rules and procedures. Thus mathematics according to this view is a set of unrelated but utilitarian rules and facts.

Hersh (1986) believes that mathematics deals essentially with ideas, and not pencil marks or chalk marks (Thompson,1993,127). Mathematical knowledge, according to Hersh, is created or invented by human beings. This creation is not arbitrary but arises from activity with already existing mathematical objects, and from the needs of science and daily life.

This discussion of the nature of mathematics would be incomplete if the view of the Mathematical Science Education Board (1990) was not given:

> "As biology is science of living organisms and physical science is a science of matter and energy, so mathematics is a science of patterns ... as a science of patterns, mathematics is a model of inquiry that reveals fundamental truth about the order of our world" (MSEB,1990, 11).

The views on the nature of mathematics that are discussed above show that there is no consensus on what mathematics is or should be. This lack of consensus has implications for the approaches used in the teaching of the subject, as will be shown in the next sections.

2.5 The Teaching and Learning of Mathematics

> "The conception of mathematics held by the teacher has a strong impact on the way in which mathematics is approached in the classroom. A teacher who has a formalist philosophy will present content in a structural format, calling on set theoretical language and conceptions - such a formalist approach may be a good retreat for the individual who does not understand the material well

enough to provide an insightful constructive viewpoint". (Dossey,1992,42)

The above quotation indicates clearly the relationship between a teacher's view of mathematics and its teaching. In addition, it challenges the formalist or traditional approach to the teaching of mathematics. A study by Cooney (1985) on the same relationship also shows the same results (see Dossey,1992,43).

The teaching of mathematics can be broadly classified into traditional or instrumental approaches and process models. Luthuli (1992,3) sees the traditional model for teaching mathematics as an approach which views mathematics as a body of concepts rules and structures. On the other hand, he sees the process model as being an approach that views mathematics as an activity involving creative investigations, discovery and problem solving. Before the discussion of these broad models and their implications for teaching mathematics, it is useful to give models identified by Kuhn and Ball (1986) in Thompson (1992, 136). These are:

- The learner focused model, in which teaching focuses on the learner's personal construction of mathematical knowledge. This approach is similar to the constructivist view of teaching.

- The content-focused model, in which mathematics teaching is driven by the content but great emphasis lies on conceptual understanding.

- The content-focused model, with emphasis on student performance. This model emphasises mastery of mathematical rules and procedure.

- The classroom focussed model, in which mathematics teaching relies on knowledge about effective classroom management. The implication of this view is that classroom activity must be well structured and organised (Thompson,1992, 136).

2.5.1 The Traditional Model of Teaching Mathematics

The model adopts a formalist or an instrumentalist view of teaching mathematics (Luthuli,1992,3). In this view the content is organised according to a hierarchy of skills and concepts and is presented sequentially to students following a pre-assessment of students' mastery of pre-requisite skills. This view concurs with the content focused model with emphasis on student performance recognised by Kuhn and Ball (1985) (see Thompson,1993,136). They assert that the model is based on premises like:

- Rules are the basic building blocks of all mathematical knowledge.
- Knowledge of mathematics is being able to get answers and do problems using the rules that have been learned.
- It is not necessary to understand the source or reason for student errors; instead, instruction on the correct way to do things will result in appropriate learning.
- In school, knowing mathematics means being able to demonstrate mastery of the skills described by instructional objectives.

This model is criticised by a number of mathematics educators. In the criticism of the traditional practice in South African schools, MASA (1988) notes:

> "the present curriculum seems dominated by content objectives in which knowledge of mathematical content becomes an end in itself, instead of a means through which wider understanding can develop" and also that this practice "tends to result in mathematics learning being reduced to the study of finished products of mathematical activity" (MASA,1988).

Stripp (1991,27) also criticises this model of teaching mathematics on the basis of its tendency of creating a strong division between the 'mathematical world' and the 'real world'.

Other criticisms of this model are provided by Thompson (1992, 136). These are based on studies conducted by Schoenfield (1985) which document that students who perform adequately on traditional tasks often have impoverished conceptions and significant misunderstandings of the mathematical ideas in those tasks. Also their performance on computational tasks cannot be viewed as evidence of their knowledge or lack of it, in mathematics. Furthermore, the model fails to involve the students in the process of exploring and investigating ideas. This may misrepresent mathematics to students.

Ernest (1991, 148) identifies the traditional approach to the teaching of mathematics with the ideology of a social group which he calls the industrial trainer group. The industrial trainer group with its dualist ideology, sees teaching as an authoritarian task involving strict discipline and transmission of knowledge as a stream of acts to be learned and applied. Thus, the view of teaching is that of rote learning, memorization and the practice of skills.

A number of reports are advocating a movement away from the traditional model of teaching mathematics. The Australian Speedy Report recommends a change away from the 'chalk and talk' method of teaching which is characteristic of this model (Crawford et al.,1993, 111). The Mathematical Sciences Education Board also advocates a similar view (MSEB,1990,39).

2.5.2 The Information Processing Model

The following paragraph by the Mathematical Association of Southern Africa (1988) (now absorbed into the new Association for Mathematics Education of South Africa) is worth quoting in full in its reference to the strategy of teaching mathematics.

> "The mathematics curriculum should be organised around mathematical concepts and processes. The mathematical concepts are those which pupils will be required to construct or discover for themselves through guided learning ... the mathematical processes should be chosen because of their importance in enhancing the individual's ability to be actively and productively involved in learning" (cited from Luthuli,1992,4)

The ideas expressed by MASA are in agreement with the approaches advocated by Cockcroft (1982) for the teaching and learning of mathematics. Amongst other things he suggests that every lesson in mathematics should include discussion between the teacher and pupils and between pupils themselves. Cockcroft also suggests that in each mathematics lesson, opportunities should be given for pupils to be engaged in problem-solving and investigations (Cockcroft,1982,71).

For the strategy advocated above, the Mathematical Sciences Education Board (1990,40) uses the metaphor of the teacher as an intellectual coach who acts as a:

- Role model - by demonstrating not just the right way, but also the false starts and higher order thinking skills that lead to the solution of a problem.

- Consultant - who helps individuals, small groups or the whole class to decide if their work is keeping to the subject and making reasonable progress.

- Moderator - who poses questions to consider but leaves much of the decision making to the class.

- Interlocutor - who supports students during class presentation and encourages them to reflect on their activities.

- Questioner - who challenges students to ensure that what they are doing is reasonable and purposeful, and that they can defend their conclusions.

(MSEB,1990,40)

It is the researcher's belief that a classroom in which such an environment of learning mathematics prevails, is likely to engender in students a view of mathematics different from the typical rule and procedure method. Moreover, it directs the teaching process away from rote learnng of facts.

2.5.2.1 Problem Solving and Investigations

> "The ability to solve problems is at the heart of mathematics. Mathematics is only `useful' to the extent to which it can be applied to a particular situation and it is the ability to apply mathematics to a variety of situations which we give the name problem-solving" (Cockcroft,1982,73).

The quotation reflects what recent research in mathematics education advocates (see MASA, Luthuli, etc). Ernest (1991, 283) suggests that the following elements should be included in the teaching and learning of mathematics:

- It should be centrally concerned with human mathematical problem posing and solving.
- Inquiry and investigations should occupy a central place.
- It should be explicitly admitted that mathematics is a changing human construction and thus fallible.
- The pedagogy employed should be process and inquiry focused.

The process here is viewed as unprescriptive to a unique answer, if at all.

In the discussion of the concept of problem solving an important question to ask is: What is a problem in mathematics? Concerning the meaning of a problem solving process, Polya (cited in Ernest, 1991, 285) uses the metaphor of trail-blazing to a desired location.

> "To solve a problem is to find a way where no way is known. Off hand, to find a way out of a difficulty ... to attain a desired end that is not immediately attainable, by appropriate means" (Ernest,1991,285).

Polya's conception of a problem concurs with Lester's in Ernest (1991, 287). Lester believes that a problem is a situation in which an individual or a group is

called upon to perform a task for which there is no readily accessible algorithm which determines completely the method of solution.

On the other hand the concept of an investigation and its processes seems to differ from that of problem-solving. Ernest (1991, 287) conceives of an investigation as an exploration of a question which may generate new situations for further exploration. The emphasis in investigation is to explore a piece of mathematics in all directions and `the journey and not the destination is the goal' (Pierie in Ernest, 285).

A useful way of differentiating between the concepts of problem solving and investigation is given by Hini (see Ernest,1991,295). The difference is that the problem-solving process is convergent whilst that of investigation is divergent.

It is worth noting that although the problem solving and investigatory approaches to teaching mathematics are well advocated by thinkers in mathematics education, the approaches are sometimes rejected by some social groups (Ernest,1991,287). The rejection centres around the preferred conception of school mathematics as being content orientated. The belief is that the central function of school mathematics should be equipping pupils with mathematics skills. Also the problem solving and investigatory approaches are believed to be too time consuming.

Notwithstanding the reasons for the rejection of the inquiry based approaches discussed above, it is informative to hear students' perceptions on the impression that these approaches make. In their research Lappan et al. (1991) report the perceptions of a student on the difference between traditional and inquiry approaches :

> "In a shameful mathematics classroom there are a set of rules and if you get a wrong answer it leads to shame, in a playful mathematics classroom there are a set of guidelines and if you get a different answer, it leads to conversation" (Breen,1991,14).

2.6 The Curriculum for the Pre-Service Education of Mathematics Teachers

The NEPI document (1992,1) notes that there is widespread dissatisfaction with the courses currently taught at the majority of teacher education institutions in South Africa, especially at the colleges of education. The dissatisfaction is believed to emanate from the syllabi which stress content and emphasise rote memorisation of facts. The situation is further exacerbated by the permeation of the teacher education curriculum by the educational philosophy of fundamental pedagogics. NEPI (1992) makes another point about the type of philosophy that underpins the teacher training programs at the institutions :

> "Fundamental Pedagogics still dominates teacher education theory in South Africa and its debilitating effects are everywhere apparent. The pretension to scientific objectivity of Fundamental Pedagogics, together with the way in which it is taught, prevent teachers from developing an understanding of the relationship between education and the content in which knowledge and understanding are created and shared. [It] is intellectually harmful in that it neutralises and depoliticises educational discourse and does not provide students and teachers with the concepts necessary to assess its claims about education" (NEPI,1992, 17).

The ANC Policy Framework for Education and Training (1994, 49), also expresses similar criticism about the philosophy of fundamental pedagogics underlying teacher education in South Africa.

2.6.1 Some Issues in the Curriculum

A basic problem of the curriculum for teacher education in mathematics seems to be: what kind of knowledge should a newly qualified teacher be equipped with on emerging from the preparation course? Some recommendations to this end are made by Cockcroft (1982). He sees the broad aims of teacher education as :

- Developing knowledge and mastery of mathematics substantially beyond the level at which they will be teaching.

- Developing enjoyment of mathematics and inculcating confidence in its application.

- Providing historical perspective of mathematics.

- Providing an appreciation of the relationship between mathematics and other fields of study and application.

- Developing the ability to communicate mathematical ideas both orally and in writing.

(Cockcroft, 1982, 195)

In respect of a teacher's mathematical knowledge, Freudenthal (see Luthuli, 1992, 2) is in agreement with Cockcroft that it is wrong if a teacher does not 'look down' on the subject matter, for if he knows no vantage point from which to view his subject, he is likely to extol it to the skies, making creed of it.

Bishop, et al. (1983, 39) have a different view on the requisite mathematics background of prospective teachers. They believe that strong academic training may detract teacher trainees from the professional aspect of initial teacher training through less emphasis of the methodology aspect.

Provision of historical perspective to mathematics education has been recommended by a number of authors (e.g., Fauvel (1991), Cockcroft (1982)). The following are some of the reasons that have been advanced for using history in mathematics education:

- It gives mathematics a human face.

- Showing pupils how concepts have developed helps their understanding.

- It changes pupils' perceptions of mathematics.

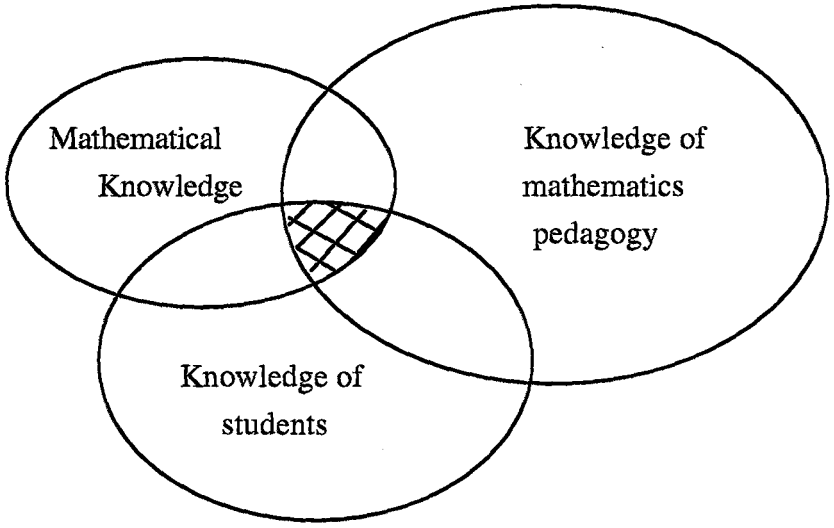
- It helps to develop a multicultural approach to mathematics.

- It makes mathematics less frightening to students.

Luthuli (1992, 6) suggests a number of topic themes that he feels should form part of an initial teacher training program in mathematics. Amongst others he suggests;

The nature of mathematics
Problems and investigations
Technology in the Classroom
Learning theories
Assessment of student and teacher performance.

On a broader basis, Lappan et al. (1994, 253) presents a framework for a training program for mathematics teachers in the following way:



The shaded portion shows the intersection of all three domains of knowledge in which a teacher works and helps to emphasize that there should be a continuous interplay between them and they should not be presented in isolation from one another.

2.6.2 Changing Student Teachers' Views on Mathematics and Mathematics Teaching

It can be deduced from the previous sections on the teaching of mathematics that teachers' beliefs and perceptions of mathematics influence, in no small way, what they do in the classroom. The question that arises from this fact is to what extent can the teacher training program succeed in changing prospective teachers' views of mathematics. Wilson (1994, 370) agrees with this point of view. He believes that a significant component of a training program should encourage teachers to reflect on their own views of mathematics and mathematics teaching.

Crawford, et al.(1993, 114) also echo the same view with respect to the importance of prospective teachers' reflection on their views of teaching mathematics. They suggest that it is only then that student-teachers will begin to develop an effective professional rationale that leads them to develop teaching practices consistent with the current educational theories and practices.

However, attempts at changing prospective teachers' deep held beliefs about mathematics and mathematics teaching have not always been successful. One such failed attempt is reported by Wilson (1994, 367), in a case study of Molly, a prospective mathematics teacher. She went through an intensive course on the application of problem solving approaches to teaching mathematics. At the end of the course her views on the nature of mathematics and its teaching remained largely unchanged and narrow. A similar one-year course on the use of an inquiry-based way of teaching mathematics was conducted by the same researcher, for pre-service students. It made very little impact on changing their practice. Despite the student-teachers' extensive discussion of children's mathematical development they retained their instrumental view of knowledge and teaching.

2.6.3 Teaching Practice

Teaching practice is believed by many authors to be one of the most important aspects of the teacher-training curriculum (see Salmon et al.,1991,59). It is important in that it exposes the teacher trainees to the reality of their chosen profession and provides opportunities for relating theory to practice.

In a South African study carried out by Salmon and Woods (1991, 69) students were asked to comment on the usefulness of teaching practice during their training. Most students felt that it was useful and had the potential of improving a student-teacher's confidence and leadership skills. In addition teaching practice could afford them chances of putting theory into practice and gaining insight into the demands of their chosen vocation. But most students felt that there were quite a number of problems with the actual organisation of teaching practices in their colleges.

One of the problems had to do with practical classroom difficulties, like managing a class of about 130 students and using a language they are not familiar with. Another problem concerned the hostility of teachers in the schools in which teaching practice was done. This hostility involved undermining student teachers' 27abilities and sometimes malicious interference in their lessons (Salmon et al.,1991,70).

Cockcroft (1982, 210) recommends that to overcome such problems as reported above, the staff of schools which receive students and the staff of the training institutions should act together in a well-defined and mutually supportive partnership. Other recommendations for overcoming the problem of animosity of teachers in schools were the extension of teaching practice sessions or re-arrangement of sessions so that students had practical experience regularly rather than in sporadic time blocks. Also overall organisation with more contact between lecturers and teachers was perceived to be one way of addressing the problem (Salmon, et al.,1991,71).

On the overall realisation of the goals of teaching practice most respondents in Salmon's study felt that the success in this regard was very limited. Lecturers, in particular, felt that students were not adequately prepared for the real situation in the classroom. They concurred with student teachers that methods used at college were often impractical and artificial when confronted with the classroom environment (Salmon, et al.,1991,76). On their part students noticed the discrepancy when staff members instructed them to use many classroom methods while they themselves were the epitome of chalk and talk pedagogue, and very rarely conducted demonstration lessons for the students (Ibid, 76).

2.7 Teacher Educators - Their Role in the Quest for Quality

> "Teacher educators have seldom been in a position to effect policy but have a crucial role in affecting it"
>
> (Thomas et al.,1993,1).

The above quotation from Thomas et al. (1993) highlights the importance of teacher educators in the preparation of prospective teachers and in the ultimate aim of improving their professionalism and self esteem.

An important question in the discussion of the role of a teacher educator in mathematics is, what makes a good teacher educator? Lappan et al. (1994, 255) suggests that not only do good mathematics teacher educators need to model good teaching, but they must also give explicit attention to the relationship between teachers' mathematical knowledge and teachers' knowledge of mathematics pedagogy and students.

The question of what makes a good teacher educator raises the question of the need for professional development of teacher educators. On this issue Thomas, et al. (1994, 8) say :

> "There is a serious need to recognize the fact, that, as there are `novice teachers' there are also novice `teacher educators' and that trainee programmes for teacher educators are necessary".

Preceding the actual training of the teacher educator Thomas, et al. (1994, 9) identify proper recruitment as imperative in the process of training. They believe that it should take into account the candidate's potential, love for teaching and experience in teaching at primary or secondary schools, depending on the type of college. The issue of academic qualification being more valued than relevant, and lack of successful experience in the field, is criticized by the authors. Salmon, et al. (1991, 8) found a similar pattern in the colleges of education that they studied with only 54% of teacher educators having more than five years' experience in teaching and as high as 12% with no experience of teaching at all.

The following are some of the areas suggested by Thomas et al.(1994, 14) for the training of teacher educators:

- Content of teaching subjects
- Pedagogical skills
- Supervision and monitoring
- Self-evaluation and reflection
- Assessment
- Basic research skills

Salmon and Woods (1991, 96) agree with Thomas's suggestion that if teachers and teacher-educators are to be seen as professionals, they need to maintain an interest in their work by reference to both research and curriculum development research. By virtue of their location, the college lecturers are ideally placed to expand understanding of the processes and practices of teacher education and its relationship to schooling. Regrettably, Salmon et al (1991, 97) found that few teacher educators read journals and other publications except for those that are supplied by the Department of Education.

2.8 Conclusion

The chapter discussed many factors which need to be taken into consideration in the improvement of the quality of mathematics education. The effect of ideology underpinning the curriculum was considered as a broad framework for the analysis of the aims and philosophy of mathematics and its teaching. What emerged from this consideration was that the teacher's conception of mathematics greatly influences his/her teaching of the subject.

In addition to the consideration of the philosophy of mathematics and its teaching, the traditional and modern approaches of teaching mathematics were examined and

contrasted. The research which was consulted indicated that, in general, the traditional approach fails to develop a broad and meaningful understanding of concepts in mathematics. On the other hand, problem solving and investigatory approaches were shown to create opportunities for the development of deeper and more meaningful understanding of the concepts.

The chapter also examines the important issues in the pre-service preparation of mathematics teachers and ways of improving the curriculum. The student teachers' perceptions of mathematics is found to be an area particularly worthy of consideration in designing the preparation program. Other issues which are suggested by research for the effective preparation of mathematics teachers, are also discussed.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

There are a variety of general approaches used for conducting educational research. These approaches include experimental, historical, action research, surveys and case study methods. Each of the methods has its own strengths and weaknesses, depending on the problem under study.

Bell (1993, 6) has the following to say about the methods of conducting research:

> "Different styles, traditions or approaches use different methods of collecting data, but no approach prescribes nor automatically rejects any particular method. Quantitative researchers collect facts and study the relationship of one set of facts to another.... Researchers adopting a qualitative perspective are more concerned to understand individuals' perception of the world. They seek insight rather than statistical analysis."

The two research perspectives mentioned above also differ in terms of their forms of measurement. Qualitative researchers use scientific techniques. Quantitative researchers question this approach to measurement especially when dealing with human beings.

In view of the fact that this study is concerned with people's perceptions of the appropriateness of the curriculum it was decided that a case-study method would be the most suitable method of collecting data. On what specifically a case-study is, Van Dalen (1979, 294) has the following to say:

> "A case study may be difficult to define because it is not a specific technique but rather a method of organising data for the purpose of analyzing the life of a social unit. One gathers pertinent data about the present status, past experiences and environmental forces that contribute to the individuality and behaviour of the unit."

The case-study method was also chosen because it enabled the researcher to make an intensive and exhaustive study of factors and processes which are at work in the implementation of the mathematics curriculum at a College of Education.

3.2 Description of Subjects

The subjects under study were the student-teachers and teacher-educators at Esikhawini College of Education. The College is situated on the north coast of the KwaZulu-Natal region. The College has been involved in the preparation of secondary school teachers since 1983. At the end of three years of successful training the student-teachers receive a Secondary Teachers' Diploma (STD) which qualifies them to teach from standard 6 to standard 10. The curriculum that is followed by the College is prescribed and validated by the Department of Education and Training. This is one of the numerous education departments in South Africa which are soon to be amalgamated under one education department.

Currently the College enrolment stands at about seven hundred student-teachers. Of these only about one hundred and seventy have elected to be trained to become secondary school mathematics teachers. These are the students who were the subjects of investigation for this study.

The professional staff at the College number at present sixty three. Of these only six are involved in the teaching of mathematics and mathematics education. The six teacher educators were also subjects of this investigation.

3.3 Questionnaires as Tools of Research

According to Wiersma (1980, 142), the questionnaire is a list of questions or statements to which the individual is asked to respond in writing, with the possible responses ranging from a checkmark to an extensive written statement. This is a very widely used tool for collecting research data. One of the reasons for its popularity is that the adminstration of the questionnaire can be cost effective in terms of time. Also when compared with the interview, it permits the respondents

to remain anonymous when they answer, and it can reach an extensive number of respondents (see Cohen and Manion, 1980, 308).

Questionnaires have a number of limitations as tools for research. In postal questionnaires, for instance, the number of returns is generally very low (Bell, 1993, 85). The reliability and validity of the study are thus challenged. Other limitations of the questionnaire as a data collecting instrument are the difficulty of probing and the emphasis on writing skills on the part of both the researcher and the respondent (Cohen and Manion,1980,308).

For the present study the questionnaires were presented personally to the respondents. This mode of presentation was chosen because it offered an opportunity for the researcher to explain the purpose of the study, clarify points, answer questions and motivate respondents to answer questions carefully and truthfully (see Van Dalen, 153).

Another factor for the researcher choosing to present the questionnaire personally, was that the students had been on strike during the previous weeks. Most of their grievances were founded in the teaching styles of some of their lecturers. The face-to-face encounter helped the researcher to dispel any suspicion about the purpose of the study and to allay their fears about the possibility of their victimisation on account of their honest responses. All students were assured of anonymity and confidentiality.

3.4 The Closed-Form Questionnaire as Research Technique for the Present Study

Except for a few open-ended items for the questionnaire, the main section was of the closed-form type. This format was implemented in this study for the following reasons:

i) A large number of respondents was envisaged. A closed-form questionnaire would be relatively easy to score under these circumstances;

ii) Most questions in the questionnaire were of the scaled response type and thus would demand little time, on the part of the respondents, for completion;

iii) The closed-form questionnaire does not demand a high level of writing skills. From the researcher's experience the majority of the student teachers lack good communication skills. One of the reasons for this state of affairs is that English is not their mother tongue;

iv) It was hoped that it would keep the respondents' minds fixed on and interested in the subject;

v) The process of tabulation and analysis would be greatly facilitated by the use of a closed-form questionnaire.

However, structured, closed-form questionnaires are not without limitations. The following are some of the limitations (van Dalen,1980,155):

- They often fail to reveal the respondents' motives for choosing a particular response.
- They do not always yield information of sufficient scope or depth.
- They may not discriminate between fine shades of meaning.

To eliminate the limitations that are mentioned above, a follow-up study in the form of interviewing a sample of the questionnaire respondents was carried out.

3.5 Validity and Reliability of the Questionnaire

> "Validity of an instrument for collecting data is defined as referring to the appropriateness, meaningfulness and usefulness of the specific inferences researchers make based on the data they collect" (Fraenkel and Wallen,1993,139).

In simple terms, this means that the drawing of correct conclusions based on the data obtained by the use of an instrument is what validity is all about. A valid instrument measures what it is designed to measure.

Reliability of the instrument refers to the consistency of the scores obtained - how consistent they are for the sample of subjects from one administration of the instrument to another and from one set of items to another (see Ibid, 147). Reliability arises when the research results obtained are the same as or close enough to those obtained in the previous study, using the same method and under identical conditions.

It is important to note that reliability and validity of an instrument do not presuppose each other. An instrument may be reliable but not valid.

3.6 The Construction of the Questionnaire as an Instrument for the Present Study

Before the construction of the questionnaire for this study, relevant literature on the preparation programmes of mathematics teachers was collected. The following were the main areas that were isolated by this preliminary study.

i) Aims and philosophies of the curriculum.
ii) Curriculum content
iii) Process of curriculum implementation
iv) Materials used for the implementation of the curriculum.

The questions in the questionnaires for both teacher educators and student-teachers revolved around their perceptions of the areas mentioned above.

The response mode required of respondents was mainly of the scaled type utilising a five point scale. This was because the purpose of the questionnaire was to measure their opinions, beliefs and feelings about some aspects of the curriculum.

To counteract possible response bias on the part of the respondents, the direction of some of the items was reversed.

Other items on the questionnaire were open-ended. This was meant to give respondents opportunities for voicing their opinions and feelings generally about the strengths and weaknesses of the curriculum. The researcher felt that this would be useful as a way of eliciting other issues which were not covered by the closed items and which warranted further investigations and follow-up.

A copy of the questionnaires for student teachers has been reproduced in Appendix 1.

3.7 Piloting the Questionnaires for This Study

Before preparing the final form of the questionnaire, the items were tried out with a small group as a pilot run. In this case the small group was a group of first years, i.e. STD I's, who were not going to form part of the sample for the questionnaire.

The purposes of the pilot run were the following:

i) To test how long it takes respondents to complete the questionnaire.

ii) To check whether all questions and instructions were clear, and

iii) To remove items which do not yield usable data (see Wiersma,1980,151).

The time that it took most respondents to complete the questionnaire was noted. However, no major need for the revision of questionnaire items arose, save for minor modifications.

3.8 The Interview

Cannel and Kahn (1968) are cited by Cohen and Manion (1980, 307) on the concept of the interview in research as follows :

> "... a two person conversation initiated by the interviewer for the purpose of obtaining research-relevant information, and focused by

him on content specified by research objectives of systematic description, prediction, or explanation."

On the purpose of the interview Tuckman (1978, 83) has the following to say:

> "By providing access to what is inside a person's head, the interview makes it possible to measure what a person knows..., what a person likes or dislikes, and what a person thinks."

Unlike questionnaires, interviews might be used to follow up unexpected results, to go deeper into the motivation of respondents and their reasons for responding as they did.

3.9 The Interview as a Research Technique of the Present Study

> "No single method of obtaining data to test a hypothesis is perfect. Each one has certain inadequacies which leave the door open for the possibility of rival hypotheses explaining the findings. For this reason, collecting data by more than one method is often a prudent procedure."
>
> (Van Dalen, 1979, 128).

Consideration of the factors mentioned in the above statement led the researcher to choose an interview as one of the techniques for gathering data. The adaptable nature of the interview as a researh technique was another factor that led to the choice of this technique (Bell,1993,91).

In addition to the above factors, and because of the issues which arose through the questionnaires, the researcher was of the view that the interview would be a useful tool in probing the issues further. It is the researcher's opinion that the interview was a useful tool in the validation of the questionnaire.

3.10 Construction of a Focused Interview Schedule for the Present Study

The focused-type of interview was implemented because the researcher had done prior analysis of the curriculum at the College and the respondents had subjective experiences of its implementation.

The process which was used in the construction of the interview schedule was similar to that used in the construction of the questionnaire. The interviews were within reasonable time limits to avoid the possible effects of tiredness and boredom. For lecturers the time limit was 45 minutes and for student-teachers it was 30 minutes. For preparation of the interview schedule, a reasonable number of books dealing with interviews were consulted.

3.11 Piloting the Interview Schedule

As in the case of the questionnaire a pilot study of the interview schedule was undertaken. Unfortunately because of political unrest factors in the College it was not possible to find a decent sample for the pilot study. After a lot of effort only one teacher-educator and one student-teacher were available for the exercise. This proved to be useful however, in identifying ambiguity and comprehensiveness of the items in the interview schedule. Also an indication was given during the pilot study of the expected duration of an interview. This proved to be very valuable in making appointments with respondents.

We now turn to items which warranted some changes in the final interview schedule for student-teachers.

i) Question 3: What can you say about the level of mathematics at College?
During the pilot study and subsequent initial interviews, feelings about re-doing high school mathematics at College kept on cropping up. It was decided to include a specific question about this issue. The original Question 3 was then modified to 3(a) and the new Question 3(b) was phrased in the following manner :

Question 3(b): What are your feelings about re-doing high school mathematics at College?

ii) Question 5: Reference is sometimes made to problem solving and investigation as approaches to the teaching of mathematics. What does this mean to you?

Some of the first few respondents had a very different conception of what problem solving is. It was understood to mean working out a mathematics problem from an ordinary textbook, like, say, solving for x in an equation. The researcher decided to drop the 'problem solving' part of the question and concentrate more on their idea of investigation as a mathematical process. The new question was changed to:

Question 5: Reference is sometimes made to investigations as an approach to teaching and learning mathematics. What does this mean to you?

iii) Question 7: In your observations during lectures would you agree that most mathematics is taught straight out of a textbook?
Some respondents did not seem to understand the question. Instead they gave responses that related to advantages of using more than one book in the process of teaching.
To get what was intended, i.e., their observations of whether the lecturer uses a prescribed textbook as the main source of teaching matter, the question was reconstructed as follows:

Question 7: How often do your lecturers teach mathematics using a textbook? Probe: Are you happy with this?

iv) Question 8: Do you think subjects like Education Theory and Teaching Science are relevant in your training as a mathematics teacher?
The pilot study respondent only answered the question as it stands, i.e., either gave yes or no. The researcher saw a need to add a probe to the question so that reasons are given for the answer, as follows:

Question 8: Do you think subjects like Education Theory and Teaching Science are relevant in your training as a mathematics teacher? Give reasons for your answer.

As far as the interview schedule for teacher educators was concerned, fewer changes were effected as a result of the pilot study. The following two questions were added to attempt to bring clarity to some of the issues. The questions are:

Question 2(b): Are you satisfied with the quality of mathematics teachers that the College produces?

Question 21: How often do you hold meetings in the Mathematics Department at College? What is the nature of the meetings?

The final interviews with the respondents were carried out during September 1994, at Esikhawini College of Education. The interviews were carried out with the researcher mindful of research ethics.

3.12 Sampling Procedures

Kirsh (1965) has identified the following criteria for a good sampling design (quoted in Wiersma, 151):

i) Goal criterion, i.e., the sampling design should be tailored to the research design and based on the research goals or objectives.

ii) Measurability criterion, i.e., the sampling design must provide the data for the necessary analysis and also enable valid inferences to be made from the sample data to the population from which the sample was selected.

iii) Practicality criterion, i.e., the actual activities of applying the sampling design have been identified and are feasible in the real situation.

iv) Economy criterion, i.e., the research objectives must be met with available resources: time, financial, personal.

3.13 Sampling Design for the Present Study

In the questionnaire study, the sample of student-teachers that were selected were the second years and third years (i.e. STD II and STD III). The reasons for this selection were:

i) The first years (i.e. STD I) were the respondents in the pilot study and had already seen the questionnaire.

ii) The questionnaires were administered in May. The researcher doubted if the first year student teachers were able to offer any meaningful insight into the implementation of the curriculum.

For the interview sample stratified sampling procedures were used (see Wiersma,1980,194). The following strata were used.

i) Year level: second or third.

ii) Gender: male or female.

This sampling procedure was implemented in order to get a more representative sample. The following table summarises the nature of the population.

	Male	**Female**
STD II	29	29
STD III	19	24

To achieve an even greater representation, the technique of stratified sampling was refined to a technique of proportional stratified sampling (see Van Dalen,1979,133). This technique involves the selection of units at random for each stratum in proportion to the actual size of the group in the population. Ultimately,

for the interviews, a sample size of 14 students teachers was selected for the sample and can be represented in strata as follows:

	Male	Female
STD II	4	4
STD III	3	3

In the opinion of the researcher the sample size was seen as reasonable. It is usually said that a sample of 10 to 20 percent of the population is sufficient in descriptive research (see Van Dalen,1979,130).

As far as the teacher educators were concerned, five out of six of them were interviewed. The sixth teacher-educator was used in a pilot study for the interview and could not take part in the main study.

Items for the teacher educators' interview schedule concerned the issues which arose from the student teachers' questionnaire.

3.14 Survey of Materials

A survey of curriculum materials available at College was also made during the course of this study. This was done through a College library search.

CHAPTER 4

ANALYSIS OF RESULTS

4.1 Introduction

This chapter presents results of the study which were obtained by using different instruments and techniques as described in Chapter 3. The results obtained through the questionnaires for student teachers and teacher educators are presented and analyzed. This is followed by the presentation of the interview schedule. The analysis of the aims and philosophy of the curriculum documents is also presented as an integral part of the results.

4.2 Analysis of Results

To facilitate analysis, an analysis framework of the items of the questionnaire was constructed. The questionnaire was planned to probe the following areas:

i) Perceptions of the nature/aims of mathematics and mathematics education.

ii) Perceptions of the mathematics curriculum content.

iii) Perceptions of the mathematics curriculum process.

iv) Perceptions of the use of curriculum materials.

The framework is reproduced in Appendix 4.

4.2.1 Background Information

4.2.1.1 Study Level

Table 4.1: Distribution of student teachers according to present study level at College

	STD II	STD III	Total
Number	58	43	101
%	57,4	42,6	100

The data shows that the majority of the respondents (57,4%) were doing their second year of study.

4.2.1.2 Gender

Table 4.2: Distribution of student teachers according to gender

	Male	Female	Total
Number	48	53	101
%	47,5	52,5	100

The data shows that the majority of respondents (52,5%) were female. This challenges the prevalent view that mathematics is less popular among girls.

Table 4.3: **Cross tabulation of study level against gender of student teachers**

	STD II	STD III
Male	29 (28,7%)	19 (18,9%)
Female	29 (28,7%)	24 (23,8%)

The table shows that there were as many male students as female students at the STD II level, whilst there were more female students than male students at the STD III level. The trend could lead one to assume that female students are more successful in mathematics at College than male students. On investigating the assumption it was found that the dropout or failure rate from one level to another was too small to cause a significant change in the gender composition. The policy of the College was that student teachers could be promoted to the next level of study in spite of failing up to three subjects, including a specialisation subject. This practice seems to be in direct conflict with the provisions of promotion as set out in the DET STD Structure (1990, 10) that student teachers who fail any subject need to repeat the entire level. During the investigation it was found that the teacher educators were very unhappy about the policy of the College in this regard concerning mathematics, which they believed is hierarichal in its nature. They felt that student teachers promoted in this way could not be expected to do well in the subject at a higher level.

4.2.1.3 Age

Table 4.4: **Distribution of student teachers according to age**

	Between 18 and 23 years	23 years and above	Total
Number	54	47	101
%	53,5	46,5	100

The table shows that the majority of the respondents were between 18 and 23 years of age (53,5%) and that a significant number (46,5%) were relatively older.

4.2.1.4 Matriculation Year

Table 4.5: Distribution of student teachers according to matriculation year

	Before 1989	1989	1990	1991	Total
Number	37	33	28	3	101
%	36,6	32,7	27,7	2,9	100

The data shows that the majority (69,3%) matriculated in 1989 or before. In 1992 the respondents were either at the first or second level of study at College and could not, therefore, have matriculated then. Only 2,9%of the respondents were directly from school in 1993 when this investigation was started. It would be interesting to investigate what the respondents were doing between the time they matriculated and the time they enroled to become teachers.

Table 4.6: Cross tabulation of matriculation years against age of student teachers

	Before 1989	During 1989	During 1990	During 1991
Between 18 and 23 years	9 (8,9%)	22 (21,8)	20 (19,8%)	3 (2,9%)
23 years and above	28 (27,8%)	11 (10,9%)	8 (7,9%)	0 (0,0%)

Cross tabulation of matriculation year and age of respondents indicates that the relationship between age and matriculation year of respondents is significant. This is shown by a calculated chi-square of 22,1 at $p < 0,01$. This was expected. Most of the older students completed their matriculation before most of the younger

students, and very few of the older students had recently completed their matriculation year. This trend has implications for the curriculum at College. Most of the respondents felt that precisely because of this fact, it was necessary for the curriculum to include high school mathematics in the College curriculum. Most student teachers thought re-doing high school mathematics was useful in that it helped them to remember topics which they had done at high school. Another reason cited by them in favour of re-doing high school mathematics at College was that there were new topics in the current school syllabus which they had never had the opportunity of doing, either because these topics were introduced after they had left school or their teachers were not confident enough to treat these topics. Calculus and Analytical Geometry were the examples given by the student teachers.

Table 4.7: Cross tabulation of study level against age of student teachers

	STD II	STD III
Between 18 years and 23 years	31 (31,0)	23 (23,0%)
23 years and above	27 (27,0%)	19 (19,0%)

The table shows that the age categories and study levels are not significantly related in the way that would have been expected. Most of the older student teachers would have been expected to be in a higher level of study than most of the younger student teachers. A calculated chi-square of 0,02 at $p < 0,001$ confirms the observation. The table further reveals that the greater proportion of the older students are in the second year of study (i.e. STD II).

The investigation of the trend shown in the table above revealed a number of causative factors. They included financial circumstances of individual students and the requirement of repeating some subjects (because of failure) during their school career. Other respondents reported that they had difficulty in finding a place at

College and had to apply in vain for admission from year to year after completing matriculation.

Further analysis of Table 4.7 reveals that it is consistent with the data given in Table 4.6.

Table 4.8: Cross tabulation of study level against matriculation year of student teachers

	STD II	STD III
Before 1989	20 (19,8%)	17 (16,8%)
1989	18 (17,8%)	15 (14,9%)
1990	17 (16,8%)	11 (10,9%)
1991	3 (3,0%)	0 (0,0%)

Cross tabulation of study level against matriculation year reveals that the two variables are not significantly related (Chi-square = 2,63 at $p < 0,05$). This was contrary to expectations that most students who matriculated earlier would be at a higher level of study. Instead, a slight majority (37,6%) of those who matriculated in 1989 or before were in the second year of study. This is against 31,7% in the third year of study for the same period. Further analysis of the table reveals that those who matriculated before 1989 (19,8%) waited for at least three years after completing matriculation before enrolling at College.

Investigating the reasons behind this trend revealed a variety of reasons. Some student teachers reported that they had been working as privately paid teachers in order to save for their further education. Difficulty in securing a place for training at a College of Education was another factor. Other student teachers reported that

teaching had never been a profession of their preference. They selected the teaching profession because they either could not find secure jobs elsewhere or they were not accepted at universities to train for preferred professions. Moreover training to become a teacher was relatively cheap. Very few of the student teachers reported that they had chosen teaching because of their love for the profession.

4.2.1.5 Matriculation Mathematics Symbol

Table 4.9: Distribtion of student teachers according to mathematics symbol obtained at matriculation

Symbol		No. (Ex 100)	%	Symbol		No. (Ex 100)	%
HG	A	0	0	SG	A	0	0
	B	0	0		B	0	0
	C	3	3		C	2	2
	D	16	16		D	6	6
	E	34	34		E	26	26
	F	6	6		F	5	5
	<F	1	1		<F	1	1
Total		60	60	**Total**		40	40

Key: HG - Higher grade
SG - Standard grade

The data shows that the majority of student teachers passed mathematics on the Higher Grade and most of them obtained an E symbol. It was interesting to note that there were no student teachers who obtained A or B symbols and that 73% of the student teachers obtained an E symbol or below. It does not seem far fetched to conclude that students who achieve good symbols in mathematics seem to shy away from the teaching profession.

The data also reveals that only 53% of the student teachers satisfied the admission requirement of at least an E symbol on the Higher Grade, which is the main admission criterion used at the College.

The teacher educators' views on the appropriateness of the admission criterion were found to be different. Some of them felt that the entrance requirement was reasonable because of the advanced nature of mathematics at College, particularly at third year level. They argued that student teachers needed a strong background in mathematics to cope with the mathematics curriculum at College, and to become effective mathematics teachers.

Other teacher educators felt that the admission requirement was not reasonable at all. A lower symbol of F on the Higher Grade was thought to be more reasonable. They felt that because of the high failure rate at matriculation level, it was not possible for the College to be "choosy" about the type of students it admits for teacher-training.

One respondent was very emphatic about the unreasonableness of the admission requirement as demanded by the College and the STD structure:

> "What is the use of demanding a high standard that few students can meet and on the other hand admitting those students with a lower standard of matric pass because there are very few who can meet the set requirement. It does not make sense because if the College insisted on symbol E on the Higher Grade, we would end up with empty classes."

The low mathematics achievement at matriculation level of the student teachers was believed by some educators to be amongst many factors which undermine the quality of teachers that the College 'produced'.

One teacher educator mentioned personality characteristics like concern for the welfare of children as important criteria which needed to be considered in the admission of prospective student teachers. This was unfortunately not considered in selecting student teachers for training.

Table 4.9 also reveals that two student-teachers failed mathematics dismally with symbols below F. It is noted that the same student teachers are expected to teach mathematics up to matriculation level after they have completed the course.

Table 4.10: Cross tabulation of gender against matriculation symbol of student-teachers

	Male	**Female**
Higher Grade C	2 (2,0%)	1 (1,0%)
Higher Grade D	11 (11,0%)	5 (5,0%)
Higher Grade E	16 (16,0%)	18 (18,0%)
Higher Grade F	0 (0,0%)	6 (6,0%)
Higher Grade Below F	1 (1,0%)	0 (0,0%)
Standard Grade C	2 (2,0%)	0 (0,0%)
Standard Grade D	3 (3,0%)	3 (3,0%)
Standard Grade E	10 (10,0%)	16 (16,0%)
Standard Grade F	3 (3,0%)	2 (2,0%)
Standard Grade Below F	0 (0,0%)	1 (1,0%)

Cross tabulation of gender against matriculation symbol of student-teachers does not reveal any significant relationship between the two variables. This is contrary to expectations that male students achieve better mathematics symbols at school than female students.

4.2.2 Analysis of the Perceptions of the College Mathematics Curriculum

The perceptions of the respondents regarding the College mathematics curriculum are analyzed in this section. The framework of analysis which is reproduced in Appendix 4 is used to do the analysis. The distributions of the student teachers' responses to individual statements of the questionnaire are presented with the questionnaire in Appendix 1.

4.2.2.1 Nature and Aims of Mathematics and Mathematics Education

The majority of student teachers' responses revealed that most of them (87%) believe that mathematics has essentially to do with learning of rules and procedures for solving problems. In addition they believe that mathematics teaching and the learning of mathematics was important for its applications in everyday life and in a variety of professions in commerce and industry. Probing student teachers deeper into giving examples of aspects of mathematics that has such applications drew a blank. Enabling student-teachers to "apply mathematical knowledge and methods ... in their daily life" is listed as one of the aims of the STD Academic Mathematics syllabus (1990, 1). The syllabus also fails to give a clue on the manner in which some aspects of the course had such a potential. A few of the respondents believed that mathematics should be taught because it inculcates efficient and logical thinking. One interesting response was from one respondent who put it this way:

> "I haven't really found out why I have to teach mathematics. Nobody has told me why it should be taught. I am just doing mathematics because I was advised to do it."

An important question arising from the above responses is: How successful would the student teachers be in motivating their own students to do and like mathematics if they have no clue themselves of why mathematics is taught?

The views of most of the teacher educators on the aim of teaching mathematics strongly overlapped with those of their student teachers. However, a few of them

were not happy with the syllabus in this respect. They thought that the syllabus was too theoretical to be of any benefit to student teachers and their future students. One teacher educator argued strongly against the utilitarian value of mathematics as the main reason for its learning. He believed that learning and teaching mathematics for its own sake was a sufficient justification.

As far as the nature of mathematics was concerned most teacher educators felt the same way as student teachers and did not see problems with the views that student teachers held. The views were reinforced by the nature of external mathematics examinations that were written at the end of the third year level. The examinations were underpinned by the 'formalistic' view of mathematics and the teacher educators saw their role largely in terms of helping student teachers pass the examinations.

During the initial investigation the process view of mathematics proved to be popular with student teachers. As many as 56% (N = 100) of them believed that problem solving processes were important in learning mathematics. This view contradicted their earlier view of mathematics as having to do essentially with rules and procedures. On further investigation, it emerged that an overwhelming majority of them did not have a correct concept of what the problem solving in mathematics entailed. Most saw problem solving as routine solving of a mathematics problem like "find x" or "factorise the expression", etc., as one would find in textbooks.

4.2.2.2 The Curriculum Process at College

The investigation revealed positive perceptions of the curriculum processes at College as far as the student-teachers were concerned. They believed that there was adequate interaction between themselves and teacher-educators during the lecturing processes. Student teachers were generally encouraged to be active participants during lectures. Groupwork was believed to feature prominently, with a lot of discussions between the lecturers and students and between students themselves. This perception was particularly stronger in the more advanced students, i.e. the third years than in the second years. The following cross tabulation of study level against the perceived implementation of groupwork shows this. (See item 9 of the questionnaire in Appendix 1)

Table 4.11: Cross tabulation of study level against the student teachers' perceptions of groupwork implementation in lectures

	STD II	STD III
Strongly agree	13 (12,9%)	27 (26,7%)
Agree	21 (20,8%)	14 (13,9%)
Undecided	12 (11,9%)	1 (0,9%)
Disagree	9 (8,9%)	1 (0,9%)
Strongly disagree	3 (2,9%)	0 (0,0%)

A calculated chi-square of 21,78 at $p < 0,001$ shows that the student teachers' perception of implementation of group work during College lectures is related to their present level of study. A reason for this perception may have been that the third year level lecturers encourage group work more than the second year level lecturers do.

The student teachers were generally very positive about the way they were lectured to by most of the lecturers. They felt that the lecturers did not assume too much prior knowledge on the student teachers' part. They believed that this approach helped them fill knowledge gaps that they brought with them from high school. In addition this enabled them, as prospective teachers, to pick up effective teaching approaches to different aspects of the school syllabus.

Team teaching as practised at College received high praise from student teachers. They felt that they benefitted from being taught different aspects of the mathematics course by different lecturers. They believed that it enabled them to get the best from each lecturer.

On using investigations as an approach to the teaching of mathematics at College, most lecturers felt that this approach was too time-consuming. Because of syllabus constraints they felt that it was not feasible to use this approach in their situation. Moreover, they argued, most of the syllabus topics do not lend themselves to this approach because they are too abstract. One lecturer put it in the following way:

> "Investigations are not really appropriate for the College. Students are not used to doing mathematics this way from high school. They like to be spoonfed all the time. It would cause real trouble in this College if we stopped spoonfeeding them."

The overall assessment of the perceptions indicated that student teachers were happy about the way mathematics is taught at College and that student involvement in lessons seemed to dominate most of the teaching. It was not possible to find out exactly what the nature of involvement of the student teachers was. Whether it involved merely "drilling" student teachers on procedures for solving problems or student teachers being meaningfully engaged with the prolems was not clear from the responses received. Considering the teacher educators' views on the nature of mathematics and from their scepticism of using investigations as an approach to teaching mathematics it became reasonable to infer that most of the lectures were in the traditional mode.

4.2.2.3 The General Curriculum Content at College

The STD Structure (1990) prescribes a number of subjects that student-teachers need to take each year of study at College. For each of the years there are at least ten such subjects. The subjects are grouped into three major categories. The categories are:

Group I: Professional subjects

The subjects in this group are:

(i) Education Theory
(ii) Teaching Science

(iii) Teaching Practice
(iv) School Management
(v) Subject Didactics

Group II: **Academic Subjects**

The subjects in this group are those subjects in which the student-teachers choose to specialise. For the population under investigation in this study the subjects are:

(i) Mathematics and either
(ii) Physical Science or
(iii) Biology

According to the STD Structure (1990,3) the subjects in this group are meant to strengthen the academic knowledge of the student-teacher up to at least one and a half year level of a university course.

Group III: **Background subjects**

The subjects in this group are :

(i) English as Medium of Introduction
(ii) Special Afrikaans
(iii) Bible and Philosophies of Life
(iv) Student Guidance
(v) Library Orientation
(vi) Physical Education
(vii) Music and Singing, and
(viii) Art and Craft

Student teachers have the option of choosing only one subject between (iv) and (viii)in this group.

On investigation of the perceptions of student teachers' on the entire STD course, most of them felt that the course was overloaded with subjects that were irrelevant to a prospective mathematics teacher. Subjects in Group III of the curriculum were

specifically singled out. In particular student-teachers were sceptical about the relevance of Special Afrikaans and Bible and Philosophies of Life. Lecturers held the same views as student teachers on the relevance of the subjects. They believed that they were included in the curriculum to inculcate in student teachers values in keeping with the ideology of Christian National Education (CNE). This ideology was believed to serve the interests of the then ruling Afrikaner Nationalism. Most respondents felt that it would have been wise for these subjects to be abolished and the time allocated for them to be used for Academic Mathematics or Mathematics Didactics.

In a recent conference of student teachers in KwaZulu-Natal, one of the resolutions called for phasing out of irrelevant subjects, particularly Afrikaans and Bible and Philosophies of Life (see Echo, 1994, 3).

As far as the other subjects are concerned most respondents were positive about their relevance in teacher education. Education Theory in particular was singled out as one of the most relevant subjects. Student teachers believed that it helped them to understand the behaviour of a child and learn about the forms of intervention that are at the disposal of the teacher. Most teacher educators also held the same attitude to Education Theory. However, they expressed concern about the overlap of some topics in Education Theory with topics in Mathematics Didactics. The example given was the topics on lesson preparation and drawing up of a scheme of work. They felt that student teachers' time could be used more profitably if these topics were treated in their relevant subject didactics course.

Teaching Practice was another subject that most respondents felt was very relevant to their training as prospective mathematics teachers. The following were reasons that were given in favour of Teaching Practice.

- It gave them a good idea of whether one had chosen the right profession for oneself.

- It helped them to put the theory learnt in lectures into practice.

- It familiarised student teachers with problems inherent in the teaching of mathematics at school and gave insight into pupils' difficulties.

- It provided opportunities for mustering confidence in teaching.

However, the organisation of Teaching Practice sessions seemed to be fraught with problems. These problems revolved around the hostilities of schools in which student teachers were supposed to do their practice and around the duration of the practice sessions. Schools were generally believed to perceive the sessions as disruptive to their own routine and as putting into jeopardy the schools' own progress in completing the syllabus. Also because of the few secondary schools in the vicinity of the College and the large number of student teachers, very little meaningful practice took place. The respondents reported that as a result of these problems the emphasis during Teaching Practice sessions fell more on evaluation of student teachers' peformance than on giving them guidance.

Another problem of the Teaching Practice sessions of concern to both the student teachers and teacher educators was the syllabus prescription of the sessions. The syllabus provided for only two two-week sessions a year. One session was to be done at a home school with no supervision from the College. The other session was to be done around the College with lecturers' supervision. The lecturers reported that because of student teachers' numbers and constraints of the school time-table, they had never been able to supervise the student teachers effectively during the sessions. It was not unusual for them to evaluate up to eight lessons in one day, offering minimum guidance to the student teachers.

4.2.2.4 The Mathematics Didactics Curriculum Content

The DET STD Mathematics Didactics syllabus (1990) prescribes the following aspects of the curriculum:

(i) SUBJECT POLICY FOR MATHEMATICS
This involves compilation of policy in issues of period allocation for the subject at school level, daily preparation and didactic principles of teaching mathematics.

(ii) INTERPRETATION AND CONTENT OF SCHOOL SYLLABUSES
The syllabuses are those from standard 5 to standard 10.

(iii) LESSON PRESENTATION AND PREPARATION

This aspect involves discussions of different types of lessons in mathematics.

(iv) DEMONSTRATION LESSONS

Six lessons are required to be demonstrated to students by lecturers each year.

(v) CONTROL OF WRITTEN WORK

Control of classwork and homework for pupils falls under this aspect of the curriculum.

(vi) MEASUREMENT AND EVALUATION

This aspect aims to enable student teachers to set papers for tests and examinations of good standard.

The syllabus prescribes that these aspects be covered over the period of three years.

The Mathematics Didactics syllabus and its implementation was a source of concern for most student teachers and teacher-educators. The words of one of the student teachers summarise the feelings of many:

> "The Didactics course is very confusing at College. No one seems to know exactly what needs to be covered in this course. Even the lecturers run out of ideas on what to do most of the time. It is usually taught just before the test and most of the time we just regurgitate what is in the handouts."

The problem as perceived by some teacher educators seemed to be on the general nature of the syllabus content of the course. As one of them put it, if any other subject was put in place of mathematics in the syllabus, there would be no change in the nature of the syllabus content. In this way the syllabus failed to address the peculiarities of teaching a problematic subject such as mathematics. Most teacher educators felt that because of the narrowness of the content of the didactics syllabus, they had always been able to complete it in one year. They concurred with student teachers that because of this situation, they have used the time for didactics to teach Academic Mathematics. A few of the teacher educators felt that the subject

was also inadequate. They pointed out that some important issues of teaching mathematics to slow learners or academically disadvantaged pupils were not covered, and believed that they were most likely to confront the student teachers after completing their training. The omission of topics related to language and the teaching and learning of mathematics was an object of great criticism. It was argued that the teacher trainees were more likely to teach mathematics in a second language relative to that of pupils. The teacher-trainees needed to understand and appreciate the complex role of language in the context of a learner.

The organisation and the implementation of demonstration lessons at College was a cause for concern to most student teachers. Most felt that they were not useful at all because of the manner in which they were conducted. It was alleged that the usual practice is to present them through a readily recorded video tape without discussion of any kind with the student teachers. The few that were presented live, were usually done haphazardly just before the Teaching Practice sessions.

On the overall evaluation of the Didactics curriculum at College, most lecturers felt that it was too "technicist". The emphasis, they explained, was on how to do this or that, like how to prepare a lesson, drawing up a scheme of work, or setting a test paper. The element of reflection on the teaching process was conspicuously absent.

4.2.2.5 The Academic Mathematics Curriculum

The STD Academic Mathematic syllabus (1990) prescribes topics in the secondary school syllabus (i.e. Std 6 - 10) and other topics in post secondary school mathematics. The secondary school topics are prescribed for the first two years and the post secondary school topics mainly for the final year, although not exclusively.

The post secondary school topics are the following:

(i) Complex Numbers
(ii) Groups and Fields (an Introduction)
(iii) Statistics
(iv) Integral Calculus
(v) Infinite Series
(vi) Vectors
(vii) Matrices and Determinants

The syllabus claims that the academic mathematics curriculum is equivalent to one and a half university mathematics courses (DET STD Academic Mathematics syllabus, 1990, 1).

Most of the teacher educators and student teachers felt that the Academic Mathematics course was appropriate for prospective teachers of mathematics. It was felt that since the student teachers were being educated to teach secondary school mathematics it was appropriate that they gain as much confidence as they can in the relevant content. As reported elsewhere in this study, most student teachers were of the opinion that re-doing school mathematics content helped them to fill the knowledge gaps they had brought with themselves from high school. They claimed that the gaps arose either because their high school teachers did not cover topics in which they were not confident or could not finish the syllabus on account of time constraints. Re-doing school mathematics was for them a welcomed opportunity.

The perceptions of student teachers on the number of topics prescribed by the syllabus were different. Most of the second years believed that there were enough and they were manageable. To justify their view they gave the example of losing considerable teaching time because of the strikes at College, yet on returning to lectures being able to finish the syllabus and pass the end of year examinations well. The final year student teachers thought differently. They believed that there was just too much work for each year at College, and cutting down some of the topics would have been welcomed by them.

The difference in the perceptions of students in the two study levels of the need for the number of topics in mathematics in academic mathematics is shown by the following cross tabulation.

(See Overleaf)

Table 4.12: Cross tabulation of study level against student teachers' responses to the perceived number of topics in Academic Mathematics

	STD II	STD III
Too few topics	0 (0,0%)	3 (3,0%)
Few topics	11 (10,9%)	2 (2,0%)
Just right	12 (11,9%)	10 (9,9%)
Many topics	25 (24,8%)	15 (14,9%)
Too many topics	10 (9,9%)	13 (12,9%)

A calculated chi-square of 10,2 found to be significant ($p < 0,01$) confirms the relationship between study level of student teachers and their perceptions of the number of topics in the Academic Mathematics syllabus.

The views of the lecturers were split in the same way as those of the student teachers with the lecturers who taught the third years believing that the topics were too many at the third year level. They felt that the number of periods allocated to Academic Mathematics were too few to cope with the number of topics.

The analysis of the responses revealed that the final year students may have been unhappy about the number of topics because of the fact that their end-of-the-year final examinations were externally set by the DET. This was in contrast to the second year student teachers who were internally examined by their own lecturers. As with most other educational institutions, the examination in this case was usually written on the work which was actually covered by the lecturer. This interpretation was corroborated by at least one of the third year student-teachers who said:

> "Last year we covered only four topics for the year amidst frequent disruptions at College. This year we already have covered much more and we are told that there are still more topics to be done."

The perceptions on the level of difficulty of Academic Mathematics at College showed the same trend for both student teachers and lecturers. This was expected since most of the topics at the third year level were new to most of the student teachers, and relatively more advanced than the topics in high school mathematics. Despite this perception of relative difficulty, most student teachers were happy about the opportunity to study the advanced topics. They felt that it was to their advantage to have a more advanced mathematical knowledge than their prospective pupils. In addition, they believed that it gave them good preparation for furthering their studies in university mathematics. This is a possibility which most of the student teachers reported never to have aspired to because of their weak background in mathematics at school.

However, most of the lecturers were not happy about the inclusion of the post secondary school topics in the College academic mathematics syllabus. The main reason given was that they were too difficult for most of their student-teachers who had poor background in mathematics. They thought that the course should have been limited to the mathematics that the student teachers would be teaching. As a form of enrichment in mathematics for them, topics on non-Euclidean geometries were suggested. These, the students had not had the opportunity to do at school. History of Mathematics was another topic that was suggested particularly as a useful topic to include in the Academic Mathematics curriculum. Its usefulness was seen in the context of its potential to motivate students by giving mathematics a 'human face'.

4.2.2.6 The Curriculum Materials and their Use

The library survey of the mathematics curriculum materials available at College revealed that there were very few such materials. The few materials which were available were in the form of standard South African school mathematics textbooks. In addition to these textbooks there were a few copies of Educamus, a journal of general educational issues for schools under the now defunct Department of

Education and Training (DET), published by that same department. The journal occasionally carries articles on mathematics teaching. Also found in the library, were a few issues of the Mathematical Digest journal. This journal publishes puzzles and non-routine problems for competition amongst school pupils.

Only one book on mathematics education was available. This was the only prescribed mathematics textbook for the College. Most teacher educators were not happy about the book. They believed that it was too narrow in scope and that it was too prescriptive about approaches to be used in the teaching of the topics. They were forced to use the book since it was written by an erstwhile examiner and most of the examination questions were taken from the book.

Enquiries on the extreme inadequacy of the resources at the library revealed that the College had a very meagre budget for the library and as a result it was not possible to provide more and better materials. In the view of the teacher educators the situation was exacerbated by the stipulation of the DET Mathematics Didactics syllabus (1990,1) that only the DET approved textbooks could be used at College.

The position in the mathematics department was no different. In addition to school textbooks, the lecturers had a few personal copies of textbooks on calculus and analytical geometry. One overhead projector and a non-functioning televideo constituted the educational technology apparatus available for sharing amongst the six teacher educators in the department. This accounted for both the teacher educator and student teachers' perceptions that educational technology was very rarely used at College.

The unavailability of resources at College has serious implications for the curriculum. The College policy prescribes a number of assignments and projects for the student teachers to do independently. Any person would find it difficult to conform to the policy because resources to refer student teachers to, are too few and too inadequate. As a result of this situation, most teacher educators could be tempted to give student teachers assignments of dubious quality, just for the sake of being seen to abide by the policy.

During the initial investigation the majority (57,4%) of student teachers indicated that the mathematics course provides adequate opportunities for developing

teaching materials (see questionnaire item no. 14 in Appendix 1). The follow-up investigation showed that the materials the students meant were only charts (posters) and not materials like worksheets. This lack of exposure to developing learning and teaching materials in general seemed to have an effect of overdependence on textbooks for both student-teachers and their lecturers. Most student teachers did not think that it was inappropriate for their lecturers and themselves to confine the subject matter to that of the book when teaching. The usefulness of being able to develop alternative materials to the textbook did not seem to be apparent to the student teachers.

4.2.2.7 Professional Development

The background information on each of the teacher educators is summarised below. A B, C, D, E and F represent the individual teacher-educators.

Table 4.13: Background Information on the Teacher Educators

	A	B	C	D	E	F
1. **Gender**	Male	Male	Female	Male	Male	Male
2. **Years teaching experience**						
(a) School	15	9	12	7	7	9
(b) College	1	1	1	5	8	5
3. **Qualifications**						
(a) Degrees	B.Paed B.Ed	B.Sc (Hons)	B.A.	B.Sc.	B.Sc. B.Ed. M.Ed.	B.Paed B.Ed.
(b) Mathematics	Maths III	Maths III	Maths III	Maths III	Maths III	Maths III
(c) Professional	STD	HED	HED	HED	JSTC	STD
4. **Membership of Maths Association**	AMESA AMTEK	AMESA AMTEK	AMESA AMTEK	AMESA AMTEK	AMESA AMTEK	AMESA AMTEK

The data in the table shows that the lecturing staff in the department was predominantly male and that the staff was well experienced and qualified with the majority possessing senior degrees. All of the teacher educators had at least third year university mathematics and were professional teachers.

The table also shows that all of the teacher educators were members of both the Association for Mathematics Education of South Africa (AMESA) and the Association of Mathematics Educators in KwaZulu Natal (AMTEK). AMESA is a national association of mathematics teachers and educators whereas AMTEK is a regional association for teacher educators. The membership of the teacher educators showed that at the least they were interested in their professional development as mathematics educators. One of the factors the investigation set out to find was, in what way besides membership of associations the teacher educators were involved in the professional development of themselves, local teachers and student teachers.

The result of this investigation showed that very little was done in this respect by the teacher educators. As far as their own professional development was concerned, only one teacher educator was involved in some kind of research which was associated with the Reconstruction and Development Programme. It also emerged that most of them rarely read mathematics journals. The reason given was that they were not available at the local libraries. The only journal which was reported to have been read, though very occasionally, was Pythagoras. This they received because of their membership of AMESA. As far as involvement in professional development of their own student teachers was concerned, the lecturers reported that they had always encouraged student teachers to form mathematics clubs. In the College this was represented by the Mathematics Society. Both student teachers and lecturers felt that the Society was far from active because of lack of enthusiasm on the part of the student teachers. The student teachers corroborated this view. The interaction between the teacher educators and the local teachers was minimal except for brief encounters during Teaching Practice sessions. The reason given for the lack of involvement or initiative in this respect was the lack of time on the teacher educators' part.

As a professional group within the College, the teacher educators reported that they rarely had staff meetings with the focus on professional development. The only meetings they held within the departments were for administrative purposes like deadlines for submission of test/examination papers, marks and on allocation of duties.

The professional involvement of teacher educators in mathematics education is crucial in ultimately determining the quality of their practice and should always be encouraged. Judging from their membership of the associations, it is apparent that the teacher educators are interested in their professional development. They only need to be encouraged and supported to be more involved with the local mathematics teachers and their student teachers. In this way they can become effective agents of change which is desperately needed in mathematics education.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

This chapter summarises the findings of the study and makes recommendations based on the analysis of the data as reported in the previous chapter. The limitations of the study are acknowledged and suggestions for further research are also discussed.

5.1 Problems with the College Admission Requirements

The study revealed that there were problems in the admission requirements to be met by prospective student teachers applying for places at College. Although the College insisted that they achieve at least an E symbol in mathematics on the Higher Grade, it was found that this policy was not always followed. Applicants with lower achievements and even those who had dismally failed mathematics were frequently admitted to train to become mathematics teachers.

The practice of accepting applicants with poor records in mathematics presents the problem of the perceived poor calibre of the student teachers being educated at College. It also has implications for the curriculum process as indicated by the teacher educators. It cannot be reasonably expected of them to produce "teachers of high calibre and quality service" as the College motto claims. The poor calibre of the student teachers has the potential to perpetuate the vicious cycle of failure in mathematics. This is especially so in historically black schools in which most of the student teachers are likely to teach after qualifying.

On the other hand, strict enforcement of the stipulated admission requirement could result in other kinds of problems for the College and the community it serves. Given that few applicants would meet the requirements, fewer mathematics teachers would ultimately be available for schools. It is common knowledge that in South Africa and in the KwaZulu -Natal region in particular, there is a shortage of mathematics and science teachers. The fewer teachers that

the College would produce under the circumstances could aggravate the problem of teacher supply in the province.

The problem of admission criteria at the College therefore becomes a problem of balancing quantity against the quality of mathematics teachers. A large number of ill-educated mathematics teachers cannot improve the standard of mathematics achievement whereas a small number of well educated teachers cannot have substantial impact on the improvement of mathematics education in schools.

Using academic requirements as the sole admission criteria at College is not without problems. Teaching is not a purely intellectual activity. It has a great deal to do with emotional factors which are characteristic of human interaction. Ignoring such factors might mistakenly lead to the conception of teaching as purely mechanical transmission of knowledge. It is important for the prospective student teachers to be sensitive to the fact that the teaching profession has more to do with the child than with the subject matter. To be a good teacher means much more than possession of good intellectual skills.

Recommendation

It is recommended that a year long preliminary STD course be established by the College for those applicants who wish to train to become mathematics teachers but have a weak background in school mathematics. They could be required to re-write the matriculation mathematics examination at the end of the year to improve their symbols and at the same time become eligible for admission to the STD course.

In addition to the academic requirement for admission to teacher training, the College should find ways of screening the prospective student teachers for personality characteristics which are in keeping with the ethos of the teaching profession. Concern for the welfare of children is one characteristic worthy of consideration in this regard.

5.2 Problems with the View of Mathematics and its Teaching

The study revealed that most teacher-educators and student teachers viewed mathematics as a body of rules and procedures and that teaching mathematics essentially entailed transmission of these rules and procedures to pupils and students. This "formalistic" view of mathematics was accounted for by both the student teachers' and teacher educators' conceptions of the narrow aims of teaching and learning mathematics.

Research abounds with examples showing that the philosophy of mathematics as held by the teacher influences in no small measure how he/she teaches the subject (see Chapter 2 of this thesis). The narrow view of mathematics as held by the respondents did not seem to be in keeping with the current view of mathematics, which adopts an `information processing' model (refer to page 21, Chapter 2). This model views mathematics as an activity which involves investigations, self-discovery and problem solving. This model empowers the learner to choose his/her own strategies from a range of possibilities in engaging with a problem. In addition, the model may impart to the learner the intellectual excitement associated with self-discovery and the shared enjoyment of understanding the discovery of other learners.

Recommendations

It is suggested that the mathematics curriculum of the College should afford student-teachers opportunities to engage in investigations, problem-solving and self discovery. To inculcate the process view of mathematics, the following activities should form the hallmark of lessons in mathematics:

- Recording
- Quantifying
- Ordering
- Classifying
- Describing
- Inferring
- Exploring
- Pattern gazing

- Hypothesising
- Generalising
- Reflecting, etc.

In addition student teachers should be given opportunities for examining the aims of teaching mathematics critically and exploring how knowledge of the aims applies to the teaching of mathematics. For instance, how the aim of inculcating logical thinking applies to the teaching of mathematics and what aspects of the subject have the greatest power to facilitate this, are some of the issues which require exploration.

5.3 Limitations of the Mathematics Curriculum Content

The analysis of the College mathematics curriculum content revealed a number of limitations.

Firstly the general curriculum content was perceived to be overloaded with subjects that were irrelevant to the preparation of a mathematics teacher. Special Afrikaans and Bible and Philosophies of Life were particular examples mentioned. The dissatisfaction with these subjects is understood. Afrikaans in particular has had a negative connotation in black society for a long time. The Soweto uprisings of 1976 were, in no small measure, a result of this resentment. In KwaZulu-Natal in particular, Afrikaans is only used by its native speakers who form a small percentage of the population in the province. Bible and Philosophies of Life does not, on the surface, seem to be a controversial subject because it purports to expose the student-teachers to the different world views. On closer examination of the subject content, however it emerges that the other philosophies are viewed only in the Christian perspective. This has the potential of misrepresenting other philosophies of life.

Secondly, although Teaching Practice was believed to be relevant and enabling student-teachers to integrate theory and practice, there were problems associated with the organisation of Teaching Practice sessions by the College. One such problem was the length of the sessions. Two weeks of College supervised teaching practice per year is, in all respects, inadequate. This period is only adequate for

student teachers to settle into the school and to begin to know their pupils. The other two weeks practice in home schools is similarly inadequate. Because it is usually done at the beginning of the semester before schools become fully operational, the student-teachers reported that they have not found their practice at home schools particularly useful.

Recommendations

It is recommended that subjects like Special Afrikaans and Bible and Philosophies of Life be removed from the College curriculum. Periods allocated to these two subjects in particular should instead be used for mathematics education. This will enrich student teachers' mathematical knowledge, thus enabling them to become more effective mathematics teachers.
It is further recommended that the Teaching Practice sessions be extended to give student-teachers further opportunities of meaningful practice. Four weeks College supervised teaching practice a year should be the minimum.

The Mathematics Didactics curriculum was another area of concern for both student teachers and teacher educators. In the student teachers' perspective, the course was confusing and there was no clear description of what it entailed. The confusion was compounded by the overlap of some of the topics with those in Education Theory. In the teacher educators' perspective the syllabus was too general and could be applicable to any other subject and was generally divorced from content. This fact coupled with its narrow "technicist" prescriptions contributed to the perception of its inappropriateness.

Certain issues which are of real concern to mathematics teachers are omitted from the Mathematics Didactics curriculum. They are real issues that student teachers are likely to encounter in their immediate professional lives. They deal with the implications of language in mathematics teaching and learning, especially if the language of instruction is not the language of the pupil. Diagnosis and remediation of pupil difficulties is also another real issue, especially in historically black education where success in mathematics is alarmingly low. Learning the skills of diagnosis and remediation in the learning of mathematics could go a long way towards improving the plight of many pupils.

Another glaring omission from the Mathematics Didactics curriculum was a section on the learning theories of mathematics. Ignorance of the learning theories could in the long run, render a teacher ineffectual. Being well grounded in theory helps a teacher make correct and informed decisions about his/her practice.

Recommendation

It is suggested that the Mathematics Didactics curriculum be structured to be more context bound by including the following areas: language in mathematics, diagnosis and remediation of learning difficulties in mathematics; learning theories with particular contributions from psychologists such as Piaget, Vygotsky, Dienes, Bruner and Van Hiele; and constructivism.

Fewer problems of limitations emerged in the investigation as far as the Academic Mathematics curriculum was concerned. The satisfaction in this regard arose from the fact that the curriculum gave opportunities for filling knowledge gaps in school mathematics and also for doing post-school mathematics. The respondents believed that this gave them confidence as mathematics teachers, and gave them good background in studying further university mathematics courses. Regrettably, although the College Academic Mathematics curriculum covers most of the first year university topics it is not recognized by any university.

Some topics were suggested for inclusion in the Academic Mathematics curriculum which were believed to have the potential of broadening the knowledge base of student teachers in school level mathematics. The topics were on Non-Euclidean geometry (e.g. transformations and tessellations) and some aspects of the History of Mathematics. These topics form important aspects of the curriculum of most other countries.

The perceptions of the level of difficulty of the Academic Mathematics curriculum at College were mixed. The analyses of the data revealed that the perceptions depended on study level of the respondents, and on whether the end of the year examinations were internally or externally set. The same trend was found on the perceptions of the amount of work. This suggested that there may have been some

measure of laxity if the examinations were set internally, with the scope of the examinations limited to the work which was actually covered.

Recommendations

It is suggested that the College explores the option of affiliating to one of the universities in the region for the setting and moderating of all examinations. In addition to the maintainance of the acceptable standards, the affiliation could facilitate recognition of the academic course for the purpose of further study in university mathematics.

5.4 Problem of Inadequate Mathematics Curriculum Materials

The study revealed that the materials for meaningful mathematics teaching and learning in the College were inadequate in the extreme. Because of the meagre learning and teaching resources at the College the teacher educators felt extremely constrained in fostering independent learning in their student teachers through projects and assignments. This situation is alarming to say the least. It makes mockery of the College motto of "Training teachers of high calibre and quality service". The pupils that the student-teachers would teach will live most of their lives in the technological and information age. How could they be expected to make a meaningful contribution to the pupils' lives if they themselves are not exposed to the technology in the classroom.

Recommendation

It is recommended that the College makes every effort to provide mathematics education materials for use by both teacher educators and student teachers.

It is further recommended that technological apparatus be provided for use as an integral part of the curriculum of teacher training.

5.5 Professional Development

The academic qualifications of the teacher educators were found to be very impressive against the background of historically disadvantaged black education. Their membership of mathematics associations revealed a great interest in professional development. However, involvement with the mathematics teachers locally was found to be inadequate. Their involvement in this regard could help to improve the standard of mathematics teaching in the area.

Involvement in research was another aspect of professional life of the teacher-educators which was found to be lacking. This is regrettable since with their wealth of experience in educating historically disadvantaged students, they could contribute substantially to the teaching of mathematics.

Recommendations

It is suggested that teacher educators be supported and encouraged to involve themselves in the professional development of local mathematics teachers. The involvement may be in the form of organising and running INSET activities with and for the teachers. In addition to helping to improve the quality of mathematics education in the area, this may help the teacher educators keep in touch with the realities in the schools in which their own student teachers will be teaching. It is further recommended that the teacher-educators make every effort to engage themselves in research.

5.6 Limitations of the Study

The following factors are in the opinion of the researcher, the limitations of the study :

1. The study was conducted over a period of two years with the questionnaire administered in the first year and the interview schedule administered in the second year. Because of this factor which was beyond the researcher's control, the second year student teachers in the interview study were not a

representative sample of the group which responded to the questionnaire study. They might not have felt the same way as the previous year's second year student teachers on the items in the questionnaire from which some of the issues in the interview study arose. Similarly the third year student teachers who responded to the questionnaire had left the College by the time the interview study began. The interview study therefore, might not have been a follow-up to the issues of concern to these student teachers.

2. College records of the student teachers could not be accessed to double-check the background information which was furnished. This information included students' matriculation mathematics symbols. Experience suggests that in dealing with such issues people tend to exaggerate their achievement for the purpose of impressing the researcher.

5.7 Suggestions for further research

The following are some of the suggestions which could be considered for further research on the issues which arose from the study :

1. A comparison of the perceptions of the mathematics curriculum of the College student teachers and teacher educators with those held by similar groups in other institutions.

2. A study of the perceptions of practising College educated teachers to ascertain the extent to which they believe the College curriculum prepared them to cope with the reality in the mathematics classroom, and in which way they thought the curriculum could be improved to be more relevant.

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APPENDIX 1

STUDENT QUESTIONNAIRE
ESIKHAWINI COLLEGE OF EDUCATION

PLEASE ANSWER THE FOLLOWING QUESTIONS HONESTLY AND FRANKLY. TO ENCOURAGE YOU TO DO THIS YOU NEED NOT GIVE YOUR NAME.

BIOGRAPHICAL INFORMATION
MAKE A TICK IN THE APPROPRIATE SPACE

1. Present level of study at College. ☑

STD I	STD II	STD III	TOTAL
0	58	43	101

2. Gender

Male	Female	Total
48	53	101

3. Age

Younger than 18 years	Between 18 and 23 years	23 years and above	Total
0	54	47	101

4. Year matriculated.

Before 1989	During 1989	1990	1991	1992	Total
37	33	28	3	0	101

5. Matric Mathematics Symbol.

Higher Grade	A	B	C	D	E	F	BELOW F	Total
	0	0	3	16	33	6	1	
Standard Grade	**A**	**B**	**C**	**D**	**E**	**F**	**BELOW F**	
	0	0	2	6	26	5	1	100

QUESTIONS

The following questions are about your experiences in the learning and teaching of mathematics in the College. Please answer each question by marking with a tick (✓) the answer which is closest to your experience.

1. In solving a mathematics problem only the answer counts.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
3	**12**	**4**	**41**	**41**	**101**

2. In my opinion, mathematics is about learning rules and procedures for solving a problem.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
38	**49**	**5**	**8**	**0**	**100**

3. Problem solving processes like recording, guessing exploring patterns etc. are not important in the learning of mathematics.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
11	25	8	43	13	100

4. Mathematical games/puzzles are irrelevant in the teaching and learning of important concepts in mathematics.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
1	6	6	51	37	101

5. During mathematics lectures, most of the talking is done by the lecturer.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
4	11	2	52	31	101

6. Discussions between students are encouraged in our lectures.

Very Often	Often	Seldom	Very Seldom	Never	Total
33	49	11	6	2	101

7. Active involvement of students tend to feature prominently in our mathematics lectures.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
24	57	10	9	0	100

8. In their teaching, the mathematics lecturers do give students opportunity to express differingopinions and ideas.

Very Often	Often	Seldom	Very Seldom	Never	Total
25	53	18	2	2	100

9. Working in groups of two or more is encouraged during mathematics lessons.

Very Often	Often	Seldom	Very Seldom	Never	Total
40	35	13	8	3	99

10. Mathematical games/puzzles are used in the teaching of mathematics at College.

Very Often	Often	Seldom	Very Seldom	Never	Total
3	14	31	12	40	100

11. Lessons in mathematics are generally presented in a traditional way of chalk and talk.

Very Often	Often	Seldom	Very Seldom	Never	Total
24	36	13	11	17	101

12. In the College mathematics course students are always encouraged to read mathematics journals (e.g. Mathematics Teacher, Arithmetic Teacher).

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
6	15	22	39	18	100

13. When doing course assignments, it is necessary to consult library references other than the prescribed textbooks.

Very Often	Often	Seldom	Very Seldom	Never	Total
36	38	18	6	2	100

14. The College mathematics course provides adequate opportunities for developing teaching materials e.g. worksheets for pupils.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
15	43	16	23	4	101

15. History of Mathematics should form an aspect of Mathematics Education at College.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
22	49	18	10	2	101

16. During Teaching Practice sessions I have found that the College Mathematics course has not prepared me adequately for the reality in the classroom e.g. teaching large classes.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
7	28	12	36	18	101

17. Opportunities are always provided for me to share problems with my lecturers which I encountered during Teaching Practice.

Very Often	Often	Seldom	Very Seldom	Never	Total
34	50	9	4	4	101

18. In my opinion the Academic Mathematics syllabus is too crammed.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
3	13	22	39	23	100

19. Most topics in the Academic Mathematics syllabus are easy to understand.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
5	42	7	44	3	101

20. The College course does not provide adequate opportunity for learning how to use and prepare mathematical learning and teaching aids.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
5	20	6	46	24	101

21. Mathematics videos are used in lectures.

Very Often	Often	Seldom	Very Seldom	Never	Total
7	9	25	17	43	101

22. The College Mathematics Society is active in promoting mathematics education amongst students.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
6	23	12	30	30	101

23. Please give one or two things that you especially like about the College Mathematics course.

24. Please give one or two suggestions for the improvement of the College Mathematics course.

Thank you very much for taking the time to complete this questionnaire.

DENNIS MSOMI

DM/mh/question.mth/w

APPENDIX 2

INTERVIEW SCHEDULE

(Student Teachers)

1. Why did you choose to become a mathematics teacher?

2. In your opinion what do you think the aim of teaching mathematics should be?

3. What can you say about the level of difficulty of mathematics at College?

4. What do you think about the number of topics in the mathematics curriculum?
   Probe: Are they too many,few or just rigt?

5. Referece is sometimes made to problem solving and investigations as approaches to teaching mathematics. What does this mean to you? Is it used in your lectures?

6. What can you say about methods or approaches used in the teaching of mathematics at lectures?
   Probe: Is it predominantly groupwork or lecture talk?

7. In your observations during lectures, would say that mathematics is taught out of textbook most of the time?

8. Do you think subjects like Education Theory and Teaching Science are relevant in your training as a mathematics teacher?

9. How relevant are the Teaching Pracyice sessions to your training? Do you think the number of sessions are enough?

10. The Mathematics Didactics syllabus prescribes a number of demonstration lessons by lecturers for students. Do you find them useful?

11. To what extent do you agree with the statement that mathematics has essentially to do with learning and application of rules and procedures for solving a problem?

12. To what extent do you think the College mathematics course gives you confidence in teaching high school mathematics effectively?

13. In general, what do you like about the College mathematics curriculum?

14. In general, what do you think should be changed in order to improve the College mathematics course?

APPENDIX 3

INTERVIEW SCHEDULE
(Teacher Educators)

1. Do you think that the entrance requirements for mathematics student teachers in the College are reasonable?
   Probe: Mathematics achievement (acceptable standard) or any other personal characteristics.

2. In your opinion what should be the aims of teaching mathematics. Probe: Is the College curriculum compatible with those aims?

3. Is the level of Academic mathematics appropriate for your student teachers.
   Probe: Too difficult or easy?
   Relevant for prospective teachers?
   Too many topics?

4. Are you satisfied with the number of periods allocated to mathematics?
   Probe: Academic mathematics?
   Didactics of Mathematics?

5. The mathematics curriculum of the College tend to emphasize set rules and procedures for solving mathematics problems. Do you agree?
   Probe: Why?

6. In your opinion, is the problem solving or investigatory approach to the teaching of mathematics appropriate for the College?
   Probe: Do you use it yourself? Why and why not?

7. Would you say that discussions between students feature prominently in your lectures?
   Probe: How do you encourage this?

8. Education Theory and Teaching Science are the other courses that your mathematics students have to take at College. How do you rate their relevance to a prospective mathematics teacher?

9. The College curriculum prescribes a number of demonstration lessons by lecturers for students. Are you finding these lessons useful? Why?

10. In your opinion, do the Teaching Practice sessions adequately expose students to the reality of the classroom?

11. What is your role during the teaching practice sessions?
Probe: Follow up to your lectures? Opportunity for integrating theory and practice?

12. In your opinion should the same lecturer teach both Didactics and Academic mathematics or separate lecturers? What are your reasons?

13. In giving assignment to students have you found it necessary to go beyond the prescribed textbook(s)?
Probe: If not what are the constraints?

14. What is usually the nature of the assignments that you set for your students?
Probe: Content based or method based?

15. How often do you use Technology (eg. videos, unifix blocks, cussenaire rods, etc) in your teaching?
Probe: Are they helpful?

16. In some Colleges, mathematics classrooms or laboratories are used for learning and teaching mathematics. In your opinion are these necessary for your College?
Probe: How would you use them?

17. Do you find the reading of mathematics journals useful in improving your teaching?
Probe: How often do you read them?

18. What can you say about the assessment system of your students?
Probe: Internal examinations?
External examination?
General Assessment?

19. Have you or are you currently involved in any research?

20. In general, what aspect of the College mathematics curriculum do you like?

21. In general, what would you change in order to improve the College mathematics curriculum?

APPENDIX 4

ANALYSIS FRAMEWORK FOR THE STUDENT QUESTIONNAIRE

Areas to be Studied
Items on the Questionnaire

A. PERCEPTIONS ON THE NATURE AND AIMS OF MATHEMATICS AND MATHEMATICS EDUCATION

1. In solving a mathematics problem only the answer counts.

2. In my opinion, mathematics is about learning rules and procedures for solving a problem.

3. Problem solving processes like recording, guessing, exploring patterns, etc. are not important in the learning of mathematics

4. Mathematical games/puzzles are important in the teaching and learning of important concept in mathematics.

B. PERCEPTIONS ON THE CURRICULUM PROCESS

5. During maths lectures, most of the talking is done by the lecturer.

6. Discussions between students are encouraged in our lectures.

7. Active involvement of students tend to feature prominently in our maths lectures.

8. In their teaching maths lecturers do give students opportunities to express differing opinions and ideas.

9. Working in groups of two or more is encouraged during maths lessons.

11. Lessons in mathematics are generally presented in a traditional way of chalk and talk.

C. THE USE OF CURRICULUM MATERIALS

10. Mathematical games/puzzles are used in the teaching of mathematics at College.

12. In the College mathematics course, students are encouraged to read mathematics journals.

13. When doing assignments it is necessary to consult library references other than the prescribed textbooks.

14. The College mathematics course provide adequate opportunities for developing teaching materials

D. PERCEPTIONS ON THE CURRICULUM CONTENT

15. History of mathematics should form an aspect of mathematics education at College.

16. During Teaching Practice sessions I have found that the College mathematics course has not prepared me adequately for the reality in the classroom.

17. Opportunities are always provided for me to share problems with my lecturers which I encountered during Teaching Practice.

18. In my opinion, the Academic mathematics syllabus is too crammed.

19. Most topics in Academic mathematics are easy to understand.

20. The College course does not provide adequate opportunity for learning how to use and prepare mathematical learning and teaching aids.

21. Mathematics videos are used in out lectures.

E. GENERAL

22. The College Mathematics Society is active in promoting mathematics education amongst students