ENTRANTS TO TRAINING COLLEGE.

An investigation into the ability in, aptitude for and attitude towards Arithmetic and Mathematics, displayed by entrants to Training Colleges for White persons in the Cape Province.

Thesis

Submitted in Partial Fulfilment of the Requirements for the Degree of

MASTER OF EDUCATION

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by

IAN ANDRI VENTER.

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Dedicated to

Erik and Carl.

That they may grow in knowledge as well as insight.

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It is my pleasure to acknowledge my debt of gratitude to the many people whose help and interest made this research possible.

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I.A. Venter.

Somerset West.
January, 1973.

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PART I

CHAPTER I

INTRODUCTION

In many cases topics for research are presented to a student in capsulated, clearly defined terms, either as the result of his own experience or as a request by some institution. In other cases the topic takes shape but gradually, very often as the result of a student slowly becoming aware of a field of research through repeated observation of related factors. In some cases the aim of research is to determine whether there is a relationship between various factors; in others the main aim may be to prove or disprove such relationship in unequivocal terms. A large body of research is, however, concerned mainly with the statement of a problem or the finding of facts.

The work presented in the following pages can be regarded as falling in the last-mentioned category. A vague suspicion was gradually strengthened by observation and experience until it finally crystallised to form the basis of the research. Facts and figures were gathered and analysed and some conclusions drawn, conclusions that gave rise to more questions and problems than fall within the scope of this work. It was, in fact, found that this research raised more questions than were answered by it and served mainly to underline the magnitude of the problem rather than to offer a solution.

1.1 The beginning.

In retrospect, I can pinpoint the occasion when the germ of the idea that led to this work was implanted. A few weeks before the September examinations, in my first year of teaching, I was approached by the Standard 5 form teacher who requested me to explain a certain sum to him. This sum appeared in an exercise in the Arithmetic text-book for Standard 5. It soon transpired that this teacher, a man with more than 20 years' experience of teaching in the Primary School, wanted to set the sum in question as a problem in the examination paper, but did not have the faintest idea of how it should be tackled, or what reasoning, or 'method' as he called it, should be used! The very next year I was faced with a similar request, but this time it was put by a Primary school teacher fresh from a Teachers' Training College. In subsequent years this occurence was repeated at least five times and in one case the teacher involved offered himself as a student for lessons in basic Mathematics.

In each case I found that the teachers who approached me were not baffled by the arithmetic involved in solving the problems, but did not know "where to start". It was not so much the "how" that caused the trouble as the "why".

I was eventually fortunate enough to be made responsible for the teaching of Mathematics in a school from Standard 6 through Standard 10 and was immediately struck by the fact that pupils in Standard 6 could do mechanical computations and simple manipulation of numbers with great facility, but could rarely give a reason for using certain "methods". Many also had difficulty in solving "word problems" and found it all but impossible to express their thoughts, as far as mathematical problems were concerned, in words.

Personal experience during the ensuing years and discussion with other teachers of Mathematics led me to the conclusion that this phenomenon was fairly general. At the same time it was fairly obvious that the pupils who could not cope with basic reasoning in Arithmetic in Standard 6 managed to pass in the Junior Certificate examination in Mathematics with more than a fair degree of success.

This apparent improvement in Mathematical ability could be attributed to the greater maturity of a pupil in

Standard 8 compared to that of a pupil in Standard 6, but I felt that, although this factor could not be ignored, it was contributory rather than the sole cause. I was further strengthened in this belief by the fact that the Junior Secondary Course is designed to

> "... provide educational apportunities for pupils with an Intelligence Quotient of +75 and above, according to the N.S.A.G. tests". (Cape Education Department, E321/0/1963.)

This does not necessarily mean that a pupil with an I.Q. equal to that of a person usually regarded as dull-normal can successfully study Mathematics to Standard 8 level, but it can be interpreted as meaning that the course as a whole, including Mathematics, is within the capabilities of the normal, average pupil.

One further aspect merits consideration at this stage, viz. that Mathematics is a compulsory subject in Standard 6 but optional in Standards 7 and 8 in schools under the Cape Education Department. It may therefore be said that the pupils with little aptitude for Mathematics do not continue with the subject in Standards 7 and 8, and that the apparent improvement often noticed in these years of the course can be attributed to the fact that it is mainly the "brighter" pupils who continue with the study of the subject. This is very often the case, but my own experience leads me to regard this view with a certain amount of scepticism. I have known pupils who had failed Mathematics in Standard 6 and yet achieved "C", "B" and even "A" symbols for Mathematics in the Junior Certificate. Many other teachers can also attest of pupils who were considered to be weak at the subject at Standard 6 level but performed well, if not extremely well, in Mathematics during the later years of their school careers. In many cases this improvement can possibly be attributed to the fact that these pupils had to start "at the beginning", with the most rudimentary Algebra and Geometry, in

Standard 6, and that the majority were taught by specialist teachers with Mathematics as a degree subject -- teachers who not only knew what they were teaching, but also had a thorough understanding of the principles of the subject.

1.2 A conclusion as a start.

These observations, as well as my experiences with teachers mentioned in the previous pages, led me to the conclusion that there was a deficiency in the teaching of Arithmetic and elementary Algebra and Geometry in the Primary school. I include elementary Mathematics, because the Arithmetic taught in the Primary school necessarily includes many concepts later formalised in the teaching of Algebra and Geometry in the Secondary school. It would also be futile to attempt to define where Arithmetic "ends" and Algebra and Geometry "begins".

In my opinion the weakness lay with the teachers, who could teach the pupils to perform the more mechanical type of manipulations to perfection, but could not lead them towards insight and understanding.

I must state at this stage that the foregoing is purely my own opinion, based on my own experience and unsupported by facts. But it was precisely this unsupported opinion that led to the investigation and the results which are presented in the following pages.

1.3 The aim of the research.

Discussions with teachers, headmasters and two Inspectors of Schools led to the decision to make an effort to find out whether there were actual weaknesses in the teaching of Arithmetic in the Primary school on the part of the teacher. Further discussion with members of the Faculty of Education of Rhodes University, and in particular, discussions with Professor A. Noble, led to the final crystallisation of the main topic of research.

It was decided to start as far back as possible as far as the Primary school teacher is concerned, that is, with students entering Teachers' Training Colleges for their first year of training. An attempt was to be made to determine the Mathematical competence and qualifications of these students as well as to investigate their attitudes towards Arithmetic and Mathematics. Attention was also to be paid to such factors as Anxiety levels and general levels of intelligence as a subsidiary study, complementary to the work being done by Professor Noble.

Following the advice of Wiseman (1966), accounts of particular aspects of previous work has been inserted in the experimental section of the thesis rather than in the first review of pertinent literature.

CHAPTER II

AN OLD PROBLEM, STILL UNSOLVED

Concern about the teaching of Arithmetic in The Primary school and of Mathematics in the Secondary school is no new manifestation in South Africa. This concern has been shown not only through research done by individuals such as Groenewald (1944) and Behr (1962) to name but two, but also by research done by the Cape Education Department on a Provincial basis in 1944 and 1945, as well as research on a national basis undertaken by the National Bureau for Educational and Social Research (now the Human Sciences Research Council) during the period 1961 to 1964.

2.1 Arithmetic in Schools in the Cape Province.

Up to 1935 Arithmetic was the main subject of instruction and inspection in the Primary school. In that year a change was made from individual to class inspection and Arithmetic began to receive less attention than was previously the case. The decrease in emphasis on Arithmetic was further aggravated by the introduction of new subjects in the Primary school.

In the Secondary school, Arithmetic was compulsory for all candidates at the Junior Certificate examinations until 1921, when the Cape Education Department instituted its own Junior Certificate examination. (Cape Education Department, 1947).

The new Junior Certificate examination made provision for a choice from a large variety of subjects. This resulted in a large number of candidates omitting Arithmetic and Mathematics from their courses. The number of such candidates increased anually until the stage was reached in 1945 when nearly 22% of the candidates did not offer either of these subjects for the Junior Certificate examinations. In that year there were even four Secondary schools for Whites that did not offer Arithmetic, Commercial Arithmetic or Mathematics for the Junior Certificate!

Up to 1950 the school leaving age was 16 years, or Standard VI. Thus the Standard VI examination, with Arithmetic as a compulsory subject, was an important milestone in a pupil's school career; in many cases as important as the present Senior Certificate examination. In 1950, however, the school leaving requirements were raised, becoming 16 years of age or Standard VII, and in 1952 this was further raised to 16 years of age or Standard VIII. In the same year Standard VI was taken from the Primary school and made an integral part of the Secondary school. (Behr and Macmillan, 1966). Thus one of the last measures for enforcing Arithmetical training at school beyond the Standard V level, i.e. for more than seven years, disappeared. The only factor that could now compel a pupil to study some form of Mathematics in the Secondary school was the requirements for the Junior Secondary Course. These requirements offered, however, a "way out". This aspect will be fully discussed at a later stage.

2.2 An Investigation by the Cape Education Department.

Towards the end of 1944 a meeting was held in the offices of the Cape Education Department at the request of the Universities of Stellenbosch and Cape Town. The aim of the meeting was to draw attention to the inadequate knowledge of Arithmetic of many school-leavers. As a result of this meeting, the Superintendent-General of Education, Dr W. de Vos Malan, appointed a Committee "to report on the question whether --

(1) primary **pupils** at the Standard 6 stage attain a standard adequate for

(a) The ordinary needs of life, employment and apprenticeship, and
(b) post-primary courses:

(2) the attainments of pupils in Standard 7 and Standard 8 in Arithmetic are adequate for

(a) apprenticeship and
(b) for courses for which the entrance requirement is the Junior Certificate;

(3) the attainments of pupils in Standard 10 in Arithmetic are adequate for courses for which the entrance requirements is the Senior Certificate or the Matriculation Certificate;

and, in the event of it being found that pupils leave school at any stage inadequately equipped, to report on and make recommendations (where necessary) in regard to ..... the desirability of including Arithmetic in the Junior and Senior Certificate courses as a compulsory subject".

This committee, with Inspector B. F. Barnard as chairman, devised a series of tests for Standards 6 through 10 and eventually tested a total of 29 521 pupils, i.e. all the White pupils in the abovementioned standards in the schools of the Cape Province at the end of 1945. A further 530 pupils in Standard 6 were used in experimental classes in order to determine validity, correlations with existing tests and a criterion of ability.

The report of this committee was published by the Cape Education Department in 1947 under the title

"Investigation into the Teaching of Arithmetic in Primary and Secondary Schools".

2.3 Some results of the investigation.

Based on the findings of the investigation and the views of 31 Inspectors of Schools, the committee was of opinion "That the standard attained by ... pupils in arithmetic at the Standard VI stage is not adequate for the ordinary needs of life.†

"That the progress of pupils taking post-primary courses is sometimes retarded in subjects where certain basic calculations are a requirement.

"That pupils taking arithmetic and mathematics in Standards VII and VIII are on the whole well enough grounded in arithmetic for further studies at high schools or other educational institutions. Those not taking arithmetic and mathematics in Standards VII and VIII will be considerably handicapped in their progress.

"That pupils taking arithmetic OR mathematics in Standards VII and VIII are less competent than the first mentioned group; (i.e. the group in the previous paragraph)* and that pupils taking neither arithmetic nor mathematics in Standard VII and VIII do not possess the necessary arithmetical competence for apprenticeship where Standard VIII is the entrance qualification.

"That pupils taking arithmetic and mathematics either to Standard VIII or to Standard X are as a rule quite competent to do the necessary calculations in connection with their subjects at the universities or technical colleges. This is to a lesser extent the case with pupils taking arithmetic or mathematics up to Standard VIII or Standard X. Those taking no arithmetic or mathematics after Standard VI will be badly handicapped in a large number of subjects at the universities, technical colleges and training institutions. †

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† Underlined by the author.

* Inserted by the author.

2.4 A recommendation by the Barnard Committee.

With regard to its Terms of Reference, the Committee felt that an integrated course in Arithmetic and Mathematics should be compulsory for all pupils up to and including Standard VIII. The Committee regarded this as of great importance since its investigation had led it to the inescapable conclusion that a student teacher who had not taken Arithmetic to a level higher than Standard 6 was not adequately grounded in Arithmetic to teach the subject in the Primary School. It felt that, if this recommendation was not adopted, it would be necessary to make Arithmetic or Mathematics to the Junior Certificate standard a pre-requisite for obtaining a Primary Teacher's Diploma.

This recommendation regarding a compulsory course in Arithmetic or Mathematics for the Junior Certificate examination was adopted by the Cape Education Department and is found as a regulation in the current Rules governing the Junior Secondary Course. (Cape Education Department, E321/0/1963). These rules do, however, make provision for exemption from the compulsory course. This will be dealt with ingreater detail at a later stage.

2.5 An independent investigation.

In 1944 H. J. Groenewald was awarded the degree M.Ed. by the University of Stellenbosch on the thesis "The Arithmetical Ability of Future Primary Teachers in Certain Training Institutions in the Cape Province".

His findings accentuated the need for a minimum qualification in Arithmetic or Mathematics as entrance requirement for Training Colleges.

Testing 691 students in the course of their training, he found that 51% of the future primary teachers were either weak or very weak in Arithmetic, according to tests based on the Standard 6 syllabus. His group included 435 students who had taken Arithmetic and/or Mathematics in the Secondary School!

Groenewald found that the main weakness was a lack of knowledge with regard to how arithmetical problems should be solved. He also found that many student-teachers lacked knowledge of fundamental concepts such as average, factor, multiple, etc.

In order to check his conclusions based on one omnibus test, Groenewald sent a questionnaire to lecturers in Arithmetic at Training Colleges, in which they were asked to express their views on the Arithmetical ability of the student teachers. Their answers led him to conclude that his results were a good indication of the actual situation.

It is apparent from the preceding discussion that all was not well with the teaching of Arithmetic in the Primary school and that much was lacking at Training College level as well.

Students entering the teaching profession without a thorough grounding in the basic principles of Arithmetic cannot teach the subject in such a way as to inspire their pupils. This in turn can result in many pupils "dropping" Arithmetic or Mathematics at the earliest possible moment. These pupils can still, however, gain the Senior Certificate and enter Teacher Training Colleges, qualify as teachers and return to the Primary School were they will very likely be compelled to teach Arithmetic, thus completing a sad, vicious circle.

2.6. South Africa is not unique in this respect.

In England the Department of Education and Science (1969) reported that virtually all teachers had to teach Arithmetic in the Primary schools --- a condition which can be regarded as identical to that in South Africa. It was further found that a high proportion of students in Training Colleges had already developed a strongly negative attitude towards Mathematics while still at school. This was found to be true especially in the case of women students. It was felt that if this negative attitude was not corrected, it could result in the vitiation of the teaching of Arithmetic and Mathematics in schools for many years to come.

The conclusion was that the "vicious circle" which had been established had to be broken in the Training College, because it was there where the teachers were trained who would largely determine the attitudes towards Mathematics of the next generation.

In the Curriculum Bulletin No. 1 published by the Schools Council (1966) the opinion is expressed that "...no subject arouses so much distaste in boys and girls as mathematics." Dr. J.B. Biggs is quoted as attributing this distaste to the teaching and being of the opinion that the negative attitudes could be attributed to a lack of proper understanding of the subject which is in many cases due to plain boredom and mechanical teaching.

It is a widely accepted fact that such mechanical teaching, the learning of "rules" and their applications, the teaching of how to solve certain "types" of problems, the acquiring of the skill without the understanding, does not necessarily lead to so-called " bad " results as far as examinations are concerned. Thus one finds in "The Times Educational Supplement" (1964) the editorial comment that

> "Arithmetic can be learnt, and learnt quite effectively, with very little understanding of the mathematical concepts involved. What is often not learnt - or learnt only by accident - is the basic mental operation that underlies all later mathematics as well - the recognition of mathematical relationships in the environment".

The result of such rote learning, of applying the 'rules', of teaching based on memorising, can only have a deleterious effect on Arithmetic and Mathematics as a whole. Criticism of this type of teaching is not a new phenomenon when it is considered that the school system of the United States was criticised for encouraging memorising and neglecting reasoning more than sixty years ago by Arthur Schultze (1912).

Schultze expressed the opinion that

> "In many schools good mathematical teaching is not understood, not appreciated, ... while the ficticious results of the drillmaster are highly commended. Instead of real mathematical work, a cramming process is employed that is not only useless, but positively harmful to the students. No other subject suffers so much and becomes so valueless as Mathematics, when treated by mechanical methods of study".

These remarks are as true today as they were sixty years ago. So too, is his statement that

> "Students fail to grasp the spirit of the subject, and are often unable to apply their knowledge to advanced work or practical problems. All who have had the opportunity to test the mathematical training of the average student a short time after his graduation agree that this training is exceedingly slight"

The results of this investigation will show that the situation in general has not changed much during the intervening fifty years and that Schultz's remarks on American students are still at least partially applicable to students in the Cape Province today. This research will show that the average arithmetical ability of a student entering Training College three months after writing the Senior Certificate examination is on a par with that of an average pupil in Standard 7, i.e. the entrant to Training College has an "arithmetical age" of 14 - 15 years!

2.7 Some changes in Education in the Cape Province.

The basic pattern of education in the Cape Province has undergone far-reaching changes since the days of the Barnard Committee of 1947.

One of the most important changes was the previously-mentioned reorganisation of the whole school system which resulted in the inclusion of Standard 6 in the Secondary school. (page 7) The inclusion was optional during a transition period of two years, 1951 to 1952, and became compulsory in 1953.

This move was preceded by intensive investigations and resulted in new syllabi for both Primary and Secondary schools. Special attention was paid to the syllabus for Arithmetic in the Primary school, since one of the facts of major importance was that the syllabi for the Junior Secondary Course, now extended over three years, was based on the new Primary school syllabi and was designed as a continuation of the Primary school syllabi. (du Toit, P. S., 1970) In this respect it anticipated at least one of the requirements of a modern syllabus, as stated by McGee (1963), by more than ten years. It satisfied McGee's requirement in that it developed fairly consistently from the introduction to numbers in the junior school, through Primary school Arithmetic and on through the Secondary school Mathematics courses. Teachers were urged not to teach topics in isolation and independent or isolated skills were not encouraged. A by-product of the continuity of the programme could then be the maximizing of transfer.

According to Behr (1968) this transfer does not necessarily mean that a knowledge of and general training in Arithmetic would automatically be transferred to other activities, but rather that Arithmetic, if it is well taught, can influence a pupil's general attitude and his approach to the tackling of problems in other situations.

Another new syllabus was introduced in Standard 6 during the years 1967 - 1968, providing for even greater continuity in the work of the Primary and the Secondary school. This continuity was further strengthened by the introduction of the concept of Sets in both Primary and Secondary courses in Arithmetic and Mathematics.

Should it then be found that a pupil entering the Secondary school at Standard 6 level does not display the ability and insight required for the very basic Mathematics of that school year, but yet displays normal achievement in other fields, has a normal (or even high) I.Q. and is generally well adapted, the fault is not likely to be found in either the syllabus or the pupil, but rather in the way in which Arithmetic and basic Mathematics were taught to him in the Primary school.

The term "taught" is used intentionally, since it is unlikely that the more modern methods leading to pupil-discovery of mathematical concepts will result in a lack of understanding of the basic arithmetical and mathematical principles. This fact is amply illustrated by the large number of examples of pupil-experiments leading to meaningful insight and learning of mathematical concepts given in the Schools Council publication "Mathematics in Primary Schools". (1966) On page 45 of this publication an example is given of a class of nine-year-olds (approximately Standard 2) performing experiments to find the thicknesses of strands of wool, thread and nylon. During these experiments they gained insight not only in the meaning of fractions, but also understanding of a difficult idea, viz. that 40 may be greater then 4 (for example), but $\frac{1}{40}$ is much smaller than $\frac{1}{4}$. Do the pupils in our schools discover and learn this fact, or is it taught to them?

2.8 <u>The change in emphasis.</u>

It requires no more than a relatively superficial perusal of the present syllabi for Arithmetic in the Primary schools of the Cape Province to realise that a greater value is placed on understanding of arithmetical principles than ever before and that the mere mechanical aspects of the subject are not being regarded as being of such supreme importance as was the case in the past. This is shown clearly by the fact that, in "Syllabus in Arithmetic, Standards III to V". (Cape Education Department, E303/1) the General Remarks preceding the syllabus for each of these standards are preceded by the sentence "The forming of concept is the chief aim of instruction." in extra-bold type.

According to Behr (1968) the modern approach can be summarized as more of an education in mathematical ideas and less of a training in arithmetical jugglery. The same principle is advocated by Butler and Wren (1960) when they state that

> "Current curriculum revision in both elementary and secondary school Mathematics continues to place emphasis on the fundamental structure of mathematics, the understanding of notational patterns, the clarification of definitions, and the refinement of basic terminology".

The whole educational system of the Cape Province is at the time of writing in the throes of another massive reorganisation which will require a very close co-operation between the Primary and the Secondary school. This co-operation will be imperative, since it is envisaged that Standard 5, the senior class of the Primary school, will become the lowest class of the first three-year period of secondary education, while still physically remaining part of the Primary school. Such a system will necessitate even better co-ordinated Primary and Secondary syllabi and it is not unrealistic to expect that the understanding of mathematical concepts will be even more strongly advocated than at present. In this sense the curriculum for Mathematics will be more modern than those of previous decades when viewed in the light of recent American thought as expressed by Brumfield et al (1963). These authors make it clear that basic mathematical concepts should be introduced as early as possible, and that more attention should be given to mathematical <u>ideas</u> than had been the case in the past, regardless of the level of student attainment. They feel that the natural place to begin such a program would be the junior high school (in the U.S.A.) since they were of opinion that many good students had an excellent understanding of arithmetic by the end of 'grade six'.

When it is borne in mind that 'grade six' in the U.S.A. corresponds with Standard 4 in the Cape Province, it becomes obvious that the present reorganisation creates an ideal opportunity for introducing a modern, integrated mathematics curriculum; a curriculum which can provide for an uninterrupted development of mathematical knowledge and skill in both Primary and Secondary schools. Such a development can then be consistent from the introduction to numbers during the first school year of a pupil, through Primary school to Secondary school and eventually to modern university mathematical courses.

The Cape Education Department makes it quite clear that such a continuous development is one of the main facets of the already-mentioned reorganisation when it states in "The Application of a National System of Differentiated Education in Schools in the Cape Province" (1972) that:

"(a) Although, - as a result of the new alignment - Standard 5 will become the first stage of the new Junior Secondary School Phase, the Standard 5 pupils will not be transferred to the secondary areas of secondary or high schools but will remain in the primary schools or areas where they are currently being taught.

(b) This ruling makes it essential that Standard 5 teachers should make a careful study of the syllabuses for those Standard 6 subjects in which the instruction commences in Standard 5. (Afrikaans, English, Mathematics, General Science, History, Geography, Art and Handwork). This will ensure that continuity and a proper standard of instruction are maintained during the Junior Secondary School Phase.

(c) Further, it is desirable that there should be close contact between teachers in primary and secondary and high schools in order that the continuity and the standard referred to may be ensured. This may be effected through mutual consultation, under the guidance of Inspectors of Education if necessary".

2.9 The Teachers.

The most modern, most integrated curriculum cannot, however, contribute much towards pupil-understanding of mathematical concepts if the teachers themselves lack this understanding and are therefore incapable of implementing the aims of the curriculum. The teacher who does not understand cannot lead the pupil to understanding through discovery; the teacher who does not have the knowledge cannot even teach. The Dutch educationalist, Prof. E. W. Beth, postulated three principles necessary for the effective teaching of Arithmetic and Mathematics. (Beth, 1962). The most important principle was "Het principe van de deskundigheid van de leraar", i.e. the principle of the expertise of the teacher. Thus, according to Beth, the teaching of Arithmetic cannot be done effectively by a teacher who is not an expert, who does not understand the principles of the subject or have full knowledge of the facts.

Butler and Wren (1960) express a similar view when they state that

> "There are two equally important aspects of any profession, viz., significant knowledge and effective technique. One cannot be efficiently professional if there is any distinct weakness in either part. .... the prospective teacher of Mathematics should (therefore)... not only strive for proficient mastery of the subject but also make every effort to be conscious of the processes by which he arrives at that mastery".

The results in some of the following pages will make it clear that many students enter Training Colleges with an abysmal lack of understanding of arithmetical ideas, as well as poor ability in nearly every form of mathematical manipulation. It is difficult to see how these students will be able to cope with the demands made by a 'modern' syllabus or how they can ever become 'expert' or even good teachers of Arithmetic.

In a massive investigation covering all aspects of Mathematics in Secondary schools in South Africa, Dr A. J. van Rooy (1965) reports that one headmaster was of opinion that the investigation should have started in the Primary school. This headmaster gave examples of pupils entering Standard 6 without the realisation that 10 + 2 = 12 while others had to have three attempts at dividing 63 by 7. These pupils had not grasped the basic concepts of numbers in the Primary school. Others, in the opinion of this headmaster, enter the Secondary school with a fear of Mathematics which had developed in the primary school, a fear caused by poor arithmetical ability which can be ascribed to indifferent or poor teaching of the subject.

It is of little purpose to maintain that such pupils have no aptitude for the subject, or are not intelligent enough, or to find other such 'popular' reasons for this weakness in their educational background. Kolmogorov (1962) is convinced that the necessity for some special ability in order to study Arithmetic or Mathematics is vastly overrated and that the impression that Mathematics is a 'difficult' subject is mainly attributable to a poor, too formal a method of teaching and explaining of the basic principles.

Support for this view can be found in the Schools Council publication "Mathematics in the Primary School". (Schools Council for the Curriculum and Examinations, 1966). On page 110 an eight-year old with an I.Q. of 75 is reported as writing:

> "After the work we find we know new things which we did not know before.
> With every card I discover new things to talk about when I get home".

On page 105 another example is quoted of pupils stating:

> "There is 0 at the end of every figure when you count in tens.

"When you count in 5s it goes like a pattern". These remarks came from a group of children with ages ranging from five to eight. The significance of these remarks lies not so much with the I.Q. or the age of the pupils, but in the fact that these pupils were learning Arithmetic by means of informal, interesting experiments under the unobtrusive and expert guidance of a well-qualified teacher.

Remarks such as those quoted on the previous page lend further substance to the opinion of Brumfield et al (1963) that even very young students, both strong and weak, are attracted to and fascinated by relations between numbers and that there is a strong natural tendency to be interested in abstract relationships for the sake of the patterns that present themselves.

Natural interest in Arithmetic will not, however, flower in an atmosphere of traditional, formal teaching where "teachers tend to do too much and pupils too little. The complaint has often been made that ... the pupils themselves did little independent exploration". (Behr and MacMillan, 1966). What is required is an approach which will give pupils the opportunity to learn the concepts in an active manner and to discover basic Mathematical truths through investigation and experiments. Such methods have proved to be most successful wherever they were applied. If one therefore finds pupils in Standard 6 who have not yet grasped the basic concepts of numbers, the weakness lies not with the pupil, nor with the syllabus, but rather with the methods that were used and the way in which certain methods were used by some teachers in our Primary schools.

2.10 Some possible reasons why the 'old' methods persist.

The preceding discussion leads one to wonder, quite naturally, why our teachers persist in using the 'old' methods in the face of accumulated evidence of their ineffectiveness. One possible reason is that it may be difficult to change from the formal, verbal communication type of teaching to the extensive use of concrete materials. Williams (1967) is of opinion that when

> "permitting pupils to progress at their own differing rates, he (the teacher) is likely to feel the strain".

This situation can be further aggravated by the fact that, according to the same author,

> "teachers at the primary level are both very likely to need to learn the new content, and very likely to find this learning difficult, for ... they are unlikely to be mathematically trained to a reasonable level".

Ausubel (1968) expresses a similar view. In discussing discovery techniques in learning Mathematics included in a program devised by the University of Illinois Committee on School Mathematics, he states that

> "For one thing, the students entering the programme, being victims of conventional arithmetic teaching in the elementary school, do not have a sound, meaningful grasp of the rudiments of mathematics, and have to be re-educated, so to speak, from scratch".

Land (1960) found that "the Vernon test discloses such gross shortcomings in simple Arithmetic that very many students will have to spend much time on basic Arithmetic in the course of their training".

The result of such lack of knowledge and understanding can only lead to apathy on the part of the teacher, with little or no desire to re-learn mathematics in order to be able to use methods proven to be more effective than the 'old' methods. They are, furthermore, very likely to show no great interest in the subject and, in their teaching, can do no more than treat it in a superficial and fragmentary way. (Bell,1970)

It is thus not difficult to picture the self-propagatory nature of the 'old' method, and the corresponding difficulty that a teacher may encounter in an effort to apply discovery techniques. Part of the difficulty may be found in the teacher's own lack of mathematical background, understanding and knowledge due to the 'old' method by which he himself was taught.

2.11 Credo.

I wish to reiterate that it is my belief, a belief backed by findings of research in South Africa as well as in other Western countries, that no method, however much active learning it involves, and no syllabus, however "modern" it may be, can ever lead to truly effective Mathematical teaching unless the teacher is capable of using the methods effectively in order to exploit all the opportunities offered by a modern syllabus. This presupposes a thorough understanding of the mathematical concepts on the part of the teacher, as well as a high degree of proficiency in basic mathematics and a healthy, enthusiastic attitude towards teaching in general and the subject in particular.

It is my intention to show in the following pages that a large number of student teachers entering Training Colleges display neither the required degree of understanding and ability in basic Mathematics, nor the desired attitude towards the subject.

CHAPTER III

ENTRY TO TEACHER TRAINING COLLEGES IN THE CAPE PROVINCE

3.1 Educational Requirements.

The educational requirements for entering a Training College, as given in the rules governing the training of European teachers in Training Colleges (Education Gazette, 14th July, 1960) is that

> "... the applicant has passed the Cape Senior Certificate examination or another examination recognised by the Department as equivalent to the Cape Senior Certificate examination and that he has passed both official languages".

No mention is made of Mathematics, Arithmetic or Commercial Mathematics as an entry requirement, in spite of the fact that the majority of Primary school teachers will be expected to teach Arithmetic as a normal part of their duties.

The abovementioned rules comply with the rules recently set out in "Criteria for the Evaluation of Qualifications for Purposes of Employment in Education" (Republic of South Africa, 1971), which are applicable, inter alia, to the training of teachers in all the provinces of the Republic. In the section dealing with the Primary Teachers' Diploma, the only requirement other than a Senior Certificate or equivalent qualification, is a pass in both official languages, at least one being passed in the Higher grade. No mention is made of any mathematical subject.

It would appear that the abovementioned regulations are stricter than those applicable to British Colleges of

Education where, according to the Clearing House (1969), 3,5% of the students accepted in 1968 did not have at least a G.C.E. "O" level or equivalent pass in English. It is also worth noting that 27,5% did not have at least an G.C.E. "O" level, or equivalent, pass in Mathematics.

3.2 Exemption from a Mathematical subject.

A pupil cannot, however, reach the Senior Certificate level without having completed the Junior Secondary Course with some degree of success. In this latter course a pupil is compelled by regulation to study either General Mathematics or Commercial Mathematics and Accountancy. (Cape Education Department, 1963) These regulations contain, however, a loophole as far as entry to Training College is concerned, in the form of a concession on page 9, rule 23, that

> "In special circumstances, as when a pupil clearly cannot benefit from further instruction in Mathematics or in Bookkeeping and Commercial Arithmetic or when the interests of a pupil's career clearly require the concession*, the Inspector of Schools may exempt such a pupil from having to take Mathematics or Bookkeeping and Commercial Arithmetic in Standards 7 and 8, provided that one of the following alternatives is chosen:
>
> (a) Social Studies or a third language, provided further that such a pupil also takes two of the following subjects: Woodwork, Agriculture, Art or Art-Craft, Needlework and Dressmaking, Domestic Science, Music, or
>
> (b) Social Studies and a third language.
>
> The Inspector's written authority to introduce the foregoing alternative shall be obtained when the pupil is admitted to Standard 7 and this authority

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* Underlined by the author

shall be submitted to the Department at the time the pupil is entered as a candidate for the Junior Certificate Examination."

This concession means that a pupil can obtain the Senior Certificate and enter a Training College for teachers without having studied a mathematical subject during the last four years of his or her school career and with a knowledge of Arithmetic which has been found to be inadequate for the ordinary needs of life. (Cape Education Department, 1947)

It is further highly improbable that a pupil who 'cannot benefit from further instruction' in a mathematical subject will choose the alternative of the more academic 'Social Studies and a third language', especially when it is considered that the third language generally offered by schools in the Cape Province is either German or Latin and that a course in either of these languages is generally considered as being 'difficult'.

3.3 A weakness in the Regulations.

The abovementioned regulations reveal at least one other weakness as far as entry to Training College, coupled to a Mathematical qualification, is concerned. The regulations governing the Junior Secondary Course and the Junior Secondary Examination require that a pupil shall pass in five of the six subjects included in the course, two of these subjects being the two official languages. It is therefore possible to find pupils who have studied a mathematical subject in standards 6, 7 and 8 with a total lack of success and who yet obtain the Junior Certificate and thereby fulfil the requirements for the Senior Certificate Course; the course which can eventually lead to entry to a Training College. Such a person, too, will suffer from a totally inadequate knowledge of Arithmetic.

The Committee conducting the investigation into the teaching of Arithmetic in the Primary and Secondary schools (Cape Education Department, 1947) recommended that

> "... it will be necessary to demand a knowledge of Arithmetic or Mathematics equivalent to that of the Junior Certificate standard as a prerequisite for obtaining a Primary Teacher's Certificate." (page 61)

The same committee reported that University professors of Education expressed the view that

> "... a student wishing to become a teacher should know more of the mathematical aspects of life than he could learn up to and including Std VI, one of the reasons being that he is not mature enough in Std VI to grasp and appreciate everything that he should learn about arithmetical matters." (page 89)

The results of this investigation, presented in the following pages, will reveal that in 1969, 22 years after the publication of the findings of the abovementioned Committee, more than 12% of the students entering Training Colleges in the Cape Province still did not study any mathematical subject beyond the Standard VI level!
This means that the Training Colleges have to deal with more than 90 students, who may eventually teach more than 3 000 pupils in any one year, whose knowledge of Arithmetic must be raised from a level at which it is insufficient to meet the needs of everyday life to a standard acceptable for the teaching of the subject. At the same time these students must be trained in effective teaching methods. All this must be done in the course of three years' training, with students who were four years previously regarded as not being able to benefit from further instruction in a mathematical subject. (See also page 45.)

It is impossible to believe that these students were allowed the concession with regard to a mathematical subject in the Junior Secondary course in the interest of their careers, when these careers eventually turn out to be that of teaching. It requires no more than a relatively superficial grasp of the duties of and the demands made upon teachers in the Primary school to make it clear that there is not any form of teaching, whether in the guise of either general form-teaching or the teaching of a specialised subject such as art, music or physical training, to name but three, which does not require a reasonable knowledge of Arithmetic.

3.4 No need for Arithmetic......

There are today still headmasters of schools, and even heads of Training Colleges, who will advance the argument that a student wishing to qualify as a teacher of a specialised subject such as music, art, physical education, woodwork, etc., does not 'need' a knowledge of Arithmetic or Mathematics at the Standard 8 level, and who will stand by this 'argument' in spite of well-founded, authoratative counter-arguments such as, for example, that put forward by Brueckner and Grossnickle (1953) who state that

> "... the teacher should ... recognize the possible contributions instruction in arithmetic can make to the social objectives of all education. Many of the experiences pupils have in school that are rich in application of number can be designed as experiences in democratic living. Here the teacher can so conduct the learning program that intelligence ... forms the basis of action. Actual practice in solving problems of daily life that are of concern to the pupils is a most valuable type of experience in democratic living. In most instances arithmetic makes valuable contributions to these experiences".

In a similar context Butler and Wren (1960) is of the opinion that

> "No teacher ... has met his full responsibility to his students until he has provided them with a sound basis for the appreciation of the social and cultural significance of number from the point of view both of historical fact and of contemporary potential".

If one therefore accepts the fact that Arithmetic forms an important part of life in all spheres, whether cultural or commercial, whether physical or aesthetic, (and it is extremely difficult not to accept this fact) one cannot but cast serious doubt on the judgement of persons who cannot see the necessity for Arithmetic in the general background of the teachers of the future generations. It may be that such people are more concerned in the fate of individual students than in the fate of the thousands of pupils whose mathematical background may suffer through the direct or indirect influence of such students once they are qualified to teach. In how many cases are students accepted at Training College, or promoted to the next year of the course due to the fact that desirable qualities of character, personality and behaviour are allowed to outweigh the lack of equally desirable and essential qualities of ability and achievement in the academic sphere in general and in Arithmetic and/or Mathematics in particular? This question alone offers a fertile field for research and investigation.

3.5 Students with special abilities.

One cannot deny the existence of pupils and students who are unable to achieve satisfactory standards in the academic sphere but who possess some 'special ability' in subjects such as music, art, art-craft, etc. There is also evidence that special abilities reach maturity later than the so-called general ability. (Valentine, 1965)

Such maturity may be reached at a relatively late stage in the person's development, and the ability may become "obvious" or sufficiently developed to be of "value" only by the end of adolescence (Derville, 1966). One can thus expect to find students entering Training College who possess such special abilities but who will reach full maturity in this respect only during the course of their training. This fact may serve as partial justification for the arguments of the heads of schools and Colleges mentioned in the previous pages.

Can one accept the fact that all of the 97 students mentioned in the previous pages, i.e. those students who had been exempted from taking a mathematical subject to Junior Certificate level, possess some or other 'special ability' to such a degree that they would not need a basic knowledge of Mathematics in their teaching careers and will, furthermore, never be asked to teach Arithmetic in the Primary school?

3.6 The shortage of teachers.

An argument often raised in defence of these students with a less than satisfactory standard of Mathematics is that any regulation making Mathematics of either Junior Certificate or Senior Certificate level a prerequisite for entry to Training College is the shortage of teachers experienced in the Primary schools in the Cape Province, a shortage which has increased steadily over the past years, from 21,52% in 1966 to 26,63% in 1970. (Cape Education Department, 1970). In this respect the Cape Province seems to be in a more unfortunate position than the other provinces. The Transvaal Education Department (1970), while not giving any figures, reports that there was no general shortage of teachers in the Primary school, while the Department of Education (1971) of the Orange Free State reports that, with regard to Primary school staff, "no problems are experienced in filling vacancies with well-qualified personnel."

The Province of Natal (1970) experienced "another difficult year in respect of staffing" but does not supply any statistics in this respect. It would seem, however, that the shortage was encountered mainly in Secondary schools and that there was an adequate supply of "new", qualified Primary teachers.

It would therefore appear that South Africa in general does not experience a shortage of Primary school teachers. It is worth noting at this stage that the American National Education Association expects the 1971 surplus of elementary school teachers to double itself by 1976.

In view of the above one can therefore expect that the situation in the Cape Province should also improve in due course. At present, however, the Cape Education Department (1970) reports a shortage of 1702 fully qualified Primary school teachers and this, together with the argument concerning "special abilities", is often used to justify the admission of students without Junior Certificate Mathematics or Commercial Mathematics to Training College. These students will make a contribution towards relieving this situation on the 6% level, but will they really have any effect on the situation or make any worthwhile contribution when the teaching profession as a whole is likely to suffer because of their presence? Will they not rather contribute towards the lowering of the status of a profession which is already so often subjected to accusations of ineptitude and ineffeciency?

The latter question can very likely be answered in the affirmative. In its Consolidated Report on the Teacher, the National Advisory Education Council (1968) devoted nearly 40 pages of a 140-page report to the status of the teacher. This report made it clear that the status of the teaching profession is adversely influenced by the 'wrong' kind of teacher, the qualified but barely capable, unenthusiastic person, and that a raise in the standard or quality of the teacher, i.e. the status in general, would require that higher minimum standards would have to be set for entry to training institutions. Such a higher entry qualification would initially result in a drop in the number of prospective teachers, but it would be a temporary state of affairs and would be offset by the 'better' type of student attracted to, or allowed into the teaching profession. Figures given in the Report make it quite clear that it is essential that the 'better' students be attracted since, according to this report, 67,7% of the male students and 31,5% of the female students in their first year of training do not possess the potential to become successful teachers! (page 56)

It has become imperative that a greater knowledge of Arithmetic and/or Mathematics than is at present regarded as acceptable for entry to a Training College for Primary School teachers, is demanded, in spite of the fact that it may temporarily result in fewer students qualifying as teachers.

3.7 Selection of Student Teachers.

Students wishing to enter a Training College must comply to certain conditions laid down by the Cape Education Department. The very first rule governing the training of White Teachers in Training Colleges is that

> "A pupil desiring to undergo training for the Primary Teachers' Diploma shall submit his application before the 31st July, in a form approved by the Department, including a medical certificate, to the principal teacher of the school he is attending or last attended. The principal teacher shall hand the application to the Inspector of Schools when he visits the school and the Inspector shall transmit the form, together with his recommendation, to the Department. The Department will inform the applicant

whether he has been selected for training as a teacher or not".

(Education Gazette, 14th July, 1960)

This regulation implies that at least three parties are involved in the selection procedure, to wit, the headmaster of a school, an Inspector of Schools and another official, or officials, of the Department of Education.

Selection as such means to choose the best, or 'to pick out from a number by preference'. (Chambers's 20th Century Dictionary) When a selection is made from a number of candidates for a profession, it means that a choice is made which is based on the demands and requirements of the profession, such as values, norms and mental and intellectual abilities necessary for the effective discharge of all the duties and tasks expected from a member of that profession. The obvious aim of such selection is thus to choose the best, the most suitable candidates and to eliminate the rest. The National Advisory Education Council (1968) is of opinion that the most suitable candidates for the teaching profession will be those who will be assets to the profession; those who have the ability, interests, convictions and attitudes that will enable them to become first-rate teachers and educationalists after the necessary training.

The results of research in South Africa seem to indicate that there is a large number of teachers who cannot be regarded as 'the best' or as having the necessary ability, interest and attitudes. (See 3.6, pg. 30 - 32). In accepting this fact, one is virtually forced to the conclusion that there must be a serious defect in the whole process of selection of student teachers.

The research done by the National Advisory Education Council during the years 1963 - 1967 revealed that the system of selection of student teachers did indeed suffer from a number of serious shortcomings. Briefly summarised, the findings were that:

1) all instances concerned made use of the results of the Standard 10-examination;
2) there is no uniformity with regard to the use of standardised tests or of Intelligence Quotients;
3) There is no uniformity with regard to degree of proficiency in the second official language;
4) objective methods of selection were seldom, if ever, used;
5) the process of selection is not sufficiently rigorous;
6) the selection is too subjective, without definite criteria;
7) the selection was often based on a single meeting between the selector and the candidate;
8) heads of schools, Inspectors of Schools and selectors at Training Colleges were all in favour of a more rigorous process of selection before the commencement of training.

Although the abovementioned report states that the Standard 10 Certificate or an equivalent qualification was demanded as the minimum qualification for entry to Teachers' Training Colleges, no mention is made of any minimum qualification in a mathematical subject.

3.8 An attempt to make selection less subjective.

At present the Cape Education Department is making use of a questionnaire (form A267) for the selection of student teachers in what seems to be an effort to make the process less subjective and to establish some form of criteria. In this form the headmaster of a school is asked to assess the applicant, i.e. to allocate points according to a given scale, with regard to academic ability, certain personality factors and general suitability for the teaching profession. On the academic side a total of 6 points out of a possible maximum of 19 can be awarded for mathematical ability, based on examination results in Mathematics and/or Commercial Mathematics. This represents 31,58% of the marks that can possibly be allocated for attainment in school subjects. A further 51 points can be allocated to the other aspects on which the candidate is judged. This means that, on the whole, no more than 8,57% of the total assessed score is allocated to mathematical subjects. At this stage it is not known what 'weight' is given to the various aspects on which the total assessment is based, or how much importance is attached to the assessment in mathematical subjects.

Thus, in spite of a minimum general educational standard as a prerequisite for entry to Training College, and a process of selection (which was found to be too lenient), one finds, as the results of this research will show, a large number of student teachers who comply with all the requirements laid down by the Department of Education but who yet do not have the ability in Arithmetic, nor the aptitude for the subject, nor the interest or attitude which is absolutely necessary for the effective teaching of Arithmetic at Primary school level.

CHAPTER IV

THE INVESTIGATION

The investigation was an attempt at determining the Arithmetical ability of entrants to Teachers' Training Colleges, as well as their attitude towards and understanding of Arithmetic and Mathematics.

It was decided to limit the extent of the research to entrants to Training Colleges for White teachers in the Cape Province, but that ALL the first-year students were to be involved in it.

The Training Colleges that co-operated in this project were:

- Cape Town Training College
- Graaff-Reinet Training College
- Grahamstown Training College
- Oudtshoorn Training College
- Stellenbosch (Denneoord) Training College
- Wellington Training College.

The result was that 752 students were involved in the research. This group consisted of 155 male students and 597 female students.

4.1 The tests and questionnaires.

It was decided that the tests in Arithmetic, Algebra and Geometry and Graphs compiled and standardised by the National Bureau for Educational and Social Research would be used to determine the students' ability in these subjects. The Bureau's IPAT Anxiety Scale Questionnaire and Junior-Senior High School Personality Questionnaire would be used in order to obtain some information about the anxiety levels and general levels of intelligence of the students who were to be trained to become teachers.

Two more questionnaires were compiled. One was designed to give some of the information needed with regard to the qualifications of the student, and to reveal his or her attitude towards Arithmetic and Mathematics and the teachers who had taught him or her. The second questionnaire was designed to give an indication of the extent to which the student understood the meaning of terms and expressions generally used in Arithmetic and basic Mathematics. This questionnaire was based on the work done by Saad and Storer (1960). These two questionnaires were finalised after a pilot run.

4.2 The pilot run of the questionnaires.

The main purpose of the pilot run was to determine whether there was any ambiguity in the questions as well as the time that would be required to complete the questionnaires. It was conducted with the co-operation of 30 Standard 10-pupils of the school at which the author was teaching at that time. In this group there were 6 pupils who had taken no mathematical subject after Standard 6, while the rest were divided into six groups containing four pupils each, these groups having taken Mathematics or Commercial Arithmetic or both subjects to either Standard 8 or Standard 10 level.

This pilot run showed that the average student would require 25 to 35 minutes in which to complete each questionnaire, and that two questions in the "Understanding" questionnaire had to be rephrased for greater clarity.

The result was that a time of 45 minutes was allocated to each questionnaire in the test programme. The students would not, however, be made aware of this, in order to remove at least one cause of stress and anxiety and give them the best possible chance to complete it to the best of their ability.

During the actual test program this time limit of 45 minutes was exceeded in only one isolated case when a female student could not complete the 'Understanding' questionnaire in time. The vast majority of the students managed to complete the questionnaires within the narrower limits indicated by the pilot run.

4.3 Departmental permission.

The Cape Education Department was approached for permission to conduct the investigation. After submission to, and scrutiny by, a senior official of the Department, the two questionnaires were approved "in toto" and the necessary permission granted. The letter granting this permission is reproduced in Appendix III.

The Department of Education showed, through the abovementioned official, active interest in the proposed research to the extent of supplying the author with most of the standardised tests, manuals and scoring keys that were required. He was also granted study leave which enabled him to visit the various Training Colleges and to conduct the tests personally.

The author received instruction and advice regarding the application of the standardised tests from the Departmental Schools' Psychologist in Grahamstown as well as from his supervisor before embarking on the test programme. These tests were conducted in strict accordance with the given instructions.

After permission for the research programme had been granted, arrangements were made with the Training Colleges with the result that the whole test programme could be completed in the period 30th January, 1969 to 19th February, 1969.

The author was enthusiastically received by all the colleges concerned and was offered all possible co-operation and help. Had it not been for this wholehearted co-operation from the side of the Training Colleges, it would not have been possible to complete the programme within the allocated time. The test programme involved, inter alia, nearly 4 000 student-hours of testing time and some 2 400 kilometres of travel by road.

The first full application of the test battery, done at the Cape Town Training College on the 30th January, 1969, was completed without any problems being encountered. This proved that the procedure and time allocation decided upon after the initial pilot run was satisfactory and did not need any modification. The time allocation made provision for at least three "breaks" of 15 minutes each during which the students could leave the hall in which the tests were conducted.

After the completion of the test programme the standardised tests were scored and the raw scores translated into standard scores which were then examined for skewness of distribution.

Each test and questionnaire will be dealt with separately in the following pages. The full text of the questionnaires as well as the detailed, summarised results of the tests and questionnaires are reproduced in the relevant appendices and in Part III.

The texts of the standardised tests are not reproduced as the Cape Education Department required that these tests be treated as strictly confidential. A full list of the tests that were used is given in Appendix I. Any person authorised to use these tests can readily obtain them from the Human Sciences Research Council.

In this thesis the S.I. decimal notation is used for numbers and percentages, while the texts of the questionnaires are reproduced in the original, non-metric form. It was decided not to separate men and women students in the analysis of the replies to the questionnaires and tests. One of the main reasons for this decision was that only 20,6% of the students were men, and that separation according to sex and attempts at comparison could therefore produce misleading results or conclusions. It was also kept in mind that 74% of the students had attended co-educational schools, while 64,9% were enrolled at co-educational Colleges. Thus the "normal" atmosphere for the majority of students was one of co-education and it was therefore felt that it would be more valid to regard any individual student as a member of a mixed group rather than to apply a form of differentiation according to the sex of the student. Furthermore, most Primary schools under control of the Cape Education Department, i.e. the schools in which the majority of the students would eventually be employed as teachers, are co-educational schools in which the sex of a teacher is usually not regarded as being of primary importance. These students would therefore not only have to teach mixed classes of boys and girls, but would also have to co-operate with both male and female members of the teaching staff. The author further feels that a teacher with a negative attitude towards Arithmetic, or poor ability in the subject, can have a deleterious effect on the mathematical development of his or her pupils regardless of the fact whether such a teacher is male or female. Thus, although some results are tabulated for men and women students separately, the discussions, classifications, etc. were based on the replies and scores for the total number of students.

PART II

CHAPTER V

THE "ATTITUDES" QUESTIONNAIRE

The questionnaire referred to as the "Attitudes" questionnaire in this work consisted of two parts. The first short section consisted of questions pertaining to the student in general, his qualifications, school subjects, etc., while the second, major part was designed to shed light on his attitudes towards Arithmetic and Mathematics and the teachers that taught the subjects to him. The full text of the questionnaire is reproduced in Appendix II.

For the sake of clarity only percentages are given in most of the cases where replies to questions are dealt with. The actual number of students replying to any one question, as well as the percentage, is given in the detailed summary of the replies in Part III.

5.1 Qualifications: General

The majority of the students, i.e. 94,5%, had written the examinations for the Cape Senior Certificate, while the remaining 5,5% had sat for the examinations of other examining bodies, inter alia the Departments of Education of the Transvaal, Natal and Orange Free State and the Joint Matriculation Board. Since the latter group represented such a small part of the whole group, and all the examinations are of a comparable standard, no distinction was made between these students and those who had sat for the examinations of the Cape Education Department.

8% of the students had been in some or other form of permanent employment between the times they left school and entered Training College. Only 18 of these 58 students (2,4% of the whole group) could have benefitted in arithmetical ability through their employment, this being of a nature involving regular dealings with numbers and basic arithmetical concept e.g. employment as bank clerks or Post Office clerks.

30% of the male students had completed their military training before entering Training College.

5.2 Type of school attended.

Co-educational schools were attended by 74% of the students, while 22,85% attended Girls' schools and 3,15% attended Boys' schools.

The majority (46,7%) attended Afrikaans Medium schools, while 25,5% attended English Medium schools. The rest i.e. 27,8%, attended either dual medium or parallel medium schools. The questions asked by the students while completing this part of the questionnaire made it clear that they were not certain what the differences between the latter two types of schools were. These differences were explained to them, but it is to be doubted whether the figures arrived at for these two types, namely 20,5% and 7,3% for dual medium and parallel medium schools respectively, can be regarded as being reliable.

5.3 Qualifications in Mathematical Subjects.

All of the students had studied Mathematics to at least Standard 6 level, as it is a compulsory subject in Standard 6. It is, however, distressing to find that 39% of the students had ceased the study of Mathematics at this level, while 28% had ceased their study at Standard 8 and only 33% had continued studying Mathematics to the Standard 10 level.

In comparison, Behr (1962) found that 58,4% of his sample, consisting of 231 students entering the professional courses of training at the Johannesburg College of Education, had taken Mathematics to matriculation level.

Commercial Mathematics can only be studied from Standard 7 onwards, and 55% of the students had availed themselves of this opportunity. 29% had, however, ceased their studies of this subject at the Standard 8 level, while the remaining 26% had continued to Standard 10.

Only 14 students indicated that they had taken Arithmetic as a school subject. These students were treated as if they had taken Commercial Mathematics in order to simplify the more detailed classification dealt with at a later stage, as well as the analysis of the second part of the questionnaire. As a result, their replies to questions dealing with Arithmetic were "pooled" with the questions dealing with Commercial Mathematics, and the former questions omitted from the analysis.

Not a single student held any qualification in either Mathematics or Commercial Mathematics other than that obtained in a Government or Private school.

A large number of students had taken both Mathematics and Commercial Mathematics at some time during their school career, with the result that a more detailed classification had to be applied. This was done according to the table set out on the next page:

5.4 Classification according to qualifications in mathematical subjects.

Table I

Classification according to Qualifications in Mathematics and Commercial Mathematics:

Mathematics up to Standard		10.	8.	6.
Commercial Mathematics up to Standard	10.	A.1.	B.1.	C.1.
	8.	A.2.	B.2.	C.2.
Commercial Mathematics not studied at school		A.3.	B.3.	C.3.

This classification gives rise to nine groups. Students falling into groups with prefix A or Suffix 1 can be regarded as "well" qualified in a mathematical subject at school level, having taken either Mathematics or Commercial Mathematics to Standard 10 level. Group C.3. represent those students with the absolute minimum qualification in these subjects, i.e. Mathematics only to Standard 6 Level. In theory no pupil or student should fall in group C.3., but this can and does happen in practice, as already expounded in 3.3, pages 26 - 28 of this thesis. It is disturbing to find a relatively large percentage of students in the Training Colleges in the Cape Province who have been granted the exemption discussed in the above-mentioned pages and who enter the Colleges with virtually no school training in a subject which will occupy at least 15% of their teaching time at school. It is worth noting at this stage that the Cape Education Department (1972) recommends that 8 periods per week, of 30 to 35 minutes each, out of a total of 49 periods, be allocated to Mathematics in Standard 5 when the system of Differentiated Education is introduced in the schools in 1973.

The percentage and number of students falling in each of the categories derived from table I is given in table II:

Table II

Classification of students: Percentage and number of students in each category.

Group	A.1. 11,0%; 83	B.1. 5,9%; 44	C.1. 8.7%; 66
	A.2. 4,3%; 32	B.2. 3,9%; 29	C.2. 16,1% 121
	A.3. 20,8%; 157	B.3. 16,4%; 123	C.3. 12,9%; 97

This shows that half of the students, i.e. the 50,7% falling in groups A.1, A.2, A.3, B.1 and C.1, can be regarded as "well qualified in a mathematical subject but that, at the same time, more than an eighth (12,9%) have only the barest minimum of mathematical qualifications, obtained, to make it even worse, at least four years before they entered College! How much have they forgotten in this interval and how much can they gain from instruction in Arithmetic during the three years of their training, when 13% of the teaching time in the first year, 10% during the second year and 16% during the third year is allocated to training in Arithmetic?* The situation is not improved by the fact that these students will have to learn the content of the subject as well as teaching methods in the limited time available. In this respect

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*These percentages are the averages of the actual teaching time allocated to Arithmetic by the Colleges, as given to the author by the responsible members of staff at the Colleges.

Behr (1962) states that:

> "The arithmetical imcompetence of their students precludes lecturers from carrying out an effective training programme, and such topics as how children think and reason in Arithmetic, new experiments in the field of the methodology of arithmetic, the use and interpretation of diagnostic and standardised tests, discussions on contemporary literature on the subject of arithmetic, etc., simply cannot be handled. The little time available in an overcrowded curriculum for teacher-training must be utilized mainly to instruct students how to do for themselves the sums which they will in turn be called upon to teach their future pupils in the classrooms".

It must also be kept in mind that the figures in Table II do not necessarily represent the pupils who had passed an examination in the subject at the indicated level. There may well be a large number of students who have studied the subject to an indicated standard without ever being successful at it. (See 3.3, pages 26 and 27)

5.5 A Similar situation in Britain.

The situation in Britain does not seem to differ much from that in South Africa. Land (1960) reported that 20% of the male students and 11% of the female students in the Colleges for Education involved in his research in England had obtained 'O' level or 'A' level passes in Mathematics at school. The Clearing House, (1969), reporting on a nation-wide survey, found that 72,5% of the male students and 55,4% of the female students accepted by Teachers Training Colleges had obtained passes in Mathematics at G.C.E. 'O' level or 'A' level. Thus, out of a total admission of 35 382 students, 21 254 (i.e. 60,1%) had obtained at least an 'O' level pass in

Mathematics. Simons (1968), using the findings of the Clearing House for the years 1962 and 1963, had already found that 8,2% of the students entered College with the minimum qualification of 5 'O' level passes. It would not be far-fetched to assume that students who had not managed to obtain more than the minimum qualifications for entry had very likely not obtained a pass in Mathematics.

The situation is comparable to that in the Cape Province where it was found that 62,3% of the students had studied (but not necessarily passed) Mathematics to at least Standard 8 level. If Commercial Mathematics is included as a mathematical subject, having a bearing on a student's ability in Arithmetic, the percentage increases to 87,1% who had taken either Mathematics or Commercial Mathematics to at least Standard 8 level. (See tables I and II)

5.6 Attitude towards Mathematics and Commercial Mathematics.

The figures quoted in the following pages were obtained from the second part of the "Attitudes" questionnaire. Unless otherwise stated, the response to questions regarding Mathematics are given first, followed by the response to questions regarding Commercial Mathematics.
The students were requested to give a reply to every question in the questionnaire, but could not be compelled to do so. The result was that only the last seven questions were answered by all the students. In no case, however, was there a response of less than 50%, the lowest being a 51% response to the part pertaining to Commercial Mathematics in Question 8. When it is borne in mind that only 55% of the students had studied Commercial Mathematics at school, that many students had "dropped" Mathematics and/or Commercial Mathematics half-way through their high school careers, and were in

all probability not able to recall their feeling accurately, the response was, on the whole, quite satisfactory.

The fact that many questions dealt directly with their "old" schools and teachers and that many could have been reluctant to answer for fear of their replies being made known, in spite of written and verbal assurances to the contrary, cannot be totally disregarded.

The questions are dealt with in related groups and not necessarily in numerical order. The actual wording of the questions under discussion will be found in Appendix II.

Questions 2 and 3: Replies to these questions indicated the students' attitudes towards Mathematics and Commercial Mathematics at the time they entered Training College. 56% of the students replied to the part pertaining to Mathematics while 53,5% replied to the part pertaining to Commercial Mathematics.

Of those who answered the questions, 5,9% regarded Mathematics as their favourite subject, while 3% held this view of Commercial Mathematics.

26% indicated that they were interested in Mathematics and enjoyed the subject, while a similar view with regard to Commercial Mathematics was held by 19,8% of the students.

Mathematics and Commercial Mathematics were liked no more or less than any other subject by 12,1% and 33% respectively, while 24,6% and 24,5% of the respondents were not really interested in the subjects.

31,5% of the respondents indicated that they disliked Mathematics, while 20% indicated a dislike for Commercial Mathematics.

It is worth noting that Mathematics evoked more definite reactions from the students than did Commercial Mathematics. 31,9% gave favourable replies regarding Mathematics compared to 22,8% for Commercial Mathematics. Similarly, 56,1% expressed unfavourable sentiments regarding Mathematics compared to 44,5% for Commercial Mathematics. The group that gave the "neutral" or "safe" replies to the questions is much smaller for Mathematics than for Commercial Mathematics -- 12,1% compared to 33%. This can possibly be attributed to the fact that Commercial Mathematics, linked with Accountancy (Bookkeeping) is often regarded as a "filler", a sixth subject which is in many cases studied only in order to comply with the regulations of the Cape Education Department, or because it is linked with a more "desirable" subject such as Typing, Shorthand or Snelskrif, and is therefore approached with a more neutral, "I-just-have-to" attitude than is the case with Mathematics. Question 15 dealt more fully with this aspect.

Question 15 was answered by 80% of the students with regard to Mathematics and by 55% with regard to Commercial Mathematics. A relatively small group of the respondents, viz. 12% and 5%, indicated that they had studied Mathematics and Commercial Mathematics respectively at school because it was their parents' wish that they should do so. The fact that the schools which they attended offered no alternative subject to Mathematics and/or Commercial Mathematics accounted for 19,6% and 22% respectively, while the lack of a suitable alternative accounted for 21,5% and 31% studying Mathematics and Commercial Mathematics respectively.

If one were to risk a generalisation based on these figures, one could come to the conclusion that the present choice of subjects in our Secondary schools does not provide for, or satisfy in the needs of between 40% and 50% of those pupils who intend to become Primary school teachers.

On the brighter side, a large group of 37,8% of the respondents indicated that they had studied Mathematics out of their own free choice. The corresponding figure for Commercial Mathematics is 27%. The extent to which these students were indirectly influenced by their parents and/or teachers could not be determined by means of the questionnaire under discussion.

Only 2,3% and 2% indicated that they had been persuaded by their teachers to study Mathematics and Commercial Mathematics respectively, while a very small group of 0,17% and 2,65% had chosen the subjects because they thought them to be "easy" alternatives to some other subjects. Another small group had chosen Mathematics or Commercial Mathematics because they were good at it. (6,6% and 9% respectively). It is interesting to note that 45 of the 79 students in this group had underlined the word "were" in question 15(h) in the questionnaire, implying that they were of opinion that their ability in these subjects had decreased during their school careers.

5.7 Change in Attitude.

Replies to questions 5 and 6 indicated whether students liked or disliked Mathematics and/or Commercial Mathematics while at school and whether their attitudes towards these subjects changed during their school careers. The response to these questions can best be presented in tabular form.

Table III: Change in attitude towards Mathematics and Commercial Mathematics.

Mathematics	Liked	Disliked	Response
During Std 6.	70% 382	30% 165	73% 547
During Std 7.	68% 310	32% 147	61% 457
During Std 8.	56% 246	44% 196	59% 442
During Std 9.	57% 140	43% 105	32,5% 245
During Std 10.	57% 139	43% 106	32,5% 245
Commercial Mathematics			
During Std 7.	57% 227	43% 162	53% 398
During Std 8.	51% 203	49% 193	52,8% 396
During Std 9.	53% 100	47% 90	25,3% 190
During Std 10.	50% 93	50% 93	24,8% 186

These responses show that, whereas the number of pupils taking these subjects seemed to have dropped sharply at the Standard 9 level, the ratio of the 'likes' to the 'dislikes' did not change to any appreciable extent.

Replies to question 10 indicated whether the pupils' like or dislike for Mathematics and/or Commercial Mathematics increased or decreased during their school careers, i.e. whether there was an actual change in attitude towards these subjects. Replies to this question was received from 71,5% and 53% of the students for Mathematics and

Commercial Mathematics respectively. In spite of the fact that at least 50% of the students had liked one or both of the subjects at school and did not positively dislike it, 52% and 21,8% indicated that their liking for Mathematics and Commercial Mathematics respectively had decreased. 24,5% and 32,2% of the respondents had experienced no change in their attitudes towards Mathematics and/or Commercial Mathematics, while 23,5% and 21,8% indicated that their liking for these two subjects had increased.

The above, combined with the results of Questions 5 and 6, show that Mathematics and Commercial Mathematics lost ground as a pupil progressed from Standard 6 through Standard 10, resulting in 68,2% and 77,5% of the students having little or no interest in the respective subjects. (See replies to questions 2 and 3, page 48).

A similar situation was found in England by Land (1960) who reported that

> "The trend towards enjoying arithmetic more for the group selecting mathematics (at Training College)* and less for the rest, begins at the Junior School level. It is in the secondary school age range that the divergence becomes considerable and the deterioration in attitude is rapid as the students pass through the grammar school. On the other hand those who like mathematics improve their attitude. The task confronting the training college lecturer is to reverse in two years, with half of the training college students, a dislike which had grown, unchecked, over a period of ten years. If this is not done there is little hope of these students approaching their own arithmetic and mathematics

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* Inserted by the author.

teaching with zest and enjoyment and thereby inculcationg an appreciation of the subjects in their pupils".

5.8 <u>The Teachers' Influence.</u>

Questions 7, 8, 11, 12, 13 and 14 were designed to show where the responsibility for the students' attitude lay.

<u>Questions 7 and 8</u> received replies from 79% and 54,5% of the students with regard to Mathematics and Commercial Mathematics respectively. The majority of the respondents, viz. 67%, indicated that their teachers had had the greatest influence on their attitudes towards Mathematics, while 75% held the same opinion with regard to Commercial Mathematics. Those who were mainly influenced by parents or siblings amounted to 13,7% for Mathematics and 9,3% for Commercial Mathematics. 12,9% and 8,5% indicated that the nature of the respective subjects or their "own feeling" had had the greatest influence on them. Here again it was not possible to determine to what extent these students had really been influenced by the people directly concerned with them and with Mathematics and Commercial Mathematics, i.e. their teachers, parents, etc.

A small minority of 6% and 6,8% indicated that their classmates or other 'outsiders' had had great influence on them with regard to their attitudes towards Mathematics and Commercial Mathematics respectively.

The replies to these questions once more emphasise the tremendous responsibility that rests on the teacher. He or she had exerted 'great influence' on at least $\frac{2}{3}$ of the students involved in this research, but were these students the better off for it? The replies to the questions already dealt with seem to indicate that, as far as

Mathematics and Commercial Mathematics are concerned, this influence did not have the positive, creative effect that is regarded as essential in the development and education of the child. The replies to questions 11 through 14 tend to confirm this conclusion.

Question 11 received replies from 69,5% and 51% of the students with regard to Mathematics and Commercial Mathematics respectively. Responsibility for the degree of change indicated in question 10 was placed on the teacher by 34,3% and 31% of the respondents. The students' own ability or inability to cope with Mathematics and/or Commercial Mathematics was blamed by 37,7% and 35,8% of the respondents respectively, while 22,5% and 29,3% attributed their change in interest to the nature of the two subjects. Parents, siblings, classmates and others accounted for the change in the case of the remaining 5,3% in respect of Mathematics and 4% in respect of Commercial Mathematics.

In questions 12,13 and 14 the parts pertaining to Mathematics and Commercial Mathematics received replies from 71% and 52% of the students respectively.

Replies to question 12 indicated that 44% and 33,5% of the respondents felt that their teachers were completely responsible for their attitudes towards Mathematics and Commercial Mathematics. 37% and 40,5% held the teacher no more or less responsible than any other person, while 19% and 26% indicated that the teachers were not at all responsible for their attitudes towards the subjects under discussion.

Replies to question 13 indicated that 28,3% and 32,4% of the respondents felt that Mathematics and Commercial Mathematics respectively had been taught well and interestingly, while 34,5% and 32,4% felt that these subjects had been taught well but not very interestingly. 21% felt that Mathematics had been taught in an indifferent manner, and 20,6% expressed the same opinion with regard to Commercial Mathematics. A minority of 16,2% and 14,6% were of opinion that these two subjects had been taught badly.

The replies to question 14 indicated that 15% and 13,5% of the respondents were usually received unsympathetically by their teachers of Mathematics and/or Commercial Mathematics respectively when these teachers were approached for help with a problem. The majority, however, indicated that they were usually received in a sympathetic manner. (56% and 62,5% with regard to Mathematics and Commercial Mathematics respectively). The remaining 29% and 24% indicated that their teachers usually maintained an attitude of indifference.

An attempt was made to determine to what extent the teachers were responsible not only for the change in interest in Mathematics and/or Commercial Mathematics, but for the increase or decrease in interest shown by the students. This was done by combining the answers of questions 7, 8, 11 and 12, dealing with Mathematics and Commercial Mathematics simultaneously. Many students had studied both subjects at school and those who showed an increase in interest in one subject and a decrease in the other, or increase/no change or decrease/no change were scored "positively" as "increase" or "no change", i.e. in such a way that the more desirable attitude towards the mathematical subjects were taken into consideration. There were 37 such cases. The rest showed changes in interest that corresponded for the two subjects.

69,3% of the students had answered all the relevant questions. Of this group, 78,5%, which represented 54,3% of all the students, held their teachers completely responsible for the change in interest or liking for Mathematics and/or Commercial Mathematics, as follows:

Change in interest or liking:

Increase	Decrease	No Change
19,6%	39,3%	19,6%

The remaining 21,5% indicated that their teachers were in no way responsible for their change in attitude towards these subjects.

One of the most widely accepted views on Education is that the teacher should have a positive part in the general development of the child and should teach him in such a way as to influence him to the good over the widest possible front. (Duminy, 1969) The figures quoted in the previous pages reveal the sad fact that, as far as the mathematical subjects are concerned, this effect had been realised in less than 20% of the cases, while the teacher had had a negative influence, or no influence at all, on nearly 60% of the respondents. It must be admitted that the 102 students whose attitudes had not changed might have included some cases where the interest had been at either a zenith or a nadir, but it is difficult to believe that such a situation, especially in the latter case, can be maintained for any length of time if the teaching is of a positive, inspiring quality. The students' replies seem to indicate that this type of teaching is relatively rare. At the same time one cannot, in spite of the lack of supporting evidence, disregard the possibility that many students may have succumbed to the temptation to "shift the blame" onto the teacher and possibly gave misleading replies in an effort to soothe a guilty conscience caused by neglect of duty while at school, or to put "unpopular" teachers in a bad light, albeit in an indirect manner. It is worth noting that "Mathematics teachers have been shown, by research findings (notably those of R. R. Dale of Swansea Department of Education) to have an unenviable image as seen by pupils. This may partly be due to the complexity of the subject itself and the difficulty of understanding the thought-processes of the unsuccessful Mathematics students". (Noble, 1972)

5.9 Students' rating of Arithmetic.

In question 16 which received 100% response, the students were asked to rate fourteen subjects found in the Primary school in order of importance. The following replies were given with regard to Arithmetic:

Supreme importance 25%
More than average importance .. 47%
Average importance 20,5%
Less than average importance .. 4%
Very little or no importance .. 3,4%

One can only hope that the group which gave a high rating to Arithmetic, and which contained 72% of the students, did not contain too many students who were unduly influenced by the fact that the greater part of the questionnaire dealt with the Secondary school equivalents of this subject.

Questions 17 and 18 received 100% response. In replying to these questions, a small minority of only 7% of the students indicated Arithmetic as the subject they would most like to teach. As could be expected, every student in this group had shown a positive attitude towards Mathematics and/or Commercial Mathematics in the preceding parts of the questionnaire.

At the same time, nearly four times as many, viz. 26% of the students, indicated Arithmetic as the subject they would least like to teach.

A disturbing fact is that, until specialist teaching or "subject teaching" is introduced in the Primary school, the majority of the students mentioned in the previous paragraph will have to teach Arithmetic after being appointed as teachers, whether they like it or not, whether they are interested or not, whether they are capable of doing Arithmetic or not. To what extent will they influence their future pupils in the same way as they had been influenced? How many individual student teachers with a negative attitude towards Arithmetic will eventually transmit this attitude to a class of 30 or 40 children in the Primary school every year of their teaching career? Butler and Wren (1960) hold the view that "the teacher of Mathematics is the seller of Mathematics". Can one expect an unenthusiastic, negatively-attuned salesman to be a good salesman?

5.10 Students' choice of subjects.

In the Primary Teachers' Diploma course in its present form in the Cape Province, student teachers who have enrolled for the Senior course can choose two academic subjects in which they can specialize during the third year of their training. Question 22, which received 100% response, dealt with this aspect of their training.

Question 22 received 914 replies, since a large number of students indicated two subjects, each chosen subject then being registered as one reply.

10,1% of the students intended to specialize in Mathematics. Once again these students were, without exception, from the group that had shown positive attitudes towards the mathematical subjects during their school careers. A further 11,2% had chosen Science while History and Geography had been chosen by 22,5% and 18,2% respectively. Various combinations of these subjects accounted for 41% of the students. The remaining 59% were still undecided or had chosen other directions than the academic for specialisation, e.g. specialisation in Music, Kindergarten, Woodwork, Physical Education, etc.

In comparison, Land (1960) had found that 12% of the male students and 6,1% of the female students involved in his research took Mathematics at training colleges in Britain.

Questions 19, 20 and 21 received a full 100% response. 37,8% of the students wanted to teach in the Kindergarten, i.e. Sub-standards A and B and Standard 1, while the remaining 62,2% wanted to teach in Standards 2 through 5.

While 47,4% hoped to have the opportunity to teach in the lower standards of the Secondary school, the remaining 52,6% had no ambition to do so. Only 4,6% of the respondents indicated that they would like to teach Mathematics in the lower Secondary standards.

5.11. The "Drop-outs" in Mathematics.

The replies to question 5 of Part A of the "Attitudes" questionnaire showed that 44,1% of the female students had "dropped" Mathematics at the end of Standard 6 and that 70,3% had done so by the end of Standard 10. The corresponding percentages for the male students are 20,0% and 54,8%. In the article "The Attitudes and Abilities of Boys and Girls in School Mathematics", A. Noble reports that more than 40% of the girls in his test sample had "dropped" Mathematics after Standard 6 and that this percentage had increased to approximately 45% by the end of Standard 8 and to more than 55% by the end of Standard 10. Of the boys in his test sample, less than 10% had "dropped" the subject by the end of Standard 8, while approximately 25% had done so by the end of Standard 10. He is of the opinion that, other than genuine inability in Mathematics, two main reasons can be advanced for this higher "drop-out" rate for girls than for boys. These are namely that girls, as they grow older, tend to undertake curricula more closely related to the stereotypes of the female role than is Mathematics, and that there is a possibility that there is a basic difference in analytical thinking between boys and girls, a difference which can be either innate or caused by teaching methods which employ analytical rather than abstractive* methods. In this respect Biggs (1962) has found evidence that girls tend to accept inferiority in Mathematics as part and parcel of their role as women, as well as the fact that they find analytical thinking more difficult than boys do.

These reasons may explain why more girls than boys drop Mathematics during their Secondary school careers, but also lead to the conclusion that, if discovery methods were applied throughout a girl's mathematical education, she might easily hold her own with boys in Mathematics. This, in turn, could result in fewer girls ceasing the study of Mathematics during their school careers and eventually more female students with better qualifications in Mathematics enrolling at the Teachers' Training Colleges. The final result could then well be the raising of the general standard of Arithmetic in the Primary school where, as in the Colleges, female teachers predominate.

On the whole, the results of this questionnaire leaves one with a feeling of depression, as it paints a picture of dislike, indifference and mediocre, uninspiring teaching of Mathematics and Commercial Mathematics in the Secondary school. If it is a true reflection of the attitudes of our future teachers towards Arithmetic, and there is little reason why it should not be a true reflection, there is but little hope for the standard of Arithmetic

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* Methods by which children are led to discover -- and so to abstract -- mathematical concepts.

in our Primary schools being successfully raised to the higher, more stringent requirements of the present and future syllabi in Mathematics in both the Primary and the Secondary school.

CHAPTER VI

THE RESULTS OF THE STANDARDISED TESTS

6.1. General.

Interest in a subject is not a criterion for performance. Many students study subjects in which they have no real interest yet obtain good, even exceptionally good results in examinations because they have the ability, the intelligence, the mental equipment, call it what you will, to do so. It is this ability which can be determined quantitatively by standardised tests. The raw scores of such tests can, after statistical treatment, serve as a reasonable accurate yardstick of a person's ability in a subject, indicating also any deviation from the norm, as well as the extent of such deviation.

The scores of standardised tests can be interpreted at various levels. In the case of the Arithmetic and the Algebra tests used in this research, the scores were interpreted at the Standard 7 level. This level is the highest level at which the Arithmetic test scores could be used with the desired degree of reliability, while Standard 7 is also the lowest level at which the Algebra scores could be interpreted with reliability. The N.B. Geometry tests were also used, but the results were found to be unreliable. This is discussed at a later stage.

A qualified teacher in a Secondary school is expected and required for purposes of higher Education Diploma to have at least two years' University training in the subject he or she teaches. It is therefore not at all unreasonable to expect a teacher in a Primary school to be able to cope with work at the Standard 7 level, the work usually regarded as of a standard suitable for a 14 to 15 year old pupil, and even more so when it is considered that at least 85% of the student teachers had but recently completed their school careers and had, in fact, written and passed the Senior Certificate examinations less than 4 months before the tests were taken. It would also be a Herculean task to convince anybody with a knowledge of the standards required by a University that the two years required to reach Standard 7 standard after Primary schooling is in any way comparable with the two years' training at University expected from a Secondary school teacher. The writer therefore feels that although the scoring at Standard 7 level is arguable it is fully justified.

6.2. Abbreviations used in the text.

The physical limitations imposed by a standard typewriter meant that certain accepted symbols could not be used, and these were therefore replaced in the following pages by standard letters or abbreviations. These are:-

p.e.	instead of	Probable Error
p.e. (M_1-M_2)	instead of	Probable Error of the Difference between Means.
s.d.	instead of	σ or Standard Deviation.
X^2	instead of	χ^2

The results of the standardised tests are presented in tabular form for ease of perusal as well as to eliminate excessive repetition.

6.3. Treatment of the results.

After scoring the tests, the raw scores were translated to stanine or sten scores using the tables of norms supplied with the Manuals for the tests. The means were calculated, as well as the probable errors of the means, standard deviations and probable errors of the standard deviations. This was done by using the standard methods and formulae found in various textbooks on statistical analysis, such as those by du Toit (1969), Edwards (1964), Garret (1940), Smith (1938), and others.

The results of the IPAT Anxiety Scale, Boys and Girls together, is used as illustration. The mean for this group was 33,67 raw score points.

The standard deviation was calculated by means of the usual formula, viz.

$$s.d. = \sqrt{\frac{\sum d^2}{N}}$$ where d is the

deviation of any single score from the mean, and N is the number of students (or scores) involved in the calculation (du Toit, 1969).

It was found that

$$d^2 = 28161{,}81, \text{ while } N = 257$$

$$\therefore s.d. = \sqrt{\frac{28161{,}81}{257}}$$

$$= 10{,}47$$

The probable error of the mean was calculated, using the formula

$$p.e. \text{ of mean} = \frac{0{,}6745 \; s.d.}{\sqrt{N}}$$ where

0,6745 s.d. represents the Semi-interquartile range for normal distribution (du Toit, 1969).

$$\therefore p.e. \text{ of mean} = \frac{0{,}6745 \times 10{,}47}{\sqrt{257}}$$

$$= \frac{7{,}062015}{16{,}03}$$

$$= 0{,}4406$$

The probable error of s.d. was calculated by means of the formula

$$\text{p.e. of s.d.} = \frac{0{,}6745 \text{ s.d.}}{\sqrt{2N}} \qquad \text{(du Toit,1969)}$$

$$\therefore \text{p.e. of s.d.} = \frac{0{,}6745 \times 10{,}47}{\sqrt{574}}$$

$$= \frac{7{,}062015}{22{,}67}$$

$$= 0{,}3116$$

The results of the tests were also compared with the National norms obtained from the Manuals for the tests with regard to the means and the distribution. The standard X^2-test, as found in the publications of the above-mentioned authors, were used to test for skewness or irregularity of distribution as compared to the normal distribution.

6.4. The Null-hypothesis.

The X^2-test requires that a null-hypothesis be formulated which is then either rejected or accepted at a pre-determined degree of probability indicated by the values of X^2. This value is obtained from, in this work, two sets of data. These were the normal distribution, of which frequencies were obtained from the Manuals, and the distribution according to the results of the tests. Since the normal distribution cannot be suspected of serious deviations and abnormalities because of its very nature, the null-hypothesis in this case was that:-

> Any deviation from the normal distribution observed in the results of the tests were due to chance and not to any real difference between the group that were tested and a large, representative sample of the population.

The level of probability chosen for rejection or acceptance was the 0,001 level, i.e. the value of X^2 had to be such that the observed difference would occur in more than 1 case in 1 000 before the null-hypothesis could be rejected.

The X^2 values for the various tests were calculated according to the standard method and formula found in the publications by the authors mentioned on the preceding page. The probability indicated by any specific X^2 value was obtained from tables by du Toit (1969).

The results of the IPAT Anxiety Scale Questionnaire, Boys and Girls together, is once more used as example. The symbols F_o and F_n are used for observed frequency and normal frequency respectively. The normal frequency percentages given in the Manual for the Questionnaire were used to estimate the actual normal frequency. The calculations are set out in the following table:-

Sten	F_o	F_n	F_o-F_n	$(F_o-F_n)^2$	$\frac{(F_o-F_n)^2}{F_n}$
1	7	5,14	1,86	3,4596	0,67307
2	9	12,85	-3,85	14,8225	1,15350
3	16	23,13	-7,13	50,8369	2,19788
4	35	38,55	-3,55	12,6025	0,32691
5	51	48,83	2,17	4,7119	0,09650
6	44	48,83	-4,83	23,3289	0,47776
7	43	38,55	4,45	19,8025	0,50972
8	35	23,13	11,27	127,0129	5,49126
9	15	12,85	2,15	4,6225	0,35973
10	2	5,14	-3,14	9,8596	1,91821
	257	257,00			13,20454

$$X^2 = \sum \frac{(F_o - F_n)^2}{F_n}$$

$$= 13,20454$$

The two sets of frequencies give rise to 9 df (degrees of freedom) (du Toit, 1969; Edwards, 1964). Entering the X^2-tables (du Toit, 1966) with 9 df gives a X^2 value of 14,6837 for a probability level of 0,100. The X^2 value obtained from the results of the Anxiety Questionnaire is less than this, and much less than the minimum value of 27,877 necessary for probability level of 0,001. The null-hypothesis is therefore accepted as being true with regard to the anxiety level displayed by the testees.

6.5. Difference of the means.

The mean of every test differed from the National norm. This difference does not necessarily indicate that there is a significant difference between the observed values and the norm, i.e. that one can state with confidence that the sample under discussion differs from a representative sample of the population as far as the mean score of a test is concerned. In order to test the significance of such observed differences, the probable error of the difference of the mean of the specific test and the National mean was calculated. The observed difference had to be at least 4½ times this calculated value to be of significance, as this would give a probability of one chance in 1 000 that there was no real difference and that the observed difference of the means was due to chance variations and errors in the tests and the related calculations. (Edwards, 1964)
Standard methods and formulae were used to calculate the probable error of the difference of the means.

The results of the IPAT Axiety Scale Questionnaire, Boys and Girls together, is once more used as illustration of the calculations involved.

The probable error of the difference of the means was calculated by using the formula

$$p.e.\ (M_1 - M_2)^{*} = \sqrt{(p.e.\ M_1)^2 + (p.e.M_2)^2}$$

(Edwards, 1964)

The tables of norms in the Manual for this Questionnaire gives a National Mean of 32,70, with a p.e. of 0,0763 while the mean of the students' score was 33,67

$$\therefore\ p.e.(M_1 - M_2) = \sqrt{(0{,}4406)^2 + (0{,}0763)^2}$$

$$= \sqrt{0{,}19995005}$$

$$= \sqrt{0{,}2000}$$

$$= 0{,}4471$$

$$4\tfrac{1}{2} \times p.e.(M_1 - M_2) = 4\tfrac{1}{2} \times 0{,}4471$$

$$= 2{,}01195$$

The students' mean is 0,97 above the norm, indicating that there is a probability of approximately 1 chance in 5 that this difference is due to chance variations and errors. (Edwards, 1964) One can therefore conclude that there is no significant difference between the mean general level of anxiety displayed by the students as compared to the mean general level of anxiety displayed by a representative sample of the population.

In the following pages the "population" can be regarded as all those pupils between the ages of 13 and 15 who are normally found in Standard 7 of the Secondary school.

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* See abbreviations, 6.2., page 63.

6.6. Ability in Arithmetic.

The English and Afrikaans versions of the N.B. Arithmetic Tests, Series 4, Form A (number N.B. 329 and 22 respectively) were used to determine the students' ability in Arithmetic. The procedure as set out in the Manual for these tests was strictly adhered to, and a stop-watch used for the timing. In all but two of the colleges the writer was able to conduct the tests personally.
In these two colleges the classes were too large for the largest available room to accomodate all the first-year students and had to be split up into various groups.
In these cases the procedure was explained in detail to those members of the college staff who were to conduct the tests.

The N.B. Arithmetic Tests are divided into three parts. Part I tests Ready Knowledge, Part II tests Fundamentals and Part IIIa and IIIb test Mechanical Computations and Problems respectively. The scores for these three parts were added to give a total score, and each one of these four scores was translated into Stanine scores, i.e. standard scores on a nine-point scale, with the aid of the tables of standard scores in the Manual for the Arithmetic tests.
The results of the Arithmetic tests are given in Table IV on the following page.

Table IV. Results of the N.B. Arithmetic Tests scored at STANDARD 7 level.

Part I READY KNOWLEDGE	1st year students at Training College	National Norms.
Mean	30,24	22,73
p.e. of Mean	0,4597	0,2226
s.d.	8,887	8,553
Observed difference	7,51 above norm	
p.e.(M_1-M_2)	0,5108	
$4\frac{1}{2}$ x p.e.(M_1-M_2)	2,299	
Part II FUNDAMENTALS		
Mean	29,30	24,38
p.e. of Mean	0,4735	0,2560
s.d.	9,153	8,292
Observed difference	4,924 above norm	
p.e.(M_1-M_2)	0,5383	
$4\frac{1}{2}$ x p.e.(M_1-M_2)	2,422	
Part III PROBLEMS, MECHANICAL COMPUTATIONS		
Mean	26,46	17,62
p.e. of Mean	0,6031	0,2766
s.d.	11,66	10,63
Observed difference	8,84 above norm	
p.e.(M_1-M_2)	0,6635	
$4\frac{1}{2}$ x p.e.(M_1-M_2)	2,986	

TOTAL. Continued on next page.

Table IV. (continued)

TOTAL		
Mean	86,00	65,14
p.e. of Mean	0,8942	0,6204
s.d.	17,28	23,84
Observed difference	20,86 above norm	
p.e.$(M_1 - M_2)$	1,088	
$4\frac{1}{2}$ x p.e.$(M_1 - M_2)$	4,896	

These results seem quite promising at first glance. The students scored consistently above the National norms, and in all the parts of the test the probability that this was due to chance is less than 1 in 1 000. Can one however be satisfied with the fact that a group of matriculants, a group of prospective teachers, show a mean Arithmetical ability comparable to that of a normal 14-year old child? This situation does not, however, seem to be uncommon, since Land (1960) found that, according to the Vernon Graded Arithmetic-Mathematics Test, the majority group of 488 students out of a total of 1 834 tested by him in England had an "Arithmetical Age" of 15 - 16 years.

An analysis of the distribution shows, however, that the difference of 20,86 raw score points above the National norm for the total scores does <u>not</u> indicate that all is well.
The high mean score can be attributed to the fact that 51,2% of the students, i.e. 386 students, fell in stanines 7,8 and 9, compared to the expected 23% as predicted by the Normal Distribution Curve and the Tables of Norms.

It is not surprising to find that all of the students who had continued their studies of Mathematics and/or Commercial Mathematics to Standard 10 fell in this group. Of the remaining 139 students in this group, 132 had taken Mathematics or Commercial Mathematics to Standard 8 level and only 7 pupils who had taken Mathematics only to

Standard 6 managed to reach the higher stanines of 7, 8 and 9. (See Table 2, Part III)

The distribution shows a marked deviation from the normal distribution, not only for the total, but also for parts I, II and III. The X^2-values obtained for the various parts of the Arithmetic test are as follows:-

Table V. X^2-values for the Arithmetic Test.

	Part I	Part II	Part III	Total
Obtained value of X^2	95,468	79,041	88,320	117,830
Minimum X^2-value necessary for a probability level of 0,001	26,125			

These values mean that there is less that 1 chance in 1 000 that the deviations from the normal distribution can be attributed to chance or coincidence. The null-hypothesis therefore has to be rejected and the conclusion drawn that the first-year students at Training College is not a representative sample of the population with regard to Arithmetical ability at the Standard 7 level. These deviations from the norm are illustrated by means of Table 1 and Graphs 1,2,3, and 4 in Part III.

In each case except Part III of the test, the number of students obtaining stanines 1 through 6 are below the norm. In Part III, 18,6% fell in stanine 2, as against the expected 7% while in Part II 22% fell in stanine 6 as compared to the expected 17%. Each of the four parts of the test show a higher than normal incidence for stanines 7, 8 and 9. This does not, however, alleviate the fact that 34,9% of the students show an Arithmetical ability no better than, or lower than, that of an average pupil in Standard 7.

The students in each of stanines 1 through 9 were also classified according to their training in Mathematics and/or Commercial Mathematics, using the classification as for Table I on page 44. Only the total score for the Arithmetic test was used for this classification, the detailed results of which are presented in Table 2, Part III. This classification revealed that the students who had studied Mathematics to Standard 10 had obtained the highest scores, as already indicated, as well as the fact that the largest single group contained 85 students, who had obtained a score which had placed them in stanine 9, and who had taken only Mathematics to Standard 10. These results also create the impression that Mathematics contributes much more to a student's arithmetical ability than does Commercial Mathematics, since more students with a high qualification in Mathematics and a lower one in Commercial Mathematics obtained high scores in the test than did students with high qualifications in Commercial Mathematics and a lower qualification in Mathematics.

6.7. Ability in Algebra.

The English and Afrikaans versions of the N.B. Mathematics Tests, Algebra, Form D (numbers N.B. 598/2 and 598/1 respectively) were used. The same basic procedure as for the Arithmetic test was followed.

It was felt necessary to include the Algebra test in the research programme as a fair amount of basic Algebra is included in the Arithmetic syllabi for the Primary school. (See 1.2., page 3.)
The test was scored at the Standard 7 level for the reasons expounded on pages 62 and 63 of this thesis.

All of the 752 students were involved in the test. When the answer sheets were inspected and scored, it was found that 30 students had supplied answers in such a way as to make their results useless, by either giving more than one answer to a question or by marking the answer sheet in a "pattern". These answers were discarded and the analysis based on the remaining 722 answer sheets.

It was found that the results of the Geometry and Graphs test were even less reliable. In this case 330 replies had to be discarded.

Discussion with a large number of students after the tests revealed that they had not been tired or intentionally unco-operative, but that many had not attempted to give reliable answers because they "felt stupid" or "embarrassed", in some cases even "afraid" to answer questions on subjects of which they had "forgotten everything" or "had always been hopeless at".

The results of the Algebra test are presented in Table VI:-

Table VI. Results of the N.B. Algebra test scored at STANDARD 7 level.

	1st year students at Training College	National Norms
Mean	29,54	26,2
p.e. of Mean	0,8014	0,3741
s.d.	15,49	9,54
Observed difference	3,34 above norm	
p.e.($M_1 - M_2$)	0,8259	
$4\frac{1}{2}$ x p.e.($M_1 - M_2$)	3,717	

In this test the students again returned a mean score that is higher than the National Norm, but not to the same degree of reliability as was the case with the Arithmetic test. There is a probability of more than 1 in 1 000, but less than 1 in 100, that this higher score is due to chance factors or coincidence. (Edwards, 1964)

The raw scores were translated to stanines and the distribution of the students in stanines 1 through 9 was determined. This showed clearly that the mean of 29,54 raw score points, or 53,7%, could not be regarded as satisfactory as it was to a large measure due to the fact that 25% of the students fell in stanine 9 instead of the expected 4% found under circumstances of normal distribution, as indicated in the Manual for the N.B. Mathematics Tests.

The group in stanine 9 consisted of 181 students, of whom 171 had taken Mathematics up to Standard 10, while the remaining 10 students had taken the subject up to Standard 8. None of the students who had ceased their study of the subject after Standard 6 managed to obtain a score higher than stanine 6.

270 of the students who took part in this test had ceased their studies of Mathematics at the Standard 6 level. This resulted in 138 falling in stanines 1 and 2 instead of the expected 79, while 115 were placed in stanines 3 and 4, 14 in stanine 5 and only 3 in stanine 6, the highest score reached by any of this group. A full analysis of these scores is given in Part III, table 3 and Graph 5.

The X^2-test serves further to prove that the distribution of students in the various stanines is <u>not</u> a normal distribution. The results yielded a X^2-value of 157,195, while a value as low as 26,125 would have indicated a probability of 1 in 1 000 that the deviations from the normal distribution was due to chance factors. The null-hypothesis must once more be rejected and the conclusion drawn that the students do <u>not</u> represent a normal sample of the population with regard to ability in Algebra at the Standard 7 level.

6.8. Ability in Geometry and Graphs.

The N.B. Mathematics Tests, Geometry and Graphs, (Numbers N.B. 606/1 and 606/2 for the English and Afrikaans versions respectively) were used and the standard, prescribed procedure was followed.

On scoring the test it became obvious that the results would not be reliable. Many students had handed back blank answer sheets while a large number of "patterned" answer sheets or sheets containing more than one answer per question were found. (See also 6.7., page 74.) After these cases were discarded, 422 replies remained, representing 59,5% of the total number of students. The results are presented in Table VII:

Table VII. Results of the N.B. Geometry and Graphs test scored at STANDARD 7 level.

	1st year students at Training College	National Norms.
Mean	17,12	15,5
p.e. of Mean	0,3923	0,1217
s.d.	7,583	4,87
Observed difference	1,62 above norm	
$p.e.(M_1 - M_2)$	0,4108	
$4\frac{1}{2}Xp.e.(M_1 - M_2)$	1,848	

In this test, as in the Algebra test, the students had a mean score higher than the National Norm with a probability of more than 1 chance in 1 000 but less than 1 in 100 that this difference was due to chance factors. On the whole however, the students scored well below average, with the high mean score due mainly to the fact that 37,7% of the students fell in stanines 8 and 9 as compared with the expected 11% of a normal distribution. It can be mentioned at this stage that this group of students, i.e. those in stanines 8 and 9, consisted of 159 students, of whom 137 had studied Mathematics to Standard 10.

The detailed results will be found in Table 4 and Graph 6 in Part III.

After scoring the Geometry and Graphs tests and translating the raw scores to stanine scores, the distribution of the students in stanines 1 through 9 was determined. This gave rise to observation such as that made in the last paragraph on the previous page. It also revealed that the composition of the test samples differed, making the results of the Geometry and Graphs test less reliable than that of the Algebra test, which had involved 96% of all the first year students. The stanine - distribution for Algebra and for Geometry and Graphs showed marked differences, as can be seen from a comparison of Tables 3 and 4 and Graphs 5 and 6 in Part III.

The above-mentioned tables also show the difference in composition of the test samples. Thus 37,6% of the students who had answered the Algebra test had studied Mathematics only up to Standard 6, while the corresponding figure for the Geometry and Graphs test is 26,5%. Similarly, the Algebra and the Geometry and Graphs test groups contained 28,6% and 32% of the students respectively who had taken Mathematics to Standard 8. The Algebra and the Geometry and Graphs test groups further contained 33,8% and 41,5% of the respondents respectively who had studied Mathematics up to Standard 10.

Because of these discrepancies in the composition of the two groups, no comparison was made between mean scores, distribution, etc.

The X^2-value for this group was 179,703, indicating that the distribution could by no stretch of the imagination be regarded as normal, or the sample representative of the general population with regard to ability in Geometry and Graphs at the Standard 7 level. A X^2-value as low as 26,125 would have led to the rejection of the null - hypothesis with a probability on the 0,001 level.

The frequency distribution of students in stanines 1 through 9 shows that, in the total score in Arithmetic, 34,2% score average or below average, while the figures for Algebra and Geometry are 57,2% and 44,3% respectively. This may be regarded as normal for a group of 14 year old pupils in Standard 7, but no stretch of the imagination can make it satisfactory for a group of students who have passed Standard 10 and who are to go and teach Arithmetic in the Primary school.

6.9. The Anxiety Scale Questionnaire and the High School Personality Questionnaire.

Due to lack of time and facilities, the Anxiety Scale Questionnaire and the H.S.P.Q. could be completed by only 257 students in three Training Colleges. This group contained 75 male students and 182 female students. This gave a male:female ratio of 1:2,43 as compared to the overall ratio of 1:3,85. Both English and Afrikaans speaking students were involved, in both co-educational and single-sex colleges and came, according to the principals of the Colleges concerned, from all parts of the Cape Province as well as from other Provinces, including South West Africa. While it is not claimed that these students are representative of the whole body of first year students, an analysis of their results in these questionnaires seemed worthwhile.

The results of this group in the abovementioned questionnaires were not only treated in the same way as the results of the tests discussed in the preceding pages, but were also linked with their results in the Arithmetic, the Algebra and the Geometry tests in order to form a clearer picture of the "type" of student being trained as Primary school teacher. The first task in this respect was to find their general level of mathematical ability by combining the scores of the Arithmetic and the Algebra tests. The results of the Geometry and Graphs test were not taken into consideration due to the previously discussed indication of lack of reliability.

6.10. General Mathematical Ability.

The separate scores for the Algebra and the Arithmetic tests do not give an indication of the students' general ability in subjects dealing with numbers. A method therefore had to be devised for combining the scores of the two tests. This was done by dividing the scores for each test into three groups, i.e. the High scores (stanines 7,8 and 9), the Average scores (stanines 4,5 and 6) and the Low scores (stanines 1, 2 and 3). This gave rise to nine groups, which were labelled P through X. The students were then classified according to these groups. A student with a High score in Algebra and a High or Average score in Arithmetic, or vice versa, was regarded as having an above-average mathematical ability. A student with a High - Low or Average - Average score was regarded as having average ability, and one with and Average - Low or Low - Low score combination was regarded as having below-average, or poor ability in subjects dealing with numbers -- at Standard 7 level. This classification is illustrated by Table 5 in Part III.

Of the 257 students in the group under discussion, 51,8% showed an above-average ability while 20,3% were classified as average and the remaining 26,9% could be regarded as having a poor ability. It can probably not be sufficiently stressed that this classification was done not at College level or Senior Certificate level, but at the level applicable to a pupil in his/her third term in Standard 7 in a Secondary school.

6.11. General Level of Intelligence.

One of the main factors influencing scholastic achievement is the general level of intelligence of the pupil or student. In the Cape Province group Intelligence Tests are administered by the School Psychologists, so that the I.Q. of all pupils are determined while at school. This information is treated as strictly confidential by everybody concerned and was not available for this research. In order to gain some idea of the general level of intelligence of the group under investigation, the students were requested to complete the English or Afrikaans version of the Jr.-Sr. High School Personality Questionnaire, Form B, compiled by the National Bureau for Educational and Social Research (numbers N.B. 453 and N.B. 455 respectively). The scores for the 'B' factor, which gives an indication of the general level of intelligence, were extracted and analysed. The tables of norms used were for boys and for girls separately and for boys and girls together. In all cases the norm tables produced STEN scores which are standard scores on a ten point scale. The following results were obtained:

Table VIII. Results of the H.S.P.Q., 'B' factor.

	1st year students at Training College	National Norms.
Mean	7,67	
p.e. of Mean	0,0691	
s.d.	1,643	
Observed difference $p.e.(M_1 - M_2)$ $4\frac{1}{2}Xp.e.(M_1 - M_2)$	National Norms not available, but mean should be 5,5. No further comparison attempted.	

The separate scores for boys and girls are given in Table IX on the next page.

Table IX. Results of the H.S.P.Q., 'B' factor: Boys and Girls separately.

	Boys	Girls
Mean	7,45	7,76
p.e. of Mean	0,1036	0,06305
s.d.	1,330	1,261
Observed difference	0,31	
p.e.(M_1 - M_2)	0,1213	
$4\frac{1}{2}$Xp.e.(M_1 - M_2)	0,5459	

These results show that there is no real, significant difference in the general level of intelligence of the male and female students involved in this test.

After translating the raw scores to stens, the frequency distribution was determined. A full analysis of this is given in Table 6(a) and Graphs 7 through 9 in Part III. These tables and graphs show that a greater percentage of students obtained the higher sten scores of 5 through 10 than would be expected in a normal distribution.

Table X. X^2-values for the H.S.P.Q. 'B' factor.

	Boys + Girls	Boys	Girls
Obtained value of X^2	53,072	61,247	42,031
Minimum X^2-value required for a probability level of 0,001	27,877		

These results mean that the null - hypothesis must be rejected since there is a probability of less than 1 in 1 000 that the deviation in the distribution is due to chance factors. One can therefore accept that the group of first year students score better in this test than the normal population of High school pupils.

Since the norm tables make no provision for classifying boys in sten 9, girls in stens 7 and 9 and boys and girls together in stens 6 and 9, the sten groups were regrouped as in table 6(b) in Part III and presented graphically in Graph 10.

Using stens 1, 2 and 3, and 8, 9 and 10 as poles, it was found that 1,2% of the students fell in stens 1, 2 or 3, showing a below - average intelligence. 72,8% of the students, falling in stens 4 through 7, display an average level of intelligence, while the remaining 26,0% falling in stens 8, 9 or 10 appear to have a level of intelligence above the normal. It must, however, be borne in mind that this 'B' factor of the H.S.P.Q. gives no more than a sketchy indication of the general level of intelligence and cannot be regarded as wholly reliable on its own. It is of so rudimentary a nature that it cannot be used as evidence to contradict the findings of a Transvaal Education Department survey of 2 169 students enrolled at that province's Teachers' Training Colleges in 1963 and cited by Professors Horwood and Nel (1969).

The above-mentioned survey revealed that 2,4% of the students had a backward I.Q. (80 to 89) while 11,5% had a dull-normal I.Q. (90 to 99) and 28,9% had an I.Q. of 100 to 109. This meant that 43,8% had an I.Q. below 110, which is the average for matriculation according to the above-mentioned report. Relating these facts to the results of the H.S.P.Q. 'B' factor, which gives the normal intelligence rating as falling in sten 6, 38,8% of the first-year test group show a level of intelligence similar to that quoted above.

Professors Horwood and Nel further state that "The existing provincial teachers' training institutions do not attract the best candidates in so far as cultural background and intelligence are concerned" and also make the comment that "It is impossible for the teaching profession to maintain a worthy status among the learned profession when 44 percent of its members have an Intelligence level below that of the average for the matriculation certificate."

It is not known whether the results of the Transvaal Education Department Training Colleges hold for the Cape Province as well, but there is no apparent reason why it should not be the case.

6.12. Mathematical Ability and Intelligence.

Using a method similar to that used to determine the general mathematical ability, described in 6.10 on page 79, the three main groups classified according to mathematical ability was further analysed with regard to the intelligence levels indicated by the H.S.P.Q. 'B' factor. Those students falling in stens 8, 9 and 10 were placed in the High Intelligence group and those in stens 4 through 7 in the Average Intelligence group. For the purpose of this classification the three students in the Low Intelligence group were placed with the others in the Average Intelligence group since their low score could possibly have been due to chance.

This classification gave rise to six groups, as indicated in Table 7 in Part III. The analysis revealed that 14% of the students displayed a high mathematical ability as well as a high intelligence rating, while 37,7% had a high ability with an average intelligence rating. (Groups i and ii) In the group displaying an average mathematical ability, 4,7% and 15,6% fell in the High and Average Intelligence groups respectively. (Groups iii and iv) The respective figures for the group with poor mathematical ability are 6,2% and 21,8%. (Groups v and vi).

It should be fairly safe to assume that the 40 students in group iv will find it difficult to achieve a satisfactorily high standard in Arithmetic during their College careers, while one can also expect that the 56 in group vi, and possibly also the 16 students in group v, have little hope of becoming teachers capable of teaching Arithmetic to a satisfactory standard in the Primary school.

It is disturbing to be faced with the fact that 43,6% of a group of student teachers are highly suspect with regard to their ability to teach one of the most important subjects in our schools to the citizens of the future, and that this degree of inability will very likely be transmitted to those who will have to suffer their efforts. (See also pages 53 to 57.)

6.13. General Level of Anxiety.

In an effort to determine the general level of anxiety in the students, the students who completed the H.S.P.Q. were also requested to complete the IPAT Anxiety Scale Questionnaire issued by the National Bureau for Educational and Social Research. Both the English and Afrikaans versions of this questionnaire, numbers N.B. 618 and N.B. 617 respectively, were used.

Cattell and Scheier (1961) have concluded that there tends to be a slight negative relation between anxiety and scholastic achievement, i.e. low anxiety tends to be associated with good marks and high anxiety with lower marks. This relation is, however, slight and there are a multitude of other factors such as learning conditions, kind of content of learning, personal characteristics of the pupils, etc., which can have an influence on scholastic achievement as great as, or greater than, the level of anxiety alone. The above-mentioned authors are also of the opinion that anxiety is in a large measure susceptible to change due to environmental circumstances. Thus moderate stress or challenge such as academic examinations can reduce anxiety whereas situational fear, social difficulties, etc. can appreciably increase the general level of anxiety.

Biggs (1963) states that

> "It is well known that anxiety can exert two fundamentally different effects on learning -- on the one hand, it can be used to motivate the learner, and so improve his learning, but on the other, too much anxiety can inhibit and depress learning. Other things being equal, we can expect the best performance in a given learning task to come from the learner who is <u>relatively</u> anxious."

It was expected that the test group would show a higher than normal level of anxiety due to the fact that they had, at the time of being tested, only recently entered Training College and were, generally speaking, still in new surroundings and being "supervised" by the more senior students.

The main value of the IPAT Anxiety Scale is, according to its Manual, that it measures that which comes closest to being the common element in all forms of mental disorders. Anxiety as measured by this scale is highly and consistently associated with all forms of mental disorders such as neurosis, psychosis, character disorder and even physical disability. Biggs (1963) rates anxiety as a major symptom of maladjustment and maintains further that pupils of average and high intelligence have difficulty in Mathematics and/or Arithmetic only if maladjusted, as often indicated by an abnormally high level of anxiety.

According to the Manual for the IPAT Anxiety Scale Questionnaire (1968), this scale is particularly effective in mass, general screening as a census of mental health since a lack of anxiety (low score on the scale) as measured by this scale serves as a most acceptable definition of such mental health.

The IPAT Anxiety Scale Questionnaire was the first of the battery of questionnaires and tests given to the students and the prescribed procedure was strictly adhered to in administering the questionnaire. The main purpose of the whole test battery was explained to the students and the assurance given that no particulars of any one individual would be disclosed. The students were given unlimited time in which to complete the questionnaire, but in no case did any student spend more than 15 minutes in doing so.

The questionnaire was scored and the scores translated to standard sten scores. The tables of norms used were for boys and for girls separately, and for boys and girls combined. The results are summarised in Tables XI and XII:

Table XI. Results of the IPAT Anxiety Scale Questionnaire.

	1st year students at Training College	National Norms.
Mean	33,67	32,70
p.e. of Mean	0,4406	0,0763
s.d.	10,47	11,40
Observed difference	0,97 above norm	
p.e.$(M_1 - M_2)$	0,4471	
$4\frac{1}{2}$Xp.e.$(M_1 - M_2)$	2,01195	

These results show that, although the mean level of anxiety is slightly higher for the students than the National Norm, there is no significant difference between the mean general level of anxiety displayed by the students and that expected to be found in the case of a representative sample of the population.

<u>Table XII:</u> Results of the IPAT Anxiety Scale Questionnaire: Boys and Girls separately.

	Boys	Girls
Mean	31,10	34,90
p.e. of Mean	0,09931	0,1189
s.d.	11,10	11,50
Observed difference	3,8	
p.e.$(M_1 - M_2)$	0,9782	
$4\frac{1}{2}$Xp.e.$(M_1 - M_2)$	4,4019	

These results show that, although the mean anxiety level of girls is higher than that of the boys, there is a probability of more than 1 chance in 100 that this is due to chance factors. One can therefore conclude that there is no significant difference in the anxiety levels of the male and female students involved in answering this questionnaire.

It is also found that the means for the boys and the girls do not differ significantly from the National Norms, which yielded means of 31,1 and 34,9 for boys and girls respectively

These figures could lead one to conclude that the non-existent "average" first year student is a perfectly normal, well - adjusted person. The X^2 - test tends to confirm this, when applied to the frequency - distribution illustrated by Graphs 11, 12 and 13 and Table 8 in Part III.

The X^2 - values calculated for the different groups are as follows:

Boys + Girls	Boys only	Girls only
13,205	13,201	13,522

In all cases these values indicate a probability of more than 1 in 10 that deviations from the normal distribution is due to coincidence and chance factors. The null -

hypothesis is therefore accepted as being true with regard to the anxiety levels displayed by the students.

The Manual for the IPAT Anxiety Scale Questionnaire suggests three basic groups, and when this classification is applied to the students, as in Table XIII, some disconcerting facts emerge:

Table XIII: Anxiety Levels; Basic Groups.

Description	Sten 1 through 3 secure, relaxed, phlegmatic etc.	Sten 4 through 7 average	Sten 8 through 10 level of anxiety serious, definitely needing help
Normal distribution	16%	67%	17%
Boys	9,4%	67,9%	22,7%
Girls	14,8%	70,8%	14,2%
Together	12,3%	61,4%	20,3%

The group with an average - high level of anxiety, i.e. those falling in sten 7, consists of:
Boys only: 16%; Girls only: 12,7%; Together: 16,7%.
This shows that 37% of the prospective teachers in this group of 257 students has a level of anxiety that can be classified as high to abnormally high. It would be unrealistic to cite the circumstances under which these students found themselves at the time of being tested, viz. at the very beginning of their College careers, as the main reason for such a high level of anxiety, although it cannot be completely ignored. It is acceptable to maintain that the level of anxiety will decrease after these students have "settled down" at college, but it cannot be said that the same effect will be achieved by the steadily increasing demands which they will have to meet in the academic field, or by their first teaching experience, or by the new group of pupils which these students

will eventually have to face each year.

It is interesting to note at this stage that, with regard to anxiety, Biggs (1963) has concluded that:

> ".....'don't like' attitudes to arithmetic involve something rather more deep-seated than dislike alone. This extra factor has been variously described as 'number anxiety', 'mathematical phobia' and suchlike -- and this brings us to the crux of the matter. It is the presence of anxiety in the emotional reactions to arithmetic that causes all the trouble."

This opinion was followed up by relating the answers given to questions 2 and 3 of the second part of the "Attitudes" questionnaire with the score of the Anxiety Scale Questionnaire, which then revealed that 29,47% of the students in stens 7 through 10 had indicated a definite dislike for Mathematics and/or Commercial Mathematics.

It is also of interest to note that, according to the Manual for the IPAT Anxiety Scale Questionnaire, the average anxiety level for a group of institutionalised neurotics suffering from anxiety reaction or anxiety state is sten 8,1. More than 20% of the students had a level of anxiety as high or higher than this group! How will these students eventually react when they have to teach under conditions of stress, and what effect will they eventually have on the personality development of their pupils? Questions such as these will have to remain unanswered until such a time as when a full study can be made of the psychological make-up of practising teachers.

6.14. Students with Abnormally High Anxiety Levels.

The results derived from the IPAT Anxiety Scale Questionnaire showed that 52 students, representing 20% of the sample, displayed an abnormally high level of anxiety, i.e.

their scores placed them in stens 8, 9 or 10. This group of students were placed according to their ability in mathematical subjects as shown by Table 5 in Part III. The result of this treatment is presented in Table 9 in Part III.

This treatment revealed that 12% of the students had both a high level of anxiety as well as high ability, while 3,8% displayed high anxiety coupled to average ability. There was, however, a group of 4,2% of these students that displayed an abnormally high level of anxiety and a poor ability in Arithmetic/Algebra. This is surely a cause for further anxiety to anyone concerned with the education of our children!

The same treatment was given to the six groups derived from combining mathematical ability with the Intelligence factor. This showed that 12,5% of the test group, placed in groups i, ii and iii, had an abnormally high level of anxiety, the highest percentage, namely 9%, being manifest in group ii. (See Table 10, Part III.) The remaining 8,1% fell in groups iv, v and vi, i.e., those groups which contained the students whose Intelligence/Ability combination is already suspect. This group may represent a relatively small percentage of our future teachers, but when it is considered that these 21 students will eventually be dealing with 30 to 40 pupils each in any one year, a total of 600 to 800 pupils, the percentage is not insignificant. And if these results are extrapolated to include the whole of the test group, 8,1% represents 61 students, who will teach as many as 2 500 pupils in any one year!

6.15. Students with Low Anxiety Levels.

Stens 1, 2 and 3 contained 32 students, who were classified with regard to mathematical ability and Intelligence/Ability in the same way as was done in the case of the group of students with high anxiety levels.

It was found that 5,6% of the respondents showed a high ability in mathematical subjects and a low anxiety level, while 3,9% displayed average ability and 1,9% showed poor ability coupled to low anxiety levels. These results will be found in Table 11 in Part III.
In the case of the Intelligence - Ability comparison, 7,7% fell in groups i, ii and iii while 4,7% were placed in groups iv, v and vi. (See Table 12, Part III.)
Since the latter group of students all have high or average intelligence levels, one could assume from these results that in these cases the low anxiety levels do not indicate stability and security but possibly an attitude of indifference. This view is supported by Biggs (1963) who found that students who "could'nt care less" perform badly when dealing with Arithmetic or Mathematics.

The combined results of Tables 10 and 12 therefore show that 12,8% or 33 students of a group of 257 show a poor combination of mathematical ability and intelligence, together with abnormally high or low levels of anxiety. Extrapolation (remembering that only a sample of the students were tested in this way) raises this number to a possible 96 students of a total group of 752. These students could eventually teach as many as 3 800 pupils in any one year!

CHAPTER VII

THE "UNDERSTANDING OF ARITHMETIC" QUESTIONNAIRE.

Being able to solve problems in Arithmetic, Algebra or Geometry does not mean that a person necessarily KNOWS why he or she is doing something. Most, if not all, teachers have known pupils who succeed in school by relying mainly on rote learning and "following the rules". There is also a certain type of teacher who uses this aspect of teaching to the utmost in order to obtain 'good' results. To be able to teach well, however, the teacher should not only know the content of his/her subject, but should also have a very thorough understanding of all the principles involved. The basis for this understanding should, ideally, be laid down by our Primary schools through the work of teachers who really know what they are teaching.

It was felt that the picture given by the results of the Arithmetic, Algebra and Geometry tests would be incomplete, as these results would not indicate the degree to which students knew the real meaning of terms, expressions and ideas usually involved in problems of a basic mathematical nature. In order to get information with regard to this aspect of the students' arithmetical ability, an "Understanding" questionaire was compiled, based mainly on the work done by Saad and Storer (1960) in Britain.

7.1. The Questionnaire.

The abovementioned questionaire consisted of 40 items of which 26 were of the multiple choice type, the students being given a choice of 5 possible answers and having to indicate the correct one only. The remaining 14 ques= tions required short, simple answers or calculations. The full text of both the English and Afrikaans versions of this questionnaire is given in Appendix III.

The items were not arranged in any specific order. Thus, for example, the process of multiplication was dealt with in questions 10 and 12 while decimal fractions were dealt with in questions 5, 14, 19 and 22.
The procedure that was followed in administering the questionnaire has already been fully described in 4.2 on page 37 of this thesis.

7.2. Evaluation of Replies.

The replies given by each student to each question were transferred to "score sheets". Straightforward addition then gave the total number of replies to each possible answer to the questions. This was done for male and female students separately, which in term gave rise to the totals for the group of students as a whole. The sexes were separated mainly as a matter of convenience since the majority of the lists of names obtained from the co-educational colleges were compiled according to the sex of the students.

The number of students who did not reply to a question was also noted and taken into consideration in the calculation of percentages. This was done because the main concern was not with how many students showed complete understanding of the items dealt with in the questionnaire, but rather with how well any specific item was understood. The instructions concerning the answering of the questionnaire furthermore included the sentence:

> "If you do not know the answer, go on to the next question. DO NOT GUESS ! "

A student not giving an answer to a question therefore contributed as much towards lowering the percentage of correct replies as did any student who gave an incorrect answer.

It may be noted at this stage that not a single item received full 100% response, and that only 17 students, representing 2,4% of the whole group, gave the correct replies to all 40 items. Each of these 17 students had taken Mathematics up to Standard 10. The best response was received by questions 6 and 7; 99,3% and 99,2% respectively. At the other end of the scale was question 38, which was answered by only 34,4% of the students.

The following section will deal only with the main findings and figures derived from this questionnaire. A full analysis of the replies to the 40 items, given for the whole group as well as separately for male and female students, will be found in Part III.

Because of the brevity of a questionnaire containing only 40 items, in relation to the wide field of Arithmetic and Mathematics, many questions dealt with relatively isolated facts and principles. It will therefore not be surprising to find that 12 questions can only be classified as "Basic General Mathematical Facts and Concepts", while the remaining questions can be classified under such headings as Multiplication, Division, Fractions, Decimal Fractions, Basic Algebra and Basic Geometry.

In the interest of clarity, each question is given before the replies to the question are dealt with.

7.3. Basic General Mathematical Facts and Concepts.

Question 1. We say that 11 is a prime number. What do we mean by prime number?

76,9% of the students replied to this question. 44% gave the correct answer (c) while (b) received the next largest number of replies, viz. 13,6%. This left a group of 42,4% of the students who do not appear to have any idea of what a prime number is.

Question 2. What do we mean by the square root of a certain number?

This question received a response from 94,2% of the students, and 70,5% gave the correct answer (b). It will soon become obvious that a question with a correct response of more than 70% is a rarity.

Question 3. Three numbers have the average of 12 and three other numbers have the same average of 12. What is the relation between the two sets of numbers?

87,9% of the students replied to this question, but only 42,7% indicated that the relation was given by (c). 26,1% indicated (b) - "The two sets have the same product".. Could it be that some of these students did not know the difference between "sum" and "product"?

Question 4. What do we mean by the cube root of a certain number?

85,4% of the students replied to this question, but the majority again gave the wrong answer. While 21,4% indicated the correct answer, i.e. (b), 21,9% indicated (c) -- "A number which if multiplied by 3 gives the original number".

Question 7. "35 per cent of our flowers are white." What is the meaning of 35 per cent?

Replies were received from 99,2% of the students. While less than one quarter, i.e. 23,4%, indicated the correct answer (a), one cannot say that the 45,9% who indicated (b) -- "It means that 35 of any 100 flowers are white" -- were totally wrong without appearing unreasonably inflexible. But even if this latter group is accepted being correct, it still leaves a group of 30,7% who could not give an explanation for such an everyday term as "percentage" !

Question 8. "John drives at a uniform speed." What does this mean?

97,3% of the students attempted this question, but only 11,8% indicated (b) as the correct answer. As many as 55,1% indicated the somewhat nonsensical reply (d) -- "John drives at a certain speed every time he drives."-- while 25,1% indicated that a uniform speed was a speed which was neither high nor low. (Reply (a)).

Question 9. We know that the approximate value of π is 3,14 or $\frac{22}{7}$. What does this π mean?

This question was answered by 78,9% of the students, but only 13,4% could indicate (c) as the correct answer. There was, however, a group of 37,4% who at least knew it was "A constant number which is used in problems dealing with circles." (reply (d)) !

Question 13. In rounding 3 748 to the nearest hundred we get 3 700. Why do we replace the 48 by 00?

97,7% of the students replied to this question. In this case it was felt that an indication that the correct answer was not available could be as good a test of understanding and knowledge as the identification of the correct reply, if not better. Only 3,5% of the students gave (e) as the correct reply. 64,8% indicated (d), with many going so far as to underline the words "nearest hundred". This could be interpreted as indicating a preoccupation with the idea of "nearest hundred" to the exclusion of the concept of "less than one-half". Such a conclusion could, however, be rather rash, as there is no evidence supporting it other than the fact that sufficient provision is made for the absence of a correct answer by the inclusion of reply (e).

<u>Question 16.</u> If a rectangle is of length 6" and breadth 4", its area is 6 x 4 = 24 sq. inches. On what idea is this conclusion based?

96,8% of the students answered this question, but 75,0% "followed the rule" and indicated (c) as the correct answer. Only a small group of 7,2% of the students gave the correct reply (b). This loyalty to the rule, to the exclusion of insight and understanding, is apparent in at least 8 more questions which are still to be dealt with. It also strengthens the argument that the ability to get the correct answer to a problem is no proof of understanding of the principles involved in the calculations.

<u>Question 18.</u> If a cuboid is 4" long, 3" broad and 2" high its volume is 4 x 2 x 3 cubic inches. On what idea is this conclusion based?

This question is similar to question 16 with regard to both type and distribution of answer. 96,9% of the students indicated possible answers to the question, but only 2,7% indicated (d) as the correct answer. The majority once more followed the rule, with either (a) or (c) indicated by a total of 85,5% of the students.

<u>Question 21.</u> If R1,00 is invested at 4% per year, which of the following expressions gives the <u>simple interest</u> in the <u>second</u> year?

86,6% of the students replied to this question, but less than one quarter (21,5%) gave the correct answer (c). 23,6% indicated (e). One wonders how many of the students in this group were looking for an answer of R0,08 or even R2,08. This result can lead one to the conclusion that 78,5% of the students will have difficulty in grasping the meaning of advertisements for building societies, savings banks, fund investments, etc. which stare at them from virtually every magazine and newspaper and are repeated ad nauseam in the commercial broadcasting programmes. One could well assume that a large number of pupils leave school without being equipped to deal with some of the basic necessities of everyday life. It is difficult to believe that such persons, after qualifying as teachers, will really be able to give their pupils the instruction and guidance which is necessary for leading a reasonably ordered, intelligent adult life.

7.4. Multiplication and Division.

Question 10. If you do not know how to multiply, how to divide or how to use the logarithmic tables, how can you manage to ..... get the answer of 173 x 13?

73,5% of the students replied to the question but only 42,6% gave some form of "repeated addition" as answer, a small number of students (19) even going so far as to do the actual addition. 11,3% simply did the multiplication, using the method of "long multiplication", while a further 4,8% attempted to do the same but could not arrive at the right answer!

Question 12.

Study the multiplication example on the right. It is written out in two different ways. Look at the way you are used to. Why is the partial product 878 moved one place to the left?

439		439
26		26
2634	OR	878
878		2634
11414		11414

This question was answered by 95,1% of the students, but only 38,8% could indicate (d) as the correct answer. 7,7% settled for the straightforward reply (a) -- "Because it is the rule" --- while a further 41,5% indicated that they really knew what the rule was by choosing (c).

Question 11. As for question 10: How can you get the answer of 875 ÷ 35?

Nearly half of the students did not attempt to answer this question, which received replies from 52,7%. Only 13,3% could indicate in some way or other that the required answer was "repeated subtraction". In this case 11,4% did the sum by long division a further 3,3% attempted to do it but could not arrive at the right answer. A group of 9,4% indicated that this problem could also be solved by repeated addition!

Question 17. Study the division example on the right. In the second step we have multiplied 38 by 5 to get the partial product represented by 190. What are the real two numbers which are multiplied to produce the partial product?

```
     256
38/ 9728
    76
    212
    190
     228
     228
```

Although 81,3% of the students replied to this question, only 14,7% indicated the correct reply (c). 37,8% however, indicated (e). Could this be attributed to the fact that "the rule" had been omitted?

7.5. Fractions.

Question 6. Mrs. Smith bought $\frac{3}{4}$ lb. of butter. What does the fraction $\frac{3}{4}$ mean?

This question received the best response of all the questions in the questionnaire, with 99,3% of the students replying to it. Only 37,9% could, however, indicate (d) as the correct answer. The largest group, containing 39,1% of the students, gave (b) -- "Three of four equal parts of a pound" -- as the correct answer. This can be regarded as a good example of a case where inexact terminology can readily give rise to confusion or incomplete understanding. It is easy to picture a teacher explaining fractions to a class and giving due emphasis to the equality of the parts but neglecting the fact that each part must also be considered in relation to the whole.

<u>Question 15.</u> In multiplying $4\frac{1}{3} \times 6$ we usually do it in the following way:-

$$4\tfrac{1}{3} \times 6 = \frac{13}{3} \times 6 = 26.$$

What is the idea involved in changing

$4\frac{1}{3}$ into $\frac{13}{3}$?

98,0% of the students responded to this question. Only 32,9% indicated the fairly obvious (b) as the correct answer. The majority of 51,3% of the students thought it best to try to show <u>what</u> was being done by indicating (a) while "the rule" could count on 5,1% of the students as faithful followers. It is also possible that this group did not recognize the "rule" in reply (a). Whatever the case may be, 56,4% of the students knew <u>what</u> to do without really knowing <u>why</u> it was being done.

<u>Question 20.</u> In adding $\frac{1}{2}$ and $\frac{1}{3}$ we do it in the following way:

$$\tfrac{1}{2} + \tfrac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{5}{6}$$

What is the idea involved in changing $\frac{1}{2}$ and $\frac{1}{3}$ into $\frac{3}{6}$ and $\frac{2}{6}$?

95,6% of the students replied to this question. It is difficult but not impossible to think that the correct answer (c) was rejected by all but 10,5% of the students because it was so obvious. It is, however, unlikely, since as many as 81,5% indicated either (a) or (d); answers that contained the terms "common denominator" and "lowest common multiple", terms that are often abused when fractions are dealt with in school. These two replies, together with (b), brought to light a group of 83,8% of the students who were either directly or indirectly once more "following the rule".

<u>Question 23.</u> In dividing 8 by $\frac{4}{3}$ we usually do it in the following way:

$8 \div \frac{4}{3} = 8 \times \frac{3}{4} = 6.$

What is the idea we have in mind in inverting $\frac{4}{3}$ into $\frac{3}{4}$?

93,1% of the students replied to this question but only a meagre 5,7% indicate (a) as the correct answer. On the other hand, 52,8% chose (c) and thus showed that they were of the opinion that the inversion was fully justified by the fact that division is the "opposite of multiplication." 17,5% chose (d) as the correct answer and in this way clearly showed to what extent half-truths and misunderstanding can be fostered in the classroom. "The Rule" was once again assured of its fair share of undiscriminating followers -- in this case 14,2% of the students.

The replies to these four questions clearly show how the indiscriminate and/or incorrect use of certain accepted terms and phrases can lead to defects in understanding in spite of the fact that the pupil may be perfectly able to do the calculations with the utmost facility and accuracy. It will be shown that this aspect is an obvious feature not only of this section but also of the sections dealing with Decimal Fractions and basic Algebraic concepts.

7.6. Decimal Fractions.

Question 5. 0,9 and 0,57 are decimal fractions. What is a decimal fraction?

While 97,3% of the students replied to this question, less than half, i.e. 46,7%, indicated that the correct reply was given in (a). 23,9% indicated (b) -- "It is a number with a decimal point" -- while to a group of 21,9% it was no more than another way of writing fractions. (reply (c)). Small wonder that so many people are confused by the "new" metric units brought into everyday use over the past years.

One can probably assume with a reasonable degree of safety that the everyday use of metric units will lead to a better understanding of decimal fractions, but the danger exists that it can happen to the detriment of the understanding of "ordinary" fractions.

Question 14. Why are the answers to the division examples $0{,}05\overline{)76{,}35}$ and $0{,}5\overline{)763{,}5}$ the same?

This question received replies from 95,4% of the students but the correct answer was indicated by only 29,5%. The majority of the students, in this case 55,1%, chose (d) and once more showed the dominating influence of "the rule" in their arithmetical thinking and ability.

Question 19. It is known that 1,5 = 1,50 = 1,500 = 1,5000. Why?

This question was answered by 97,6% of the students but once again less than half, i.e. 42,6%, indicated (b) as the correct reply. 22,6% were of the opinion that "zeros mean nothing" as indicated by response to reply (a) while "the rule" as presented by reply (c) accounted for a further 29,4%

Question 22. In multiplying 4,367 by 100 we have to move the decimal sign two places to the right. Why?

98,5% of the students replied to this question but only 30,6% were successful in indicating (c) as the correct answer. "The rule" was followed either directly or indirectly by 53,0% of the students, who indicated either (b) or (d).

Behr (1962) found that "the results of the test in decimals indicate that professional students on entering the teachers' training course have a very inadequate knowledge of the computational aspects of decimals." Of 10 sums in his test dealing with decimals, there were 8 that were done incorrectly by more than 50% of the testees.

7.7. Directed (Negative) Numbers.

Question 32. What does −5 mean?

93,6% of the students replied to this question. In this case there were two replies that could be considered correct. 48,4% indicated (d), the "standard" explanation of "5 units less than zero" while 10,8% indicated (b) -- "The number which when added to 5 gives zero".

<u>Question 34</u>. What is the principle illustrated in the statement $2 + (-5) = -5 + 2$?

This question, answered by 75,1% of the students, dealt with the commutative law for addition rather than with directed numbers, but is grouped with question 32 since it does involve a directed number. 19,3% of the students indicated the correct answer (a), while 26,9% of the students were satisfied with the fact that "a number without a sign ..... is positive". (Reply (d)).

7.8. <u>Basic Algebraic Concepts</u>.
(Complementary to the N.B. Standardised Tests.)

<u>Question 24</u>. What is the sum of x and y?

92,0% of the students answered this question and 69,0% gave the correct answer.

<u>Question 25</u>. What is the product of x and y ?

85,6% of the students replied to this question and in this case 75,0% could give the required answer of xy.

These two questions showed that many students did not have a clear grasp of the meanings of the two terms "sum" and "product", since 18,2% gave xy as the answer to question 24 while 4,3% gave x+y as the answer to question 25. There were even a few isolated cases where x-y was given as the answer to either question 24 or question 25.

Question 26. What is left if x is subtracted from y ?

83,6% of the students responded to this question, but less than half, viz. 41,9%, could give the correct answer. Of the rest, the majority, representing a group of 26,2% of the students, gave x-y as the answer. There were 6 students who even went so far as to substitute numbers for x and y, and of these 2 did the x-y subtraction while one student could not correctly subtract 7 from 13 !

Question 27. In the algebraic expression

$3ab - 5a^2b^3 + 7a^3b^5$:

(a) How many terms are there in this expression?

(b) What is the second term of this expression?

78,5% of the students replied to part (a), but only 56,1% gave the correct answer. The remaining 22,4% gave answers ranging from 1 to 18 terms !

Part (b) was answered by 74,6% of the students, with 23,7% giving the correct answer. 26,0% gave $5a^2b^3$ instead of $-5a^2b^3$ as the second term while 15,7% indicated that the second term was either a or b. The remainder gave answers involving wondrous feats of addition, multiplication and addition showing a high degree of either imagination or ignorance of basic mathematical facts.

Question 28. If x is an even number, what is the next even number?

Only 67,7% of the students replied to this question. Less than $\frac{1}{3}$ of the respondents, i.e. 21,7% of the whole body of students, gave the correct answer, while 18,4% gave 2x as answer.

Question 29. If a is a whole number, what is the whole number consecutive to it?

63,6% of the students replied to this question, and in this case only a meagre 19,8% could give the correct answer. Of the remainder, 17,4% indicated that the next number was b !

Question 30. What is the value of the number in which x is the units digit and y is the tens digit?

60,0% of the students replied to this question. Only 8,2% could give the required answer of $10y + x$, while 37,6% gave yx as the answer. This result is not particularly surprising, as any teacher of Mathematics can tell of average and even bright pupils struggling with this concept when they come across it for the first time. It does, however, show that the colleges have to face a very difficult task if they desire to give training that leads to understanding as well as knowledge. It is, after all, not a giant step from "two tens plus five" to $10y + x$!

Question 31. $(3x + 1)$ is a factor of the expression $(3x^2 - 2x - 1)$. What does factor mean?

69,6% of the students replied to this question and 41,5% indicated the correct answer (c). The rest of the replies was fairly evenly distributed among the remaining four responses.

Question 33. When we solve the equation $5x = 10$ we get $x = 2$. What is the idea we are applying?

This question received replies from 80,5% of the students. The correct answer was not supplied, for the same reason as stated for question 13 on page 96. 23,0% indicated (e), while 12,1% followed the rule by indicating (c). 42,0% indicated (d) -- "Getting rid of the 5 in 5x".

This group knew what to do, and can apply a method correctly, but obviously does not have a complete understanding of the principle involved in solving the equation. Thus there is once more a large group of students, i.e. 54,1% of the whole group, who can do a problem, who can solve a simple equation, without knowing what they are really doing or why they use a specific method.

Question 35. In dividing $a^5 \div a^3$ we get a^2. Why ?

87,1% of the students replied to this question, with 29,9% indicating the correct reply (d). "The Rule" as presented in (c) was adhered to by 26,7%, while 23,1% indicated (b), i.e. $\frac{\not a+\not a+\not a+a+a}{\not a+\not a+\not a} = a^2$!

In this question 43,4% knew neither the "why" nor the "what", indicating a disturbing lack of understanding of the meaning not only of division of algebraic fractions but also of such basic a concept as indices or "powers" as they are so often called.

The replies to these questions brought to light a serious lack in understanding of basic algebraic concepts, concepts that are frequently applied in Arithmetic in Standards 3, 4 and 5. The fact that numbers are used at that stage instead of alphabetical symbols cannot be used to extenuate this weakness unless we are prepared to accept a form of teaching that offers mechanical methods and overworked "rules" without the balancing aspects of mathematical insight into the principles that are involved.

7.9. Basic Geometry.

(Complementary to the N.B. Standardised Tests.)

Question 36. Draw a diagram to show .... the distance from A to BC.

73,7% of the students attempted this question and 27,8% completed the given figure by sketching the perpendicular from A to BC. 14,6% completed the triangle ABC and indicated that both AB and AC were the required distances.

Question 37. As for question 36: ..... to show .... a reflex angle ABC.

While 60,5% of the students responded to this question, only 11,3% could complete the diagram correctly. One of the unsuccessful students wrote that he could not complete the diagram since he did not have the necessary instruments with him, while another thought that there was insufficient space in which to draw the reflex angle.

Question 38. .... a figure symmetrical to ABCD with respect to PQ.

A meagre 34,3% of the students attempted to answer this question, and only 11,0% could draw anything even faintly resembling the required diagram. It is hard to believe that 89% of the students could not interpret the term "symmetrical" as this is a concept which is surely often used in a context other than mathematical ! One is therefore virtually forced to the conclusion that the majority of the students cannot apply a known concept to an unfamiliar situation, or do not even try to do so !

Question 39. What is the complement of 78° ?

48,9% of the students replied to this question and 30,1% could give the correct answer of 12°. The supplement, i.e. 102° , was given as answer by 9,8% while 1,2% gave 22° as answer. The remainder of the replies consisted of an apparently completely random selection of values.

Question 40. The sides of a triangle are 6', 8' and 10' and the angles are 37°, 53° and 90°. Find (a) the sides and (b) the angles of the triangle if it is magnified 2 times.

Part (a) received replies from 57,6% of the students, with 47,9% giving the correct values. 5,3% gave the sides the values of 18', 24' and 30', while the remainder of the replies consisted of values apparently completely unrelated to those given in the question.

55,9% of the students replied to part (b), with 37,1% giving the correct answers. 12,7% gave the angles the values 74°, 106° and 180°, while a further 2,7% gave the values of 111°, 159° and 270°. It is obvious that these students are not conversant with one of the most rudimentary facts concerning the properties of triangles.

7.10. General Conclusions.

The results of this questionnaire show that its inclusion in the battery of tests was fully justified and that one fact emerges with glaring clarity: There are many students who display the desired degree of ability in mathematical topics as far as the solving of problems at the Standard 7 level is concerned, but that this ability depends on set methods and a slavish adherence to "The Rule". One can but reiterate the remark made on more than one occasion in the foregoing pages, viz. that many students can cope adequately with simple problems without having the faintest idea of what they are doing or why they are using a certain method; that they can do Arithmetic and, to a lesser degree, Algebra and Geometry, but that they do so with a disconcerting lack of mathematical insight and understanding. These, then, are the people who will be going out to teach, at a stage when the emphasis in teaching is shifting more and more from the "how" towards the "why"; at a stage of our educational evolution where the understanding of basic principles is being given greater importance than the mere mechanical implementation of these principles. But can pupils be led towards understanding and insight by teachers in whom these qualities are lacking? Can any Training College foster these qualities in the short period of three years if the schools could not do so over a period of twelve years?

One expects the Colleges to be sufficiently aware of this lack in the student teachers and that the lecturing staff have not yet come to accept this state of affairs as normal or inevitable. In South Africa, as in Britain, the schools "have to utilize fully new entrants to the profession as soon as they arrive. Since it is the class teacher in primary schools who introduce children to mathematics, it is essential that at least a majority of students entering the colleges, whether they have an entrance qualification in mathematics or not, should obtain some understanding of that subject." (The Royal Society, 1972) Given the proper guidance and instruction, a student who exhibits a normal degree of intelligence and who is, after all, supposedly more mature than a pupil at school, should be able to come to a better level of understanding of mathematical concepts in the course of three years of training than is exhibited by these entrants to Training College. Whether this does in fact happen will, however, as previously indicated, be difficult to determine. The task of the colleges will furthermore not become less demanding as long as pupils can pass a Senior Certificate examination and gain entrance to a Training College with no more than a Standard 6 qualification in Mathematics.

CHAPTER VIII

SUMMARY, CONCLUSIONS and RECOMMENDATIONS.

8.1. Concern about the teaching of Arithmetic and Mathematics in the Primary and Secondary school in South Africa is of long standing, as shown by research done by various institutions and individuals.

8.2. Changes in the examination system and syllabi in schools in the Cape Province resulted in decreasing numbers of pupils taking mathematical subjects at school, until a stage was reached where the Cape Education Department launched a research programme to investigate this phenomenon, the results of which were published in 1947.

8.3. The investigation revealed inter alia that the standard attained in Arithmetic by pupils in Standard 6 was not adequate for the needs of everyday life.

8.4. It was recommended that an integrated course in Arithmetic and Mathematics be made compulsory for all pupils up to Standard 8. This recommendation was adopted but still made provision for certain pupils to be exempted from the course.

8.5. Research in Britain and the U.S.A. shows that the teaching of Mathematics is often of such a quality as to foster a dislike for the subject in the pupil, and that this is often due to the teachers' inability in the subject, as well as the use of ineffective, outdated teaching methods.

8.6. The whole educational system in the Cape Province is changing, resulting in new, modern syllabi which offer opportunities for the introduction of modern methods of teaching. The question is raised whether the teachers are capable of adapting to new syllabi and to abstractive teaching methods.

8.7. Students entering Teachers' Training Colleges are not required to have any qualification in Mathematics as entry requirement. Mathematics and/or Commercial Mathematics and Accountancy are compulsory subjects up to Standard 8.

8.8. When a pupil cannot benefit from further instruction after Standard 6 in these subjects, or when it is in the interest of his/her career, he/she can be exempted from studying Mathematics and/or Commercial Mathematics and Accountancy in Standards 7 and 8.

8.9. The regulations are such that a pupil can obtain the Senior Certificate without ever having passed an examination in Mathematics or Commercial Mathematics and Accountancy.

8.10. Special abilities and the shortage of teachers are often advanced as reasons for admitting students without any qualifications in Mathematics or Commercial Mathematics to Training Colleges.

8.11. The process of selection of student teachers is of such a nature that pupils without qualifications in a mathematical subject are not eliminated.

8.12. The research results presented in the preceding pages reveal that first year students at Training Colleges in the Cape Province held the following qualifications:

Mathematics: Up to Standard 10 --- 33%
Up to Standard 8 --- 28%
Up to Standard 6 --- 39%

Commercial Mathematics:
Up to Standard 10 --- 26%
Up to Standard 8 --- 29%
Not studied --------- 45%

8.13. It was found that 12,9% of the students had taken neither Mathematics nor Commercial Mathematics after Standard 6.

8.14. 50,7% of the students could be regarded as "well qualified" in a mathematical subject.

8.15. 31,5% of the respondents to the "Attitudes" questionnaire positively disliked Mathematics, while 20% displayed the same attitude towards Commercial Mathematics. Only 5,9% and 3% regarded Mathematics and Commercial Mathematics respectively as their favourite subjects.

8.16. While 52% and 21,8% of the respondents indicated that their liking for Mathematics and Commercial Mathematics respectively had decreased during their school careers, only 24,5% and 32,2% indicated an increase in liking for the respective subjects.

8.17. A large number of students held their teachers responsible for their decrease in liking, a minority indicating that they usually received unsympathetic treatment from their teachers.

8.18. The majority of students regarded Arithmetic as being of great importance in the Primary school.

8.19. Only 7% of the students regarded Arithmetic as the subject they would most like to teach, while 10,1% indicated that they intended specialising in Mathematics during their third year of training.

8.20. 26% of the students indicated Arithmetic as the subject they would least like to teach.

8.21. In the N.B. Arithmetic test, the students' mean score in each of the three parts, as well as the total score, was significantly higher than the National Mean, when scored at STANDARD 7 level.

8.22. The X^2-test proved that the distribution of students in stanines 1 through 9 was not a normal distribution. This was found for each of the three parts of the test, as well as for the total score. The deviations from Standard 7 norms in favour of the Training College entrants were mainly due to the high scores of the students who had taken Mathematics or Commercial Mathematics to Standard 10.

8.23. It was nevertheless found that 34,9% of the students had an Arithmetical ability equal to, or lower than that of an average pupil in Standard 7.

8.24. The students' mean score for the N.B. Algebra test was higher than the National Mean, but there was a probability of less than 1 in 100 but more than 1 in 1 000 that this was due to chance factors.

8.25. The X^2-test revealed that the students could not be regarded as a normal sample of the population with regard to Algebra at the Standard 7 level. The largest variations from the normal distribution for Standard 7 pupils could be attributed to the students who had studied Mathematics to Standard 10 level.

8.26. The results of the N.B. Geometry and Graphs test were similar to those of the Algebra test.

8.27. A group of 257 students completed the H.S.P.Q. and the IPAT Anxiety Scale Questionnaire, and their results were subjected to a more detailed analysis.

8.28. 51,8% of the minority group mentioned in 8.27 showed above-average ability in mathematical subjects, while 20,3% showed average ability and 26,9% showed poor ability.

8.29. The results of the H.S.P.Q. with regard to the

'B' factor (general level of intelligence according to Cattell) showed no significant deviations from a normal distribution. It cannot, however, be regarded as satisfactory that 38,8% of a group of prospective teachers have a 'B' factor (level of intelligence, according to Cattell) below that which can be regarded as the average for Matriculation.

8.30. The results of the IPAT Anxiety Scale Questionnaire showed no significant deviations from the normal distribution. It was however found that 37% of the group of students have a level of anxiety that can be classified as high to abnormally high. More than 20% of the students display a level of anxiety (according to this test) equal to that determined for a group of institutionalised neurotics.

8.31. The "Understanding" questionnaire revealed that the students showed a disturbing lack of understanding of mathematical concepts. 20 of the 40 items in the questionnaire were answered correctly by less than 25% of the students, and 9 items by less than 40%. Only 2 items received a correct reply from more than 70% of the students.

A brief speculation on possible future developments.

The reorganisation of the school system in the Cape Province, resulting in Standard 5 becoming part of the Junior Secondary School phase but physically remaining part of the Primary school, necessitates the introduction of subject teaching in the Primary school. (Cape Education Department, 1972). Although this subject teaching is limited to Standard 5, it is not difficult to envisage its gradual, perhaps initially imperceptible spread to the lower classes of the Primary school. There are already schools which have introduced this in a limited measure. (South African Teachers' Association, 1972.) The course for the Primary Teachers' Diploma in its present form in Training Colleges in the Cape Province prepare Primary teachers in a limited way for subject teaching in the Primary school. During the third and final year of this course students following the "academic" Senior course can "specialise" in two subjects other than the official languages, chosen from a list which include Mathematics, Science, History and Geography. Primary teachers can also attend College for a fourth year of training in order to qualify for the Teachers' Diploma. during this year they can specialise in one of the subjects which they had chosen for the third year of their initial training course.

During the past sixty years a number of moves have been made to bring all teacher training under the control of the Universities. All these moves have been defeated, as is clearly shown in summarised form on pages 103 to 106 of the Report of the Commission of Inquiry into the Training of White Persons as Teachers. (Republic of South Africa, 1969). Thus one finds a system of divided control of teacher training, with the Provinces responsible for the training of Primary teachers in the Training Colleges, and the Universities, as well as certain Technical Colleges, training teachers for the Secondary school. At the same time the Universities offer courses which qualify students as Primary school teachers. A recent move, such as that by the University of Stellenbosch, has been to introduce degree courses in Primary Education. Thus one finds a lack of uniformity of training, of standards and even of nomenclature as far as the training of Primary school teachers are concerned, and it is not surprising that Principals of Primary schools are often at a loss to determine the "value" of a teacher's qualifications. It is heartening to find that criteria have at last been formulated for at least the evaluation of teachers' qualifications. (Republic of South Africa, 1971.)

It is worth noting that the James Report (1971) disapproves of the idea of integrated courses in which academic and professional training takes place concurrently --- which is the basic system at present in force in the Training Colleges in the Cape Province --- and recommends that teacher training should be divided into three consecutive cycles, which would separate personal higher education from professional training.

One can therefore expect that the future will see not only the introduction of subject teaching throughout the Primary school, starting in a limited way at Standard 2 level and becoming more specialised in Standards 3 and 4, but also the eventual rationalisation of all teacher training. Such expectations may be regarded as over-optimistic at the present stage, but cannot be held to be totally undesirable or unrealistic. Time will tell whether these expectations are justified or not.

A last conclusion.

The results of this research show that a large number of entrants to the Training Colleges in the Cape Province cannot be regarded as suitable for the teaching profession, especially with regard to the teaching of Arithmetic in the Primary school. It is difficult to believe that the Training Colleges can achieve in three years' time that which the schools could not do in 12 years. The inevitable result is that the inability and negative attitudes of some teachers will be transmitted to the pupils whom they will teach. When it is considered that a class in the Primary school generally consists of 30 to 40 pupils, one realises the extent of the damage that can be done by as few as 70 (less than 10% of the entrants) "bad" teachers during every year of their teaching careers. The Colleges turn out more than 700 teachers every year.

Can the preparation of teachers of Arithmetic be adequate when the Colleges are faced with a large number of students who dislike the subject, do not understand the basic principles and have little ability in the subject? This question, as well as others raised in the preceding pages, receives an answer from Glennon (1958) when he states:

> "The answer to this question, among people who are competent to judge, is a clear-cut and emphatic NO! And there is overwhelming evidence to support the answer. The arithmetic training of the elementary school teacher really begins when he is a child in the elementary school. The quality of the teaching that he experiences will determine the degree of achievement and the kind of attitude that he acquires. Unfortunately the typical teacher-to-be gets off to a poor start in both of these areas. In the recent report on mathematical education by the Educational Testing Service is this statement: 'Future teachers pass through the elementary school learning to detest mathematics. They drop it in high schools as early as possible. They avoid it in teachers' college because it is not required. They return to the elementary school to teach a new generation to detest it.'"

The above-mentioned detestation could well be the underlying reason for the fact that the teaching of Arithmetic is of such a quality that the pupils are "Too often ... bored by it and find in it no relevance to the stirring life outside school or the many pleasurable occupations that school itself can offer." (Association of Teachers in Colleges and Departments of Education, 1956.)

The results of such uninspiring teaching is reflected in the statement by Busschau (1961) that "Matriculants are not very 'numerate'. In a world applying science to an ever increasing degree in its production and daily living, the importance of increasing numeracy is obvious, and the continuous and growing complaints about 'unnumerate' matriculants is all the more regrettable."

Thus the effects of unsatisfactory teaching of Arithmetic in the Primary school does not only result in a vicious circle from school to College and back to school, but is also felt in all spheres of modern life. The remedy must be applied at Training College level and is sketched by Behr (1962) in his statement that:

> "To provide ... instruction that is merely an extension and an elaboration of the primary school syllabus will no longer do. Instruction in arithmetic alone is not enough. Our students require a well co-ordinated, adequately planned course in basic modern mathematics that will give them insight into the rigours of mathematical thinking, and will make them aware of the meaningfulness of absolute truths, precision of statement and deductive logic. It is this mental equipment which our future teachers need.
> This, then, is a challenge we in the teacher training colleges of South Africa must face."

Recommendations:

The situation with regard to ability in Arithmetic, understanding of, and attitudes toward the subject, shown by prospective Primary school teachers in the Cape Province, cannot be expected to change to any appreciable extent as long as the status quo is maintained in the Teachers' Training Colleges. The author therefore takes the liberty to make the following recommendations:

If the criticism that the knowledge underlying educational practice is intellectually shallow (Renshaw, 1972), is to be met, and if the Training Colleges are to train teachers capable of meeting the challenges and demands of the present and future syllabi in Arithmetic and Mathematics in the Primary school, as well as leading their pupils to mathematical insight and understanding, it is recommended that:

1) A minimum qualification in Mathematics or Commercial Mathematics is demanded as one of the academic qualifications for entry to a Teachers' Training College.

2) In view of the results of the standardised tests presented in the preceding pages, this qualification should initially be a pass in Mathematics or Commercial Mathematics at the Junior Certificate level.

3) The standard of the above-mentioned qualification should eventually be raised to a pass at the Senior Certificate level.

4) The training course in Mathematics at the Training Colleges should prepare the future teachers not only in mathematical skill, but also in the underlying philosophy and psychology that is unique to the subject. In this respect a training course such as outlined by Noble (1972) is well worth considering.

5) A form of selection should be applied to determine which teachers are suitable, in respect of both ability and attitude, to teach Arithmetic and basic Mathematics in the Primary school.

Suggestions for further research.

This investigation has revealed at least three major fields for further research, these being:

1) As an obvious sequal to this work: The extent to which the Training Colleges manage to raise the students' standard of, and ability in Arithmetic, and to change their attitudes toward the subject during the three - year training course for the Primary Teachers' Diploma.

2) The system of promotion in Training Colleges and the relative importance attached to desirable personality factors as compared to academic ability.

3) An investigation of personality factors, degree of maladjustment (if any) and general psychological make - up of practising teachers which can affect their pupils' learning and understanding of new facts and concepts.

PART III.

DETAILED RESULTS and GRAPHS.

Note: On all graphs the broken line indicates the Normal Distribution.

Analysis of Replies to
"Attitudes" Questionnaire.

SECTION A

Question		n	%
1.	(a)	693	92
	(b)	58	8
	(N)	108	70
	(Y)	47	30
2.	(a)	558	74
	(b)	23	3,05
	(c)	171	22,8
	(d)	192	25,5
	(e)	351	46,7
	(f)	154	20,5
	(g)	55	7,35
3.	(a)	300	40
	(b)	452	60

Question		n	%
4.	(a)	752	100
	(b)	414	55
5.	Mathematics		
	(a)	752	100
	(b)	211	28
	(c)	247	33
	Commercial Maths		
	(b)	218	29
	(c)	196	26
6.	(a)	752	100
	(b)	0	0

SECTION B

Question		n	%
2.R		424	56,0
	(a)	25	5,9
	(b)	110	26,0
	(c)	52	12,1
	(d)	104	24,6
	(e)	133	31,5

Question		n	%
3.R		403	53,5
	(a)	12	3,0
	(b)	79	19,8
	(c)	133	33,0
	(d)	98	24,5
	(e)	81	20,0

Question		R		Liked		Disliked	
		n	%	n	%	n	%
5.	(a)	-	-	-	-	-	-
	(b)	547	73,0	382	70,0	165	30,0
	(c)	457	61,0	310	68,0	147	32,0
	(d)	442	59,0	246	56,0	196	44,0
	(e)	245	32,5	140	57,0	105	43,0
	(f)	245	32,5	139	56,8	106	43,2
6.	(a)	-	-	-	-	-	-
	(b)	400	53,0	238	59,5	162	40,5
	(c)	398	53,0	227	57,0	171	43,0
	(d)	396	52,8	203	51,0	193	49,0
	(e)	190	25,3	100	53,0	90	47,0
	(f)	186	24,8	93	50,0	94	50,0

Question	n	%
7.R	592	79,0
(a)	49	8,2
(b)	21	3,5
(c)	12	2,0
(d)	397	67
(e)	34	5,7
(f)	79	13,2
10. Mathematics		
R	539	71,5
(a)	128	23,5
(b)	279	52,0
(c)	132	24,5

Question	n	%
8.R	410	54,5
(a)	16	3,9
(b)	10	2,5
(c)	12	3,0
(d)	309	75,0
(e)	28	6,8
(f)	35	8,5
Commercial Maths		
R	399	53,0
(a)	86	21,8
(b)	184	46,0
(c)	129	32,2

Question		n	%	n	%
11.	Mathematics			Commercial Maths	
	R	521	69,5	382	51,0
	(a)	7	1,32	5	1,3
	(b)	6	1,14	1	0,26
	(c)	4	0,77	1	0,26
	(d)	179	34,30	118	31,0
	(e)	6	1,14	6	1,56
	(f)	5	0,96	2	0,52
	(g)	197	37,70	137	35,8
	(h)	117	22,50	112	29,3
12.	R	533	71,0	390	52,0
	(a)	234	44,0	131	33,5
	(b)	196	37,0	158	40,5
	(c)	103	19,0	101	26,0
13.	R	533	71,0	390	52,0
	(a)	151	28,3	126	32,4
	(b)	184	34,5	126	32,4
	(c)	113	21,0	81	20,6
	(d)	85	16,2	56	14,6
14.	R	533	71,0	390	52,0
	(a)	297	56,0	244	62,5
	(b)	155	29,0	94	24,0
	(c)	81	15,0	52	13,5
15	R	602	80,0	436	58,0
	(a)	72	12,0	22	5,0
	(b)	118	19,6	96	22,0
	(c)	130	21,5	136	31,0
	(d)	227	37,8	122	27,0
	(e)	12)	2,3	9)	2,05
	(f)	2)		)	
	(g)	1	0,17	12	2,65
	(h)	40	6,6	39	8,95

Question	n	%
16. Arithmetic		
R	752	100,0
(1)	189	25,0
(2)	354	47,0
(3)	155	20,5
(4)	30	4,0
(5)	24	3,2
17. Arithmetic		
	53	7,0
18. Arithmetic		
	197	26,0
19. R	752	100,0
(K)	233	31,0
(1)	51	6,8
(2)	71	9,4
(3)	129	17,0
(4)	89	11,8
(5)	179	23,7

Question	n	%
20. R	752	100,0
(a)	356	47,4
(b)	396	52,6
21. Arithmetic		
	35	4,6
22. R	914	% based on 752 students
(a)	77	10,1
(b)	85	11,2
(c)	170	22,5
(d)	138	18,2
(e)	444	59,0

Table I

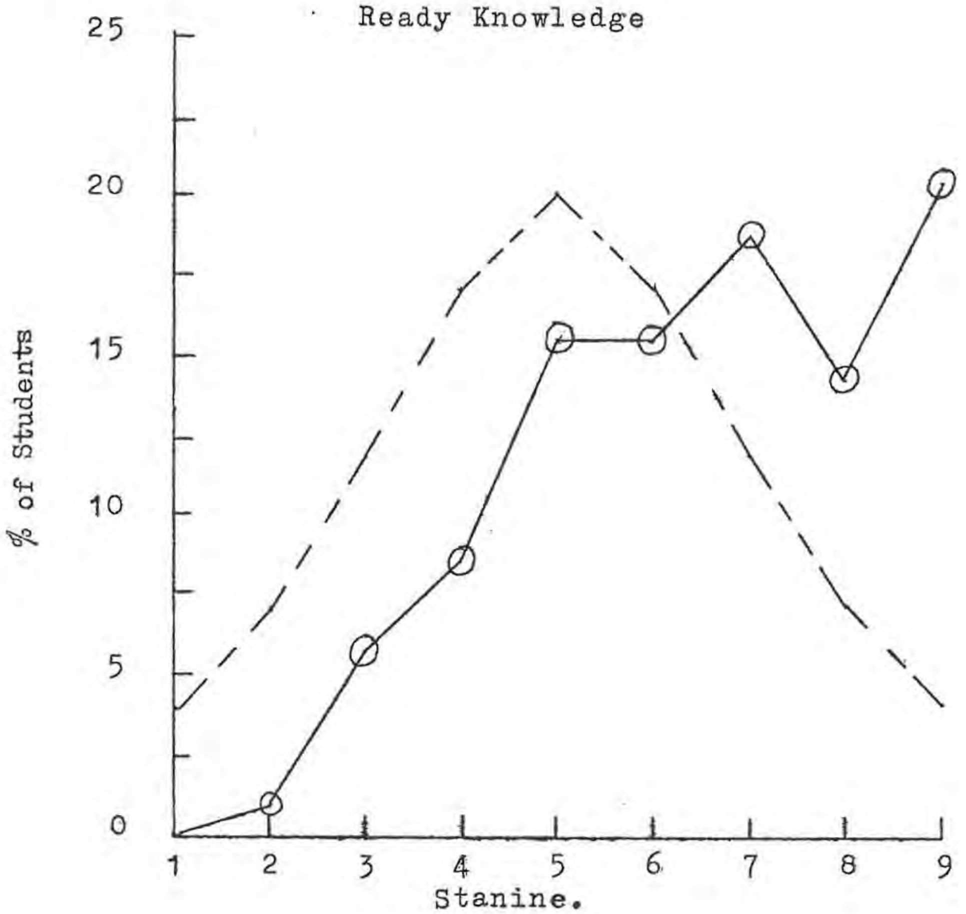
Arithmetic

Distribution

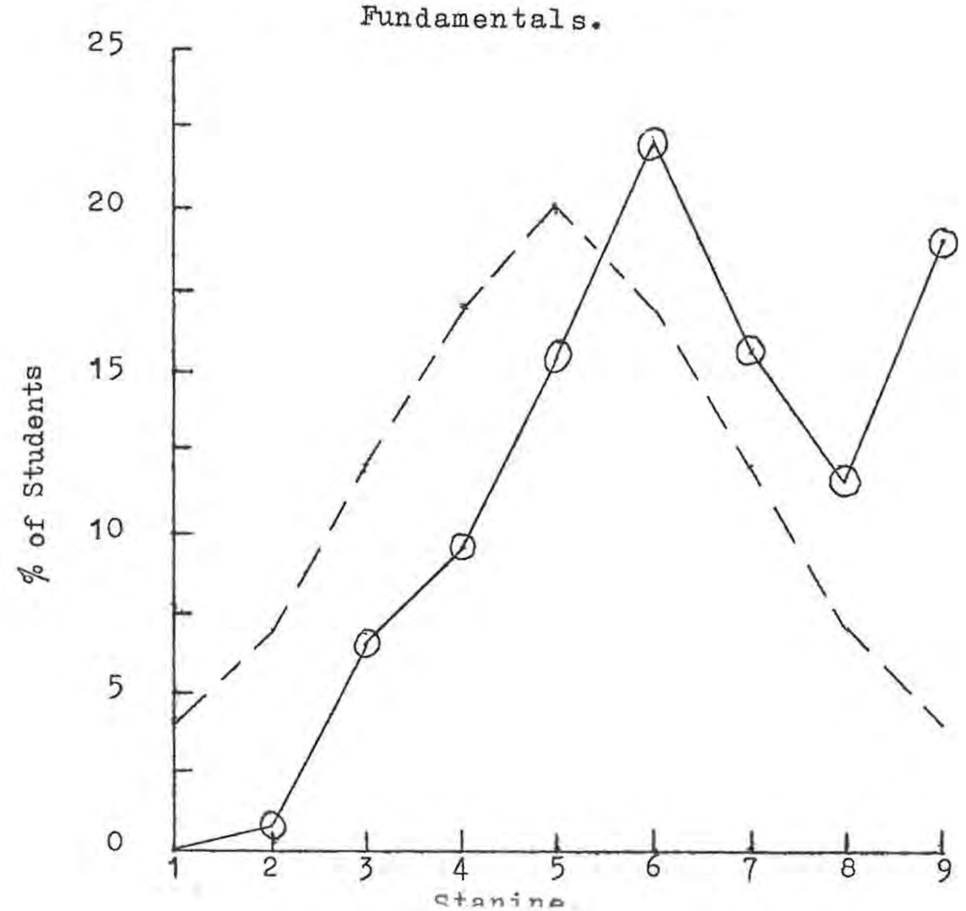
Number and Percentage of Students per Stanine

Stanine	Distribution				
	Total	I	II	III	Normal Distribution
1	-	-	-	1 0,13%	4%
2	4 0,53%	9 1,2%	5 0,7%	14 1,86%	7%
3	49 6,5%	43 5,7%	48 6,4%	42 5,7%	12%
4	78 10,4%	63 8,4%	70 9,5%	50 6,6%	17%
5	126 16,8%	118 15,4%	116 15,4%	140 18,6%	20%
6	109 14,5%	116 15,4%	165 22,0%	128 17,0%	17%
7	110 14,6%	142 18,8%	117 15,5%	106 14,1%	12%
8	94 12,5%	108 14,3%	87 11,5%	127 16,8%	7%
9	182 24,1%	153 20,3%	144 19,1%	144 19,1%	4%
Total	752	752	752	752	

Graph I: Arithmetic, Part I.
Ready Knowledge

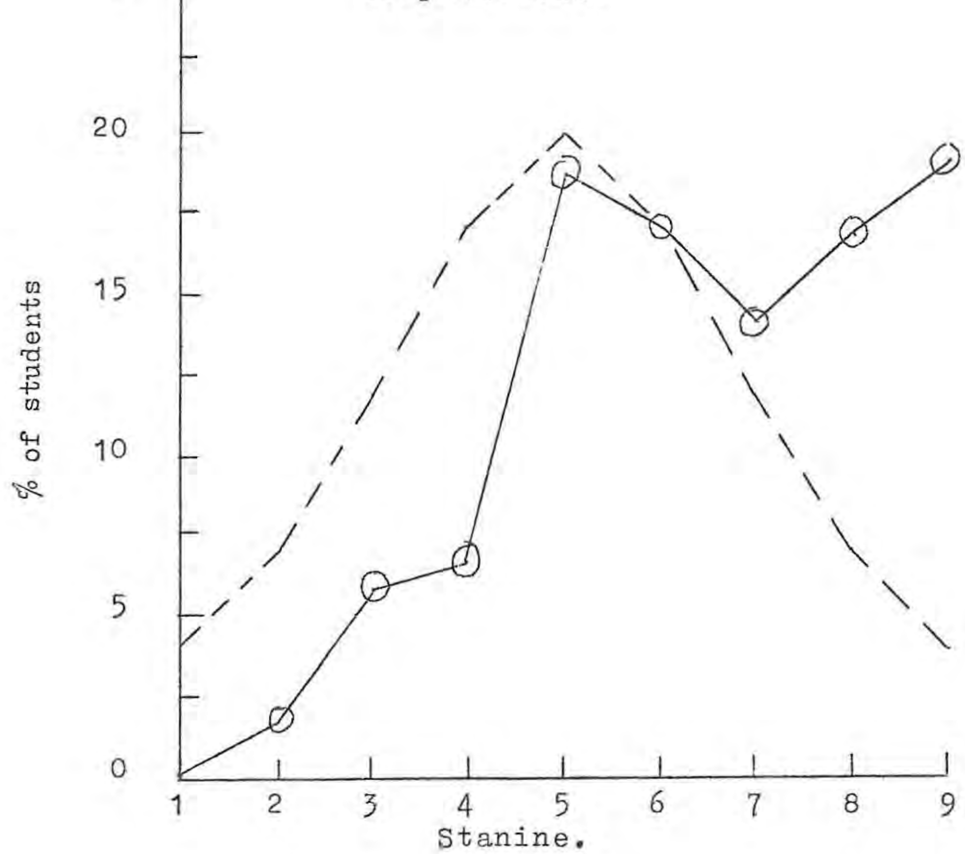


Graph II: Arithmetic, Part II.
Fundamentals.



Graph III: Arithmetic, Part III

Problems and Mechanical Computations.



Graph IV: Arithmetic, Total.

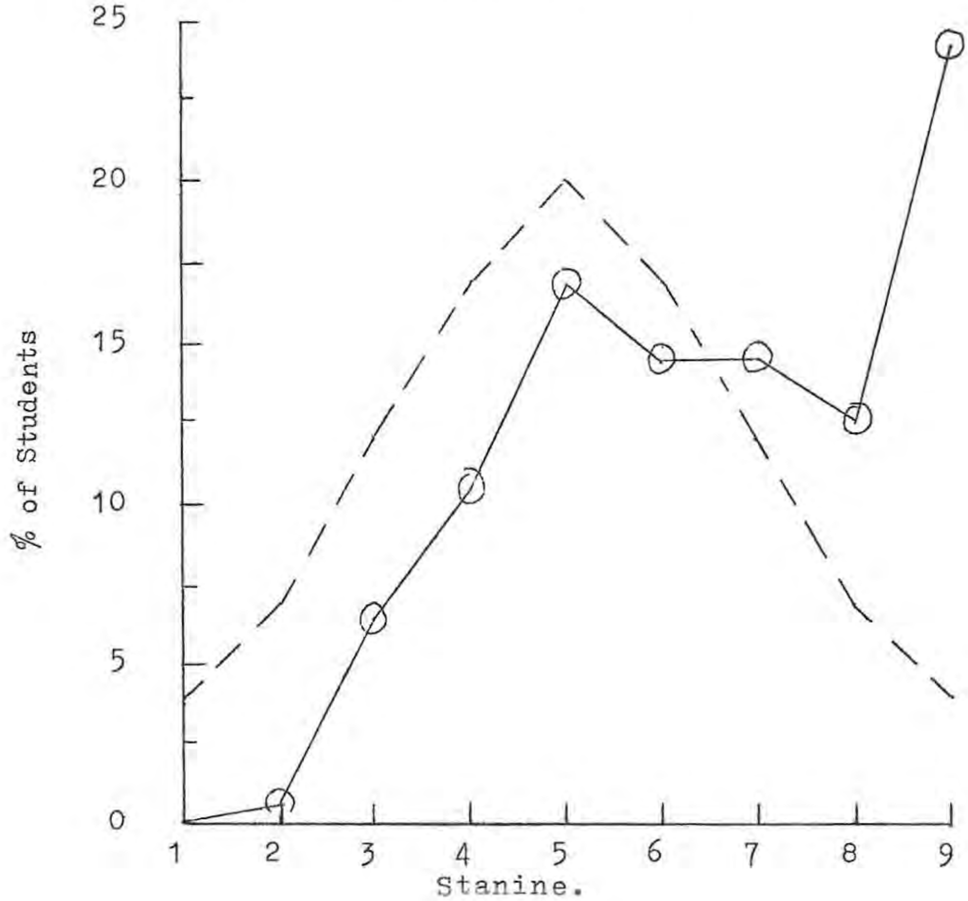


Table 2. Classification of students according to Qualifications and Arithmetic score.

Qualifications	Mathematics to Standard 10			Mathematics to Standard 8			Mathematics to Standard 6			Total per Stanine	Percentage per Stanine
Arithmetic: Total Score	Commercial Mathematics to Std. 10	Commercial Mathematics to Std. 8	Nil	Commercial Mathematics to Std. 10	Commercial Mathematics to Std. 8	Nil	Commercial Mathematics to Std. 10	Commercial Mathematics to Std. 8	Nil		
Group	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3		
Stanine: 1	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	1	-	1	2	4	0,5
3	-	-	-	-	-	2	-	19	28	49	6,5
4	-	-	3	-	-	24	3	18	30	78	10,4
5	-	2	11	3	6	35	18	39	22	126	16,8
6	3	-	13	10	10	32	13	19	9	109	14,6
7	11	15	19	6	-	29	9	15	6	110	14,6
8	19	-	26	8	10	-	21	10	-	94	12,5
9	50	15	85	17	3	-	12	-	-	182	24,1
Total:	83	32	157	44	29	123	66	121	97	752	
Percentage	11	4,3	20,8	5,9	3,9	16,4	8,7	16,1	12,9		100
	36,1			26,2			37,7				

Table 3.

Algebra

Distribution

Number and Percentage of Students per Stanine

Stanine	Maths taken to			Total	Normal Distribution
	St. 10.	St. 8	St. 6		
1	-	2 0,3%	103 14,2%	105 14,5%	4%
2	-	7 1,0%	35 4,8%	42 5,8%	7%
3	-	34 4,7%	74 10,3%	108 15,0%	12%
4	4 0,5%	36 5,0%	41 5,7%	81 11,2%	17%
5	5 0,7%	58 8,0%	14 2,0%	77 10,7%	20%
6	8 1,0%	29 4,0%	3 0,6%	40 5,6%	17%
7	12 1,7%	22 3,0%	-	34 4,7%	12%
8	44 6,2%	10 1,3%	-	54 7,5%	7%
9	171 23,7%	10 1,3%	-	181 25,0%	4%
N	244 33,8%	208 28,6%	270 37,6%	722 100%	100%
				96,0% of whole sample	

Table 4

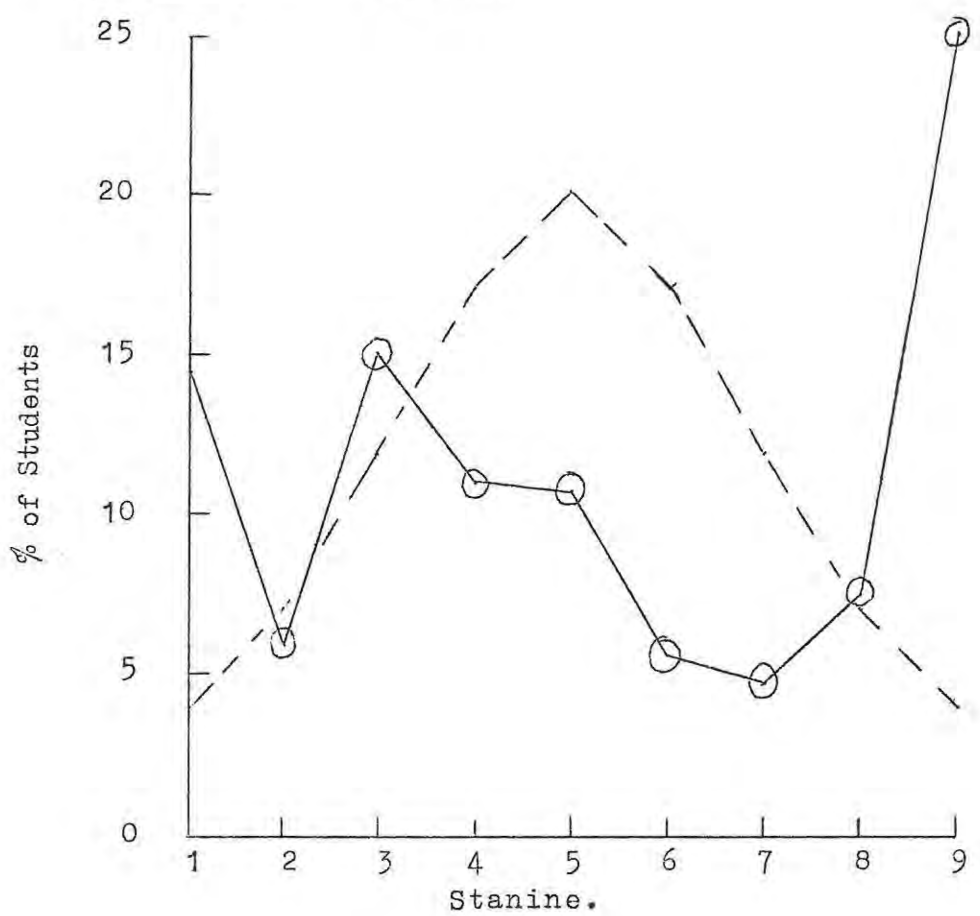
Geometry and Graphs

Distribution

Number and Percentage of Students per Stanine

Stanine	Maths taken to			Total	Normal Distribution
	St. 10	St. 8	St. 6		
1	-	3 0,7%	51 12,1%	54 12,8%	4%
2	-	2 0,5%	18 4,2%	20 4,7%	7%
3	2 0,5%	10 2,4%	12 2,8%	24 5,7%	12%
4	2 0,5%	26 6,1%	19 4,5%	47 11,1%	17%
5	5 1,2%	29 6,9%	8 1,9%	42 10,0%	20%
6	12 2,8%	30 7,1%	4 1,0%	46 10,9%	17%
7	16 3,8%	14 3,3%	-	30 7,1%	12%
8	23 5,5%	18 4,2%	-	41 9,7%	7%
9	114 27,0%	4 1,0%	-	118 28,0%	4%
N	174 41,3%	136 32,2%	112 26,5%	422 100%	100%
				59,5% of whole sample	

Graph V: Algebra.



Graph VI: Geometry and Graphs.

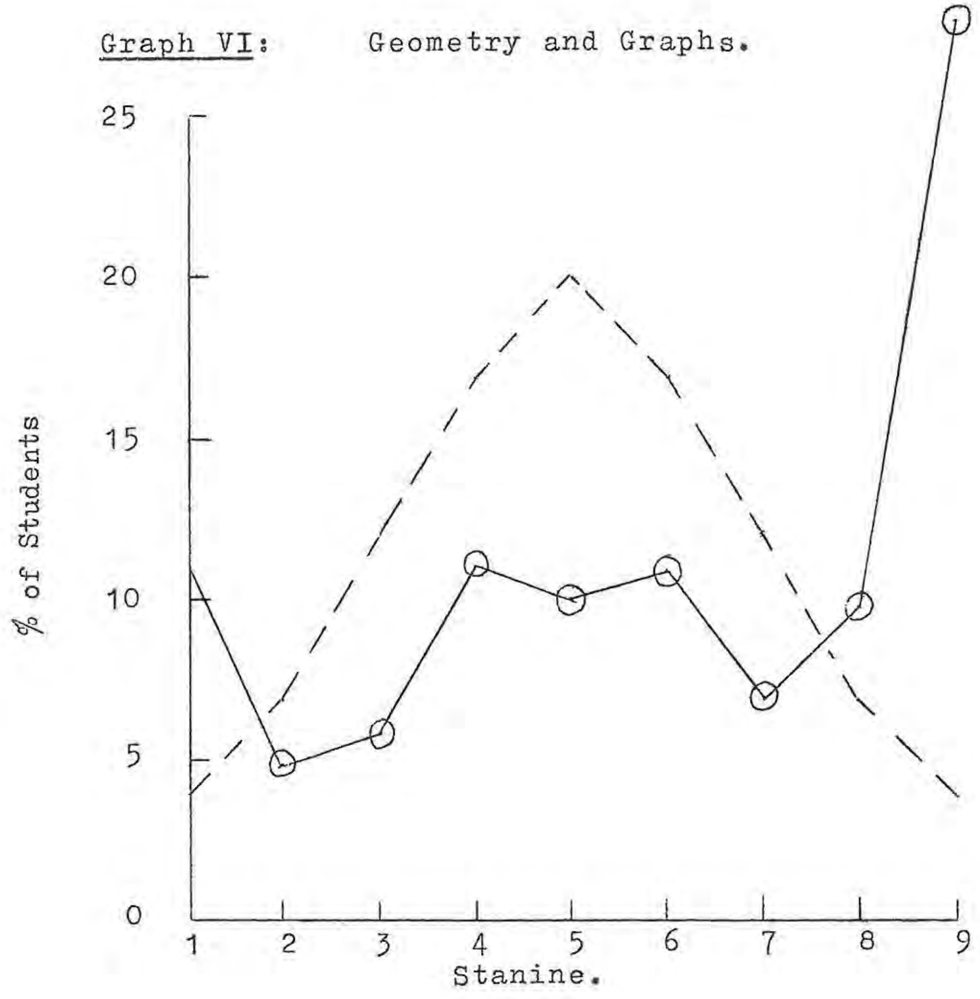


Table 5.

General Mathematical Ability

Algebra \ Arithmetic	High: Stanines 9, 8, 7.	Average: Stanines 6, 5, 4.	Low: Stanines 3, 2, 1.
High: Stanines 9, 8, 7.	P 36,6% (94)	Q 4,7% (12)	R 0,0% (0)
Average: Stanines 6, 5, 4.	S 10,5% (27)	T 15,6% (40)	U 1,1% (3)
Low: Stanines 3, 2, 1.	V 4,7% (12)	W 21,0% (54)	X 5,8% (15)

High Ability:	Groups P, Q, S.	51,8%
Average Ability:	Groups R, T, V.	20,3%
Poor Ability:	Groups U, W, X.	27,9%

Table 6 (a)

H.S.P.Q. 'B' Factor

Frequency Distribution

Stens	1	2	3	4	5	6	7	8	9	10
Boys and Girls Together	- -	0,8% 2	0,4% 1	14,8% 38	23,8% 61	- -	34,2% 88	21,0% 54	- -	5,0% 13
Boys Only	- -	1,3% 1	1,3% 1	5,4% 4	12,0% 9	28,1% 21	28,1% 21	22,7% 17	- -	1,3% 1
Girls Only	0,6% 1	- -	5,5% 10	8,1% 15	22,1% 40	36,8% 67	- -	20,4% 37	- -	6,6% 12
Normal Distribution	2%	5%	9%	15%	19%	19%	15%	9%	5%	2%

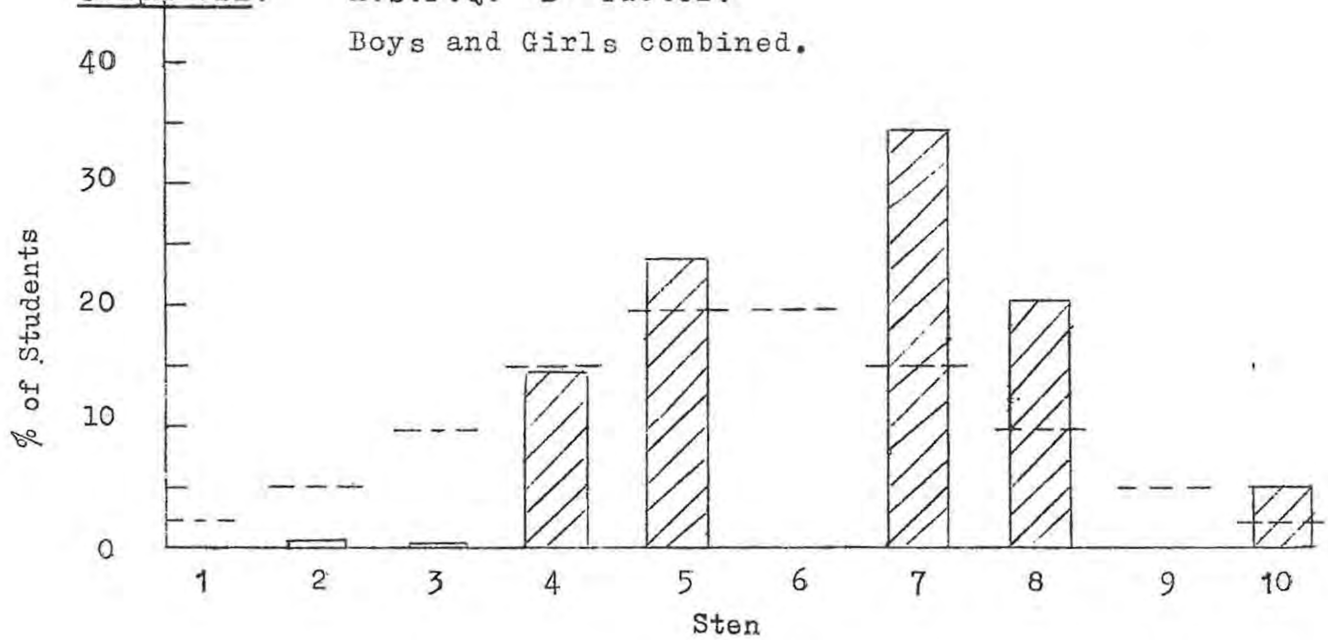
Table 6 (b)

H.S.P.Q. 'B' Factor

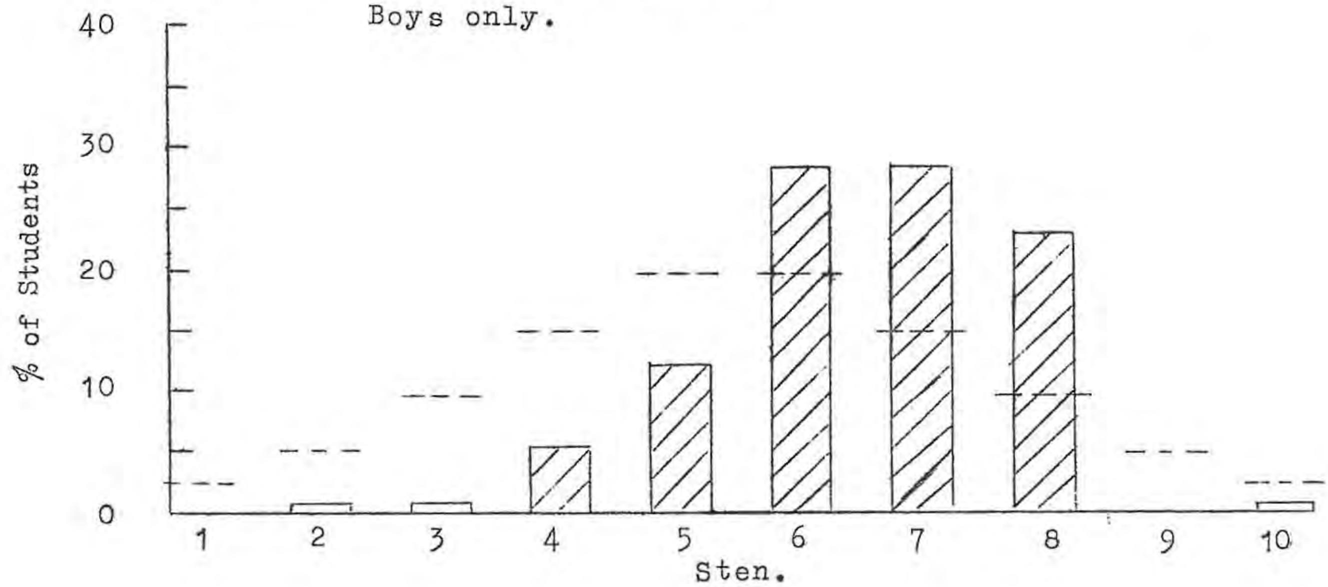
Frequency Distribution. Stens Grouped.

Stens	1	2,3	4,5	6,7	8,9	10
Boys and Girls Together	- -	1,2% 3	38,6% 99	34,2% 88	21,0% 54	5,0% 13
Boys Only	- -	2,6% 2	17,4% 13	56,2% 42	22,7% 17	1,3% 1
Girls Only	0,6% 1	5,5% 10	30,2% 55	36,8% 67	20,4% 37	6,6% 12
Normal Distribution	2%	14%	34%	34%	14%	2%

Graph VII: H.S.P.Q. "B" Factor.
Boys and Girls combined.



Graph VIII: H.S.P.Q. "B" Factor.
Boys only.



Graph IX: H.S.P.Q. "B" Factor.
Girls only

Graph X: H,S,P.Q. "B" Factor.
Stens grouped. Boys and Girls combined.

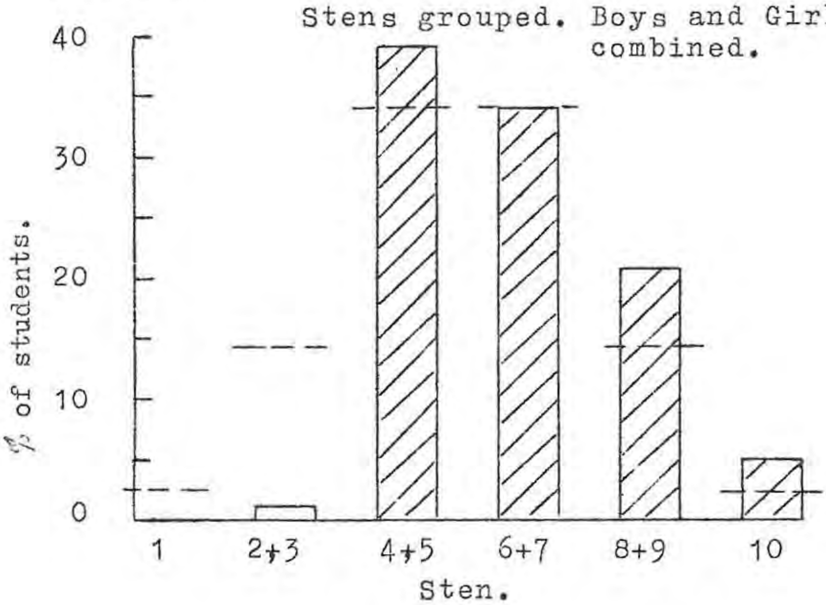


Table 7

Comparison of Mathematical Ability with

General Level of Intelligence

Intelligence / Mathematical Ability	High: Stens 10, 9, 8.	Average: Stens 7, 6, 5, 4.	Low: Stens 3, 2, 1
High: P, Q, S.	i 14% (36)	ii 37,7% (97)	
Average: V, T, R.	iii 4,7% (12)	iv 15,6% (40)	
Poor: U, W, X	v 6,2% (16)	vi 21,8% (56)	

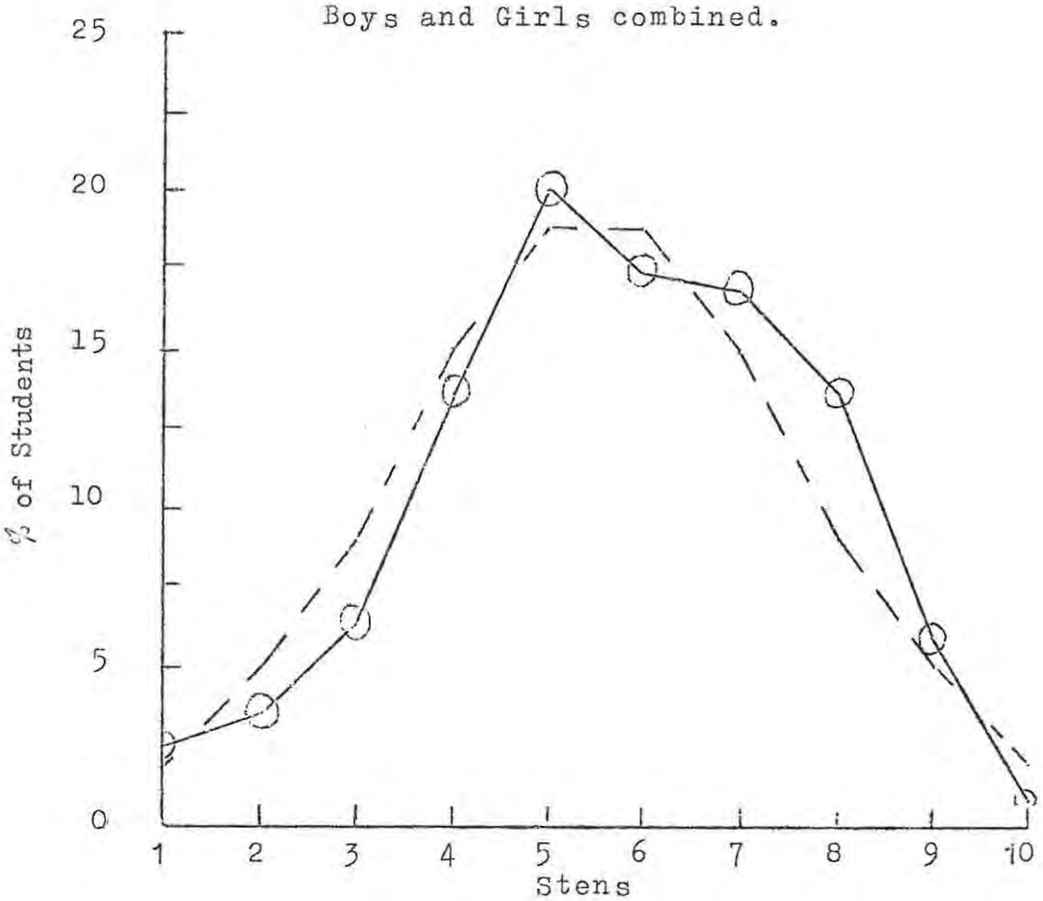
Table 8

IPAT Anxiety Scale

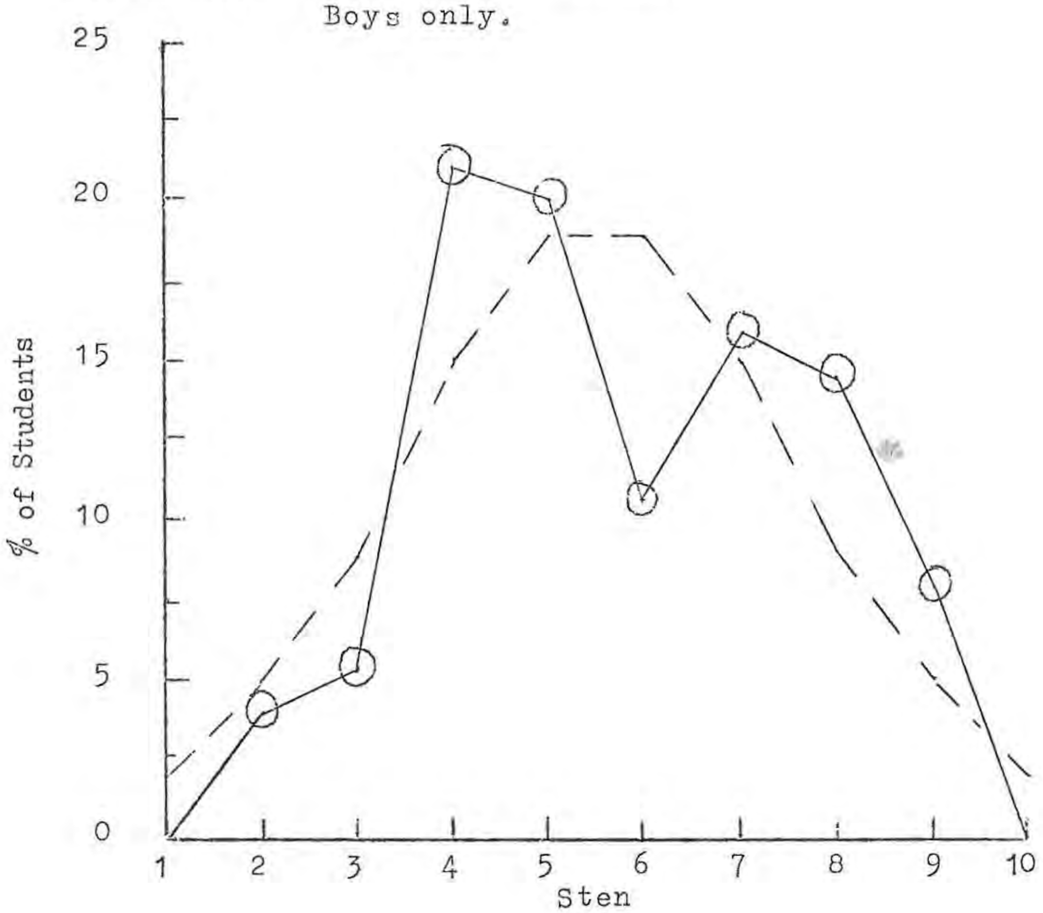
Frequency Distribution.

Stens	1	2	3	4	5	6	7	8	9	10
Boys and Girls Together	2,6% 7	3,5% 9	6,2% 16	13,6% 35	20,0% 51	17,1% 44	16,7% 43	13,6% 35	5,9% 15	0,8% 2
Boys Only	0,0% 0	4,0% 3	5,4% 4	21,2% 16	20,0% 15	10,7% 8	16,0% 12	14,7% 11	8,0% 6	0,0% 0
Girls Only	4,4% 8	2,7% 5	7,7% 14	15,9% 29	19,2% 35	23,0% 42	12,7% 23	9,3% 17	4,9% 9	0,0% 0
Normal Distribution	2%	5%	9%	15%	19%	19%	15%	9%	5%	2%

Graph XI: IPAT Anxiety Scale.
Boys and Girls combined.



Graph XII; IPAT Anxiety Scale.
Boys only.



Graph XIII: IPAT Anxiety Scale.
Girls only.

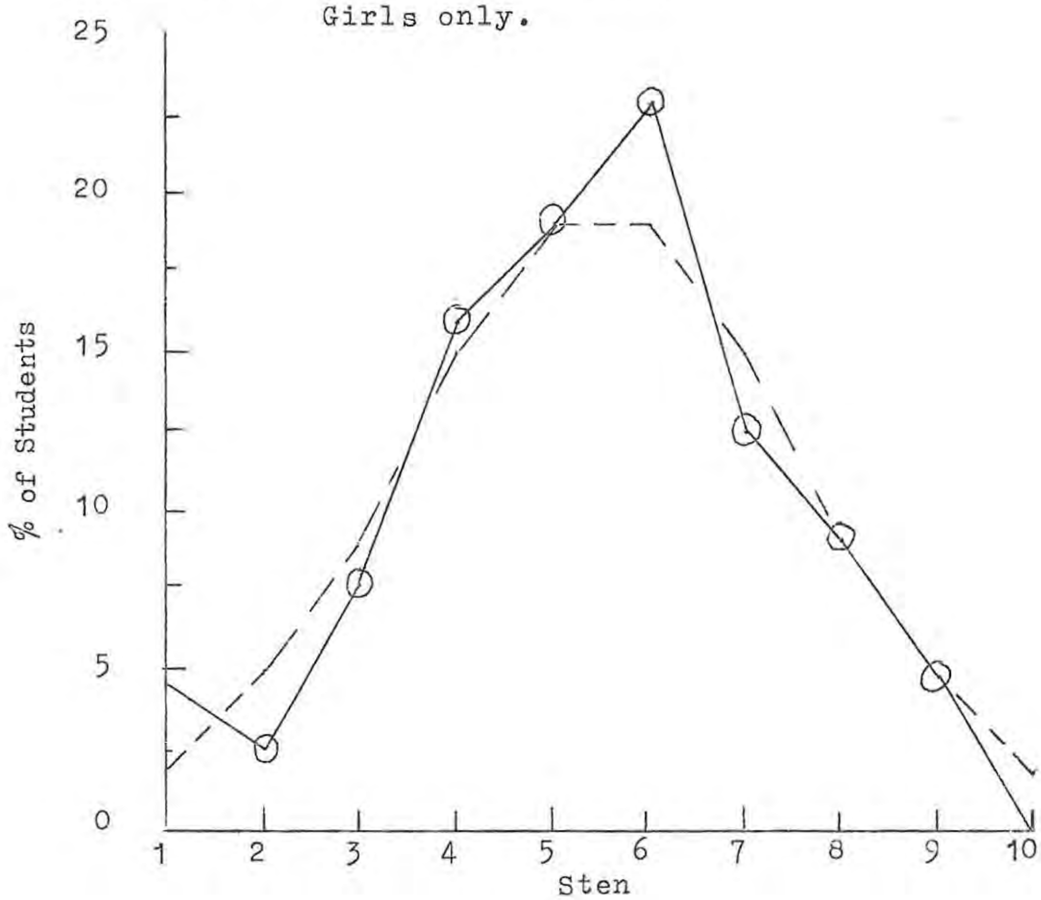


Table 9.

Students with High Anxiety Level
(Stens 8, 9, 10):

Mathematical Ability

Arithmetic / Algebra	High: Stanines 9, 8, 7.	Average: Stanines 6, 5, 4.	Low: Stanines 3, 2, 1.
High: Stanines 9, 8, 7.	P 9,3% (24)	Q 0,0% (0)	R 0,0% (0)
Average: Stanines 6, 5, 4.	S 2,7% (7)	T 2,7% (7)	U 0,0% (0)
Low: Stanines 3, 2, 1.	V 1,1% (3)	W 3,1% (8)	X 1,1% (3)

High Ability --------- High Anxiety: 12%

Average Ability ------ High Anxiety: 3,8%

Poor Ability --------- High Anxiety: 4,2%

Table 10

Students with High Anxiety Level

(Stens 8, 9, 10):

Intelligence - Mathematical Ability

Intelligence / Mathematical Ability	High: Stens 10, 9, 8.	Average: Stens 7, 6, 5, 4.	Low: Stens 3, 2, 1.
High: P, Q, S.	i 3,1% (8)	ii 9,0% (23)	
Average: V, T, R.	iii 0,4% (1)	iv 3,9% (10)	
Poor: U, W, X.	v 1,1% (3)	vi 3,1% (8)	

Table 11

Students with Low Anxiety Level:

(Stens 1, 2, 3.):

Mathematical Ability

Arithmetic / Algebra	High: Stanines 9, 8, 7.	Average: Stanines 6, 5, 4.	Low: Stanines 3, 2, 1.
High: Stanines 9, 8, 7.	P 4,7% (12)	Q 0,8% (2)	R 0,0% (0)
Average: Stanines 6, 5, 4.	S 1,1% (3)	T 3,5% (9)	U 0,0% (0)
Low: Stanines 3, 2, 1.	V 0,4% (1)	W 1,5% (4)	X 0,4% (1)

High Ability: ------------ Low Anxiety: 6,6%

Average Ability: --------- Low Anxiety: 3,9%

Poor Ability: ------------ Low Anxiety: 1,9%

Table 12

Students with Low Anxiety Level

(Stens 1, 2, 3):

Intelligence - Mathematical Ability

Intelligence / Mathematical Ability	High: Sten 10, 9, 8.	Average: Sten 7, 6, 5, 4.	Low: Sten 3, 2, 1.
High: P, Q, S	i 2,3% (6)	ii 4,3% (11)	
Average: V, T, R	iii 1,1% (3)	iv 2,7% (7)	
Poor: U, W, X.	v 1,6% (4)	vi 0,4% (1)	

Group i, ii, iii: 20 - 7,7%

Group iv, v, vi : 12 - 4,7%

Analysis of replies to the "Understanding of Arithmetic" questionnaire.

n = number of students. R = response, i.e. number of students replying to a Question.

Question	Total		Male		Female	
	n	%	n	%	n	%
1.R	578	76,86	120	77,42	458	76,72
a	41	5,45	3	1,94	38	6,37
b	100	13,30	21	13,55	79	13,23
c	331	44,02	59	38,06	272	45,56
d	70	9,31	21	13,55	49	8,21
e	36	4,79	16	10,32	20	3,35
2.R	708	94,15	152	98,06	556	93,13
a	26	3,46	6	3,87	20	3,35
b	530	70,48	119	76,77	411	68,84
c	41	5,45	9	5,81	32	5,36
d	59	7,85	8	5,16	51	8,54
e	52	6,91	10	6,45	42	7,04
3.R	661	87,90	140	90,32	521	87,27
a	81	10,77	15	9,68	66	11,06
b	196	26,06	40	25,81	156	26,13
c	319	42,42	74	47,76	245	41,04
d	31	4,12	4	2,58	27	4,52
e	34	4,52	7	4,52	27	4,52
4.R	642	85,37	141	90,97	501	83,92
a	73	9,71	14	9,03	59	9,88
b	161	21,41	26	16,77	135	22,61
c	165	21,94	38	24,52	127	21,27
d	111	14,76	27	17,42	84	14,07
e	132	17,55	36	23,23	96	16,08
5.R	732	97,34	150	96,77	582	97,49
a	351	46,68	80	5,16	271	45,39
b	180	23,94	28	18,06	152	25,46
c	172	22,87	37	23,87	135	22,61
d	23	3,06	3	1,94	20	3,35
e	6	0,80	2	1,29	4	0,67
6.R	747	99,34	153	98,71	594	99,50
a	105	13,96	20	12,90	85	14,24
b	294	39,10	50	32,26	244	40,87
c	57	7,58	12	7,74	45	7,54
d	285	37,90	68	43,87	217	36,35
e	6	0,80	3	1,94	3	0,50

Question	Total		Male		Female	
	n	%	n	%	n	%
7.R.	746	99,20	153	98,71	593	99,33
a	176	23,40	38	24,52	138	23,12
b	342	45,48	75	48,39	267	44,72
c	121	16,09	18	11,61	103	17,25
d	80	10,64	14	9,03	66	11,06
e	27	3,59	8	5,16	19	3,18
8.R	732	97,34	149	96,13	583	97,65
a	190	25,27	37	23,87	153	25,63
b	89	11,84	23	14,84	66	11,06
c	29	3,86	10	6,45	19	3,18
d	414	55,05	75	48,39	339	56,78
e	10	1,33	4	2,58	6	1,01
9.R	593	78,86	130	83,87	463	77,55
a	55	7,31	17	10,97	38	6,37
b	138	18,35	26	16,77	112	18,76
c	101	13,43	29	18,71	72	12,06
d	281	37,37	56	36,13	225	37,69
e	18	2,39	2	1,29	16	2,68

Question	Total		Male		Female	
	n	%	n	%	n	%
10.R	553	73,54	123	79,35	430	72,03
	320	42,55	71	45,81	249	41,71
11.R	396	52,66	93	60,00	303	50,75
	100	13,30	27	17,43	73	12,23
12.R	715	95,08	141	90,97	574	96,15
a	58	7,71	8	5,16	50	8,38
b	25	3,32	10	6,45	15	2,51
c	313	41,62	51	32,90	262	43,89
d	292	38,83	67	43,23	225	37,69
e	27	3,59	5	3,23	22	3,69
13.R	735	97,74	142	91,61	593	99,33
a	184	24,47	42	27,10	142	23,79
b	34	4,52	6	3,87	28	4,69
c	3	0,40	2	1,29	1	0,17
d	488	64,89	83	53,55	405	67,84
e	26	3,46	9	5,81	17	2,85

Question	Total n	Total %	Male n	Male %	Female n	Female %
14.R	717	95,35	151	97,42	566	94,81
a	222	29,52	53	34,19	169	28,31
b	53	7,05	11	7,10	42	7,04
c	12	1,60	2	1,29	10	1,68
d	414	55,05	83	53,55	331	55,44
e	16	2,13	2	1,29	14	2,35
15.R	737	98,01	151	97,42	586	98,16
a	386	51,33	81	52,26	305	51,09
b	247	32,85	53	34,19	194	32,50
c	38	5,05	5	3,23	33	5,53
d	56	7,45	10	6,45	46	7,71
e	10	1,33	2	1,29	8	1,34
16.R.	728	96,81	151	97,42	577	96,65
a	97	12,90	27	17,42	70	11,73
b	54	7,18	11	7,10	43	7,20
c	564	75,00	112	78,71	452	75,71
d	6	0,80	0	0,00	6	1,01
e	7	0,93	1	0,65	6	1,01

Question	Total n	Total %	Male n	Male %	Female n	Female %
17.R	611	81,25	133	85,81	478	80,07
a	46	6,12	10	6,45	36	6,03
b	161	21,41	40	25,81	121	20,27
c	108	14,36	18	11,61	90	15,08
d	21	2,79	7	4,52	14	2,35
e	275	36,57	58	37,42	217	36,35
18.R	729	96,94	149	96,13	580	97,15
a	446	59,31	86	55,48	360	60,30
b	59	7,85	20	12,90	39	6,53
c	197	26,20	36	23,23	161	26,97
d	20	2,66	5	3,23	15	2,51
e	7	0,93	2	1,29	5	0,84
19.R	734	97,61	150	96,77	584	97,82
a	170	22,61	21	13,55	149	24,96
b	320	42,55	69	44,52	251	42,04
c	221	29,39	56	36,13	165	27,64
d	6	0,80	1	0,65	5	0,84
e	17	2,26	3	1,94	14	2,35

Question	Total		Male		Female	
	n	%	n	%	n	%
20.R	719	95,61	145	93,55	574	96,15
a	355	47,21	71	45,81	284	47,57
b	17	2,26	3	1,94	14	2,35
c	79	10,51	15	9,68	64	10,72
d	258	34,31	55	35,48	203	34,00
e	10	1,33	1	0,65	9	1,51
21.R	651	86,57	141	90,97	510	85,43
a	114	15,16	20	12,90	94	15,75
b	108	14,36	24	15,48	84	14,07
c	162	21,54	37	23,87	125	20,94
d	89	11,84	19	12,26	70	11,73
e	178	23,67	41	26,45	137	22,95
22.R	741	98,54	151	97,42	590	98,83
a	93	12,37	14	9,03	79	13,23
b	289	38,43	51	32,90	238	39,87
c	230	30,59	53	34,19	177	29,65
d	110	14,63	24	15,48	86	14,41
e	19	2,53	9	5,81	10	1,68

Question	Total		Male		Female	
	n	%	n	%	n	%
23.R	704	93,12	142	91,61	562	94,14
a	43	5,72	8	5,16	35	5,86
b	107	14,23	24	15,48	83	13,90
c	397	52,78	89	57,42	308	51,59
d	132	17,55	18	17,61	114	19,10
e	25	3,32	3	1,94	22	3,69
24.R	692	92,02	150	96,77	542	90,79
	519	69,02	121	78,06	398	66,67
	173	23,00	29	18,71	144	24,12
25.R	644	85,64	146	94,19	498	83,42
	564	75,00	130	83,87	434	72,70
	80	10,64	16	10,32	64	10,72
26.R	629	83,64	140	90,32	489	81,91
	315	41,89	63	40,65	252	42,21
	314	41,75	77	49,67	237	39,70

Question		Total n	Total %	Male n	Male %	Female n	Female %
27.R		590	78,47	136	87,74	454	76,05
(a)	✓	422	56,11	99	63,87	323	54,10
	×	168	22,36	37	23,87	131	21,95
(b)R		561	74,61	129	83,24	432	72,36
	✓	178	23,67	40	25,82	138	23,13
	×	383	50,94	89	57,42	294	49,23
28.R		509	67,69	123	79,35	386	64,66
	✓	163	21,68	32	20,65	131	21,94
	×	346	46,01	91	58,70	255	42,71
29.R		478	63,56	119	76,77	359	60,13
	✓	149	19,81	29	18,71	120	20,10
	×	329	43,75	90	58,06	239	40,03
30.R		451	59,97	110	70,97	341	57,12
	✓	62	8,24	11	7,10	51	8,54
	×	389	51,73	99	63,87	290	48,58

Question	Total n	Total %	Male n	Male %	Female n	Female %
31.R	523	69,55	126	81,29	397	66,50
a	61	8,11	16	10,32	45	7,54
b	47	6,25	12	7,74	35	5,86
c	312	41,49	73	47,10	239	40,03
d	34	4,52	9	5,81	25	4,19
e	69	9,18	16	10,32	53	8,88
32.R	704	93,62	147	94,84	557	93,30
a	83	11,04	11	7,10	72	12,06
b	81	10,77	20	12,90	61	10,22
c	143	19,02	26	16,77	117	19,60
d	364	48,40	84	54,19	280	46,90
e	33	4,39	6	3,87	27	4,52
33.R	605	80,45	132	85,16	473	79,23
a	11	1,46	1	0,65	10	1,68
b	14	1,86	3	1,94	11	1,84
c	91	12,10	25	16,13	66	11,06
d	316	42,02	65	41,94	251	42,04
e	173	23,01	38	24,52	135	22,61

Question	Total n	Total %	Male n	Male %	Female n	Female %
34.R	565	75,13	121	78,06	444	74,37
a	145	19,28	32	20,65	113	18,93
b	72	9,57	11	7,10	61	10,22
c	77	10,24	14	9,03	63	10,55
d	202	26,86	44	28,39	158	26,47
e	69	9,18	20	12,90	49	8,21
35.R	644	87,10	135	87,10	509	85,26
a	29	3,86	7	4,52	22	3,69
b	174	23,14	32	20,65	142	23,79
c	201	26,73	53	34,19	148	24,79
d	225	29,92	39	25,16	186	31,16
e	15	1,99	4	2,58	11	1,84
36.R	554	73,67	123	79,35	431	72,19
✓	209	27,79	59	38,06	150	25,13
✗	345	45,88	64	41,29	281	47,07
37.R	455	60,50	101	65,16	354	59,30
✓	85	11,30	25	16,13	60	10,05
✗	370	49,20	76	49,03	294	49,25

Question	Total n	Total %	Male n	Male %	Female n	Female %
38.R	259	34,44	73	47,10	186	31,16
✓	83	11,04	22	14,19	61	10,22
✗	176	23,40	51	32,90	125	20,94
39.R	368	48,93	90	58,06	278	46,57
✓	226	30,05	53	34,19	173	28,98
✗	142	18,88	37	23,87	105	17,59
40.R	Sides:					
R	433	57,58	106	68,39	327	54,77
✓	360	47,87	93	60,00	267	44,72
✗	73	9,71	13	8,39	60	10,05
	Angles:					
R	420	55,85	103	66,45	317	53,10
✓	279	37,10	79	50,97	200	33,50
✗	141	18,75	24	15,48	117	19,60

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APPENDIX I.

List of Standardised Tests and Questionnaires used in the Investigation:

N.B. Arithmetic Tests, Series 4, Form A.
English version: N.B. 329.
Afrikaans version: N.B. 22.

N.B. Mathematics Tests, Algebra, Form D.
English version: N.B. 598/2 .
Afrikaans version: N.B. 598/1.

N.B. Mathematics Tests, Geometry and Graphs, Form B.
English version: N.B. 606/1.
Afrikaans Version: N.B. 606/2.

Jr. - Sr. High School Personality Questionnaire, Form B.
English version: N.B. 453.
Afrikaans version: N.B. 455.

IPAT Anxiety Scale Questionnaire. (Self Analysis Form.)
English version: N.B. 618.
Afrikaans version: N.B. 617.

APPENDIX II.

THE "ATTITUDES" QUESTIONNAIRE.

1) English version

2) Afrikaans version.

Note: The questionnaires used in the investigation were duplicated on foolscap-size paper, which necessitated re-typing on size A4 paper for inclusion in this Appendix. This meant that some questions could not be reproduced in full on a page and had to be continued on a following page. In the original format all question were set out in such a way that no such "overflow" occurred.

NAME: ....

Date of birth: .... Age: ....yrs. ......months.

Sex: ....

Section A:

This section will serve to find out your qualifications in Arithmetic and/or Mathematics. Answer all questions applicable to you personally. Indicate the appropriate answer by means of a tick. (✓)

1. Have you been in any form of PERMANENT employment since leaving school? If "yes", please specify type and duration of employment.

(a) No .....

(b) Yes .....

Type (a) .... for ......yrs. ..... months.

(b) .... for ......yrs. ..... months.

If male, have you completed your military training?

(a) No .....

(b) Yes .....

2. Which type of school did you attend?

(a) Co-educational .....

(b) Boys' School .....

(c) Girls' School .....

(d) English Medium .....

(e) Afrikaans Medium .....

(f) Dual Medium .....

(g) Parallel Medium .....

3. Which of the following academic qualifications do you hold?

(a) Cape Senior Certificate with Matriculation Exemption. .....

(b) Cape Senior Certificate without Matriculation Exemption .....

(c) Any other. Please specify:

....

4. Which of the following subjects did you study at school beyond Standard 5 level?

(a) Mathematics .....

(b) Commercial Arithmetic .....

(c) Arithmetic .....

(Note: Commercial Arithmetic is also called Commercial Mathematics).

5. At which level did you cease to study these subjects at school?

	Maths.	Commercial Arithmetic	Arithmetic
(a) Std 6			
(b) Std 8			
(c) Std 10			
Symbol or percentage obtained in your last exam.			

Estimate if not known exactly.

6. Do you hold any qualification in either Mathematics, Commercial Mathematics or Arithmetic other than that achieved in a Government or Private school?

(a) No .....

(b) Yes .....

If "yes", please specify.

....

....

Section B:

This section will serve to find out your attitude towards the subjects dealt with in section A. Please answer all the questions truthfully and honestly, according to your own feeling and opinion and NOT according to what you think other people may expect you to answer.

The information in this questionnaire will be treated as strictly confidential and cannot be revealed. Answer all questions applicable to you personally.

1. Which of the following brief statements would best describe your attitude towards ARITHMETIC while you were at school?

.....(a) Favourite subject.

.....(b) Very interested, enjoyed it.

.....(c) Liked it no more or less than other subjects.

.....(d) Was not really interested.

.....(e) Disliked it.

2. Which of the following brief statements would best describe your attitude towards MATHEMATICS while you were at school?

.....(a) Favourite subject.

.....(b) Very interested, enjoyed it.

.....(c) Liked it no more or less than other subjects.

.....(d) Was not really interested.

.....(e) Disliked it.

3. Which of the following brief statements would best describe your attitude towards COMMERCIAL MATHEMATICS while you were at school?

.....(a) Favourite subject.

.....(b) Very interested, enjoyed it.

.....(c) Liked it no more or less than other subjects.

.....(d) Was not really interested.

.....(e) Disliked it.

4. What did you feel about ARITHMETIC:

Try to re-call your feeling to the best of your ability.

	Liked it	Disliked it
(a) Before Std 6		
(b) During Std 6		
(c) During Std 7		
(d) During Std 8		
(e) During Std 9		
(f) During Std 10		

5. What did you feel about MATHEMATICS:

(a) Before Std 6		
(b) During Std 6		
(c) During Std 7		
(d) During Std 8		
(e) During Std 9		
(f) During Std 10		

6. What did you feel about COMMERCIAL MATHEMATICS:

(a) Before Std 6		
(b) During Std 6		
(c) During Std 7		
(d) During Std 8		
(e) During Std 9		
(f) During Std 10		

7. Who, according to your experience, had the greatest influence on your attitude towards MATHEMATICS?

.....(a) Your father.

.....(b) Your mother.

.....(c) Your brother(s) and/or sister(s)

.....(d) Your teachers.

.....(e) Your classmates.

.....(f) Any others: ....

8. Who, according to your experience, had the greatest influence on your attitude towards COMMERCIAL MATHEMATICS?

.....(a) Your father.

.....(b) Your mother.

.....(c) Your brother(s) and/or sister(s).

.....(d) Your teachers.

.....(e) Your classmates.

.....(f) Any others: ....

9. Who, according to your experience had the greatest influence on your attitude towards ARITHMETIC?

.....(a) Your father.

.....(b) Your mother.

.....(c) Your brother(s) and/or sister(s).

.....(d) Your teachers.

.....(e) Your classmates.

.....(f) Any others: ....

10. Did your liking in the following subjects increase or decrease during your school career?

	Arithmetic	Mathematics	Commercial Mathematics
(a) Increased			
(b) Decreased			
(c) No change			

11. Who was mostly responsible for this change in degree of interest indicated in question 10?

	Arithmetic	Mathematics	Commercial Mathematics
(a) Your father			
(b) Your mother			
(c) Your brother(s) and/or sister(s)			
(d) Your teachers			
(e) Your classmates			
(f) Your own ability or inability to cope with the work			
(g) The nature of the subject itself			

12. To what extent do you feel that your teachers were responsible for your present attitude towards these subjects?

(a) Completely responsible			
(b) No more or less than other persons.			
(c) Not responsible at all			

13. Do you feel that the subjects were taught:

(a) Well and interestingly			
(b) Well but not very interestingly			
(c) Indifferently			
(d) Badly			

14. When you approached your teacher with a problem did he/she usually receive you:

	Arithmetic	Mathematics	Commercial Mathematics
(a) Sympathetically			
(b) Indifferently			
(c) Unsympathetically			

15. Why did you take these subjects at school? Answer this question for the subjects which you took to the HIGHEST level. N.B.: Do not mark off more than TWO reasons.

(a) Because your parents wanted you to do so			
(b) Because the school offered no alternative			
(c) Because the school offered no alternative that suited you			
(d) Because you yourself wanted to do so			
(e) Because your teacher persuaded you to do so			
(f) Because your friends took it			
(g) Because it was the "easiest alternative			
(h) Because you were good at it			

16. Which of the following subjects do you regard as important in the primary school at Std 4 level? Give each subject an "importance" rating according to the following list, but DO NOT give MORE THAN TWO subjects a rating of 1. Similarly, DO NOT give MORE THAN TWO subjects a rating of 5. Rating of 2, 3 and 4 can be given to as many subjects as you like, but preferably not more than four subjects should receive the same rating.

1 - Supreme importance
2 - More than average importance
3 - Average importance
4 - Less than average importance
5 - Very little or no importance

Languages	.....
Handicraft/ Needlework	.....
General Science	.....
Arithmetic	.....
Art	.....
Singing and Class Music	.....
Reading	.....
Religious Instruction	.....
History	.....
Spelling	.....
Geography	.....
Handwriting	.....
Nature Study	.....
Physical Education	.....

17. Which of the subjects in (16) would you MOST like to teach?

....

1 . Which of the subjects in (16) would you LEAST like to teach?

....

19. At what level do you hope to teach? Simply mark the appropriate standard given next to this question.

Kindergarten	.....
Standard 1	.....
Standard 2	.....
Standard 3	.....
Standard 4	.....
Standard 5	.....

20. Do you hope that you will also teach subjects in either Std 6, Std 7 or Std 8?

(a) Yes .....
(b) No .....

21. If "yes" to (20), which two subjects would you most like to teach?

(a) ....
(b) ....

22. Which of the following subjects will you choose or have you chosen to continue with in your third year?

(a) Mathematics .....
(b) Science .....
(c) History .....
(d) Geography .....
(e) Undecided .....

NAAM: ....

Geboortedatum: ....Ouderdom: ....jr. .....mde

Geslag: ....

Afdeling A.

Hierdie afdeling sal dien om uit te vind wat u kwalifikasies in Rekenkunde en/of Wiskunde is. Beantwoord al die vrae wat op u persoonlik van toepassing is. Dui slegs die gepaste antwoord aan met 'n regmerkie. (✓).

1. Was u in enige vorm van PERMANENTE werk sedert u die skool verlaat het? Indien "ja", spesifiseer asb. die soort en duur van die werk. (a) Ja .....

   (b) Nee.....

   Soort (a)..................vir.....jr. .....maande.

   Soort (b) ....vir.....jr. .....maande.

   Indien manlik, het u u militêre diensplig voltooi?

   (a) Ja .....

   (b) Nee.....

2. Watter soort skool het u bygewoon?

   (a) Gemengde ....

   (b) Seunskool ....

   (c) Meisieskool ....

   (d) Afrikaansmedium ....

   (e) Engelsmedium ....

   (f) Dubbelmedium ....

   (g) Parallelmedium ....

3. Watter van die volgende akademiese kwalifikasies besit u?

   (a) Kaapse Senior Sertifikaat met Matrikulasievrystelling. .....

   (b) Kaapse Senior Sertifikaat sonder Matrikulasievrystelling. .....

   (c) Enige ander. Spesifiseer asseblief. .....

   ....

   ....

4. Watter van die volgende vakke het u na St. 5 op skool geneem?

(a) Wiskunde .....

(b) Handelsrekenkunde .....

(c) Rekenkunde .....

(Let wel: Handelsrekenkunde word ook Handelswiskunde genoem).

5. Aan die einde van watter standerd het u die studie van die volgende vakke op skool gestaak?

	Wiskunde	Handelswiskunde	Rekenkunde
a) St. 6			
b) St. 8			
c) St. 10			
Skat, indien nie presies bekend, u simbool of persentasie in u laaste eksamen behaal.			

6. Besit u enige ander kwalifikasie in óf Wiskunde óf Handelswiskunde óf Rekenkunde behalwe dié wat u in ŉ Goewerments- of Privaatskool verkry het?

(a) Nee .....

(b) Ja .....

Indien "ja", spesifiseer asb.

....

Afdeling B:

Hierdie afdeling sal dien om uit te vind wat u houding is teenoor die vakke in Afdeling A genoem. Gee asseblief eerlike antwoorde op die vrae, volgens u eie gevoelens en menings, en NIE volgens wat u dink andere miskien van u mag verwag nie. Die inligting in hierdie vraelys sal as STRENG VERTROULIK beskou word en kan nie openbaar gemaak word nie. Antwoord al die vrae wat op u persoonlik van toepassing is.

1. Watter van die volgende kort bewerings gee die beste beskrywing van u houding teenoor REKENKUNDE terwyl u op skool was?

.....(a) U geliefkoosde vak.

.....(b) Het baie daarin belang gestel en dit geniet.

.....(c) Het nie meer of minder daarvan gehou as van ander vakke nie.

.....(d) Het nie werklik belang gestel nie.

.....(e) Het gladnie daarvan gehou nie.

2. Watter van die volgende kort bewerings gee die beste beskrywing van u houding teenoor WISKUNDE terwyl u op skool was?

.....(a) U geliefkoosde vak.

.....(b) Het baie daarin belang gestel en dit geniet.

.....(c) Het nie meer of minder daarvan gehou as van ander vakke nie.

.....(d) Het nie werklik belang gestel nie.

.....(e) Het gladnie daarvan gehou nie.

3. Watter van die volgende kort bewerings gee die beste beskrywing van u houding teenoor HANDELSWISKUNDE terwyl u op skool was?

.....(a) U geliefkoosde vak.

.....(b) Het baie daarin belang gestel en dit geniet.

.....(c) Het nie meer of minder daarvan gehou as van ander vakke nie.

.....(d) Het nie werklik daarin belang gestel nie.

.....(c) Het gladnie daarvan gehou nie.

4. Wat was u gevoel teenoor REKENKUNDE. Probeer om u gevoel te herroep na die beste van u vermoë.

	Daarvan gehou	Nie daarvan gehou nie.
a) Voor St. 6		
b) Gedurende St. 6		
c) Gedurende St. 7		
d) Gedurende St. 8		
e) Gedurende St. 9		
f) Gedurende St. 10		

5. Wat was u gevoel teenoor WISKUNDE

a) Voor St. 6		
b) Gedurende St. 6		
c) Gedurende St. 7		
d) Gedurende St. 8		
e) Gedurende St. 9		
f) Gedurende St. 10		

6. Wat was u gevoel teenoor HANDELSWISKUNDE

	Daarvan gehou	Nie daarvan gehou nie.
a) Voor St. 6		
b) Gedurende St. 6		
c) Gedurende St. 7		
d) Gedurende St. 8		
e) Gedurende St. 9		
f) Gedurende St. 10		

7. Wie, volgens u ondervinding, het die meeste invloed op u houding teenoor WISKUNDE gehad?

.....(a) U vader.

.....(b) U moeder.

.....(c) U broer(s) en/of suster(s)

.....(d) U onderwysers.

.....(e) U klasmaats.

.....(f) Ander persone: ....

8. Wie, volgens u ondervinding, het die meeste invloed op u houding teenoor HANDELSWISKUNDE gehad?

.....(a) U vader.

.....(b) U moeder.

.....(c) U broer(s) en/of suster(s).

.....(d) U onderwysers.

.....(e) U klasmaats.

.....(f) Ander persone: ....

9. Wie, volgens u ondervinding, het die meeste invloed op u houding teenoor REKENKUNDE gehad?

.....(a) U vader.

.....(b) U moeder.

.....(c) U broer(s) en/of suster(s).

.....(d) U onderwysers.

.....(e) U klasmaats.

.....(f) Ander persone: ....

10. Het u belangstelling in die volgende vakke gedurende u skoolloopbaan toegeneem of afgeneem?

	Rekenkunde	Wiskunde	Handelswiskunde
a) Toegeneem			
b) Afgeneem			
c) Geen Verandering			

11. Wie was hoofsaaklik verantwoordelik vir die verandering in die graad van belangstelling aangedui in vraag 10?

	Rekenkunde	Wiskunde	Handels-wiskunde
(a) U vader			
(b) U moeder			
(c) U broer(s) en/of suster(s)			
(d) U onderwysers			
(e) U klasmaats			
(f) Ander persone			
(g) U eïe vermoë of onvermoë om die werk te doen			
(h) Die aard van die vak self.			

12. Tot watter mate, voel u, was u onderwysers verantwoordelik vir u huidige houding teenoor hierdie vakke?

(a) Heeltemal verantwoordelik			
(b) Nie meer or minder as ander persone nie			
(c) Gladnie verantwoordelik nie			

13. Hoe, voel u, was onderrig gegee in hierdie vakke?

(a) Goed en interessant			
(b) Goed, maar nie besonder interessant nie.			
(c) Middelmatig			
(d) Swak			

14. Wanneer u u onderwyser(es) met 'n probleem genader het, hoe het hy/sy u <u>gewoonlik</u> behandel?

(a) Simpatiek			
(b) Ongeïnteresseerd			
(c) Onsimpatiek			

15. Hoekom het u hierdie vakke op skool geneem? Antwoord hierdie vraag vir die vakke wat u tot die hoogste standaard geneem het. L.W.: Moenie meer as TWEE redes afmerk nie.

	Rekenkunde	Wiskunde	Handels wiskunde
(a) Omdat u ouers wou hê dat u dit moes doen.			
(b) Omdat die skool geen keuse aangebied het nie.			
(c) Omdat die skool nie 'n keuse wat u beter gepas het aangebied het nie.			
(d) Omdat u self die vak wou neem.			
(e) Omdat u onderwyser u oorreed het om dit te doen.			
(f) Omdat dit die "maklikste" keuse-vak was.			
(g) Omdat u goed was in die vak.			

16. Watter van die volgende vakke beskou u as belangrik in die primêre skool by St. 4-standaard? Gee aan elke vak 'n "belangrikheids-gradering" volgens die onderstaande lys, maar MOENIE aan MEER AS TWEE vakke 'n gradering van 5 gee nie. Graderings van 2, 3 en 4 kan aan soveel vakke gegee word as wat u wil, maar dit is wenslik dat nie meer as vier vakke dieselfde gradering ontvang nie.

1 - Hoogste belang
2 - Meer as gemiddelde belang
3 - Gemiddelde belang
4 - Minder as gemiddelde belang
5 - Weinig of geen belang

Tale .....
Handwerk/Naaldwerk .....
Algemene Wetenskap .....
Rekenkunde .....
Kuns .....
Sang en Klasmusiek .....
Lees .....
Godsdienonderrig .....
Geskiedenis .....
Spel .....
Aardrykskunde .....
Skrif .....
Natuurstudie .....
Liggaamsoefening .....

17. Van watter vak in (16) sal u die MEESTE daarvan hou om in onderwys te gee? ....

18. Van watter vak in (16) sal u die MINSTE daarvan hou om in onderwys te gee? ....

19. In watter standerd hoop u om onderwys te gee? Merk slegs die gepaste standerd langsaan.

Kindertuin	.....
Standerd 1	.....
Standerd 2	.....
Standerd 3	.....
Standerd 4	.....
Standerd 5	.....

20. Hoop u dat u ook in St. 6, St. 7 en St. 8 onderrig in sommige vakke sal gee?

(a) Ja .....

(b) Nee .....

21. Indien "ja" vir (20), in watter twee vakke sal u die graagste onderrig wil gee?

Vak (a) ....

Vak (b) ....

22. Watter van die volgende vakke gaan u kies of het u gekies om mee voort te gaan in u derde jaar?

(a) Wiskunde .....

(b) Wetenskap .....

(c) Geskiedenis .....

(d) Aardrykskunde.....

(e) Onbeslis .....

APPENDIX III.

THE "UNDERSTANDING" QUESTIONNAIRE.

1) English version.

2) Afrikaans version.

Note: The questionnaires used in the investigation were duplicated on foolscap-size paper, which necessitated re-typing on size A4 paper for inclusion in this Appendix. This meant that some questions could not be reproduced in full on a page and had to be continued on a following page. In the original format all questions were set out in such a way that no such "overflow" occurred.

NAME ....

READ THE FOLLOWING VERY CAREFULLY:

1. The purpose of this test is to find out to what extent you understand the meanings of the expressions, ideas and principles involved in arithmetical, algebraical and geometrical exercises.

2. Each group of questions has its own directions. Study them carefully and follow them exactly. No tricks are involved, but each question requires care and attention.

3. If you do not know the answer to a particular question, leave it and go on to the next one, but DO NOT GUESS!

4. You will be told when to start.

5. Answers must be written on this questionnaire. You should not use any extra paper.

6. Pencils must be used.

7. No questions are allowed.

8. DO NOT WORRY if you come across a question dealing with a subject which you did not take at school. The first questionnaire which you answered today already shows which subjects you did and did not take at school.

<u>DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO.</u>

Directions:

Read each question carefully. After each question there are five statements, one of which may be the correct statement. If you find it, tick the particular statement with a ✓ on the left. If none of the first four statements give the correct answer, tick the fifth statement. If you do not know the answer, go on to the next question. NO NOT GUESS!

1. We say that 11 is a prime number. What do we mean by prime number?

.....(a) A number which does not involve any fraction.

.....(b) A number which if divided by one and by itself leaves no remainder.

.....(c) A number which can only be divided by one and by itself without remainder.

.....(d) All prime numbers except 2 are odd numbers.

.....(e) None of the above.

2. What do we mean by the SQUARE ROOT of a certain number?

.....(a) A number which if multiplied by 2 gives the original number.

.....(b) A number which if multiplied by itself gives the original number.

.....(c) A number which if added to twice its value gives the original number.

.....(d) A number which if divided by 2 gives the original number.

.....(e) None of the above.

3. Three numbers have the average of 12 and three other numbers have the same average of 12. What is the relation between the two sets of numbers?

.....(a) The two sets are one set repeated.

.....(b) The two sets have the same product.

.....(c) The two sets have the same sum.

.....(d) The middle number is the same in the two sets.

.....(e) None of the above.

4. What do we mean by the CUBE ROOT of a certain number?

.....(a) A number which if divided by 3 gives the original number.

.....(b) A number which if multiplied by itself twice gives the original number.

.....(c) A number which if multiplied by 3 gives the original number.

.....(d) A number which if added to three times its value gives the original number.

.....(e) None of the above.

5. .9 and .57 are decimal fractions. What is a decimal fraction?

.....(a) It is a fraction in terms of tenths, hundredths, etc.

.....(b) It is a number with a decimal point.

.....(c) It is another way of writing fractions.

.....(d) It is another way of writing percentages.

.....(e) None of the above.

6. Mrs. Smith bought $\frac{3}{4}$ lb. of butter. What does the fraction $\frac{3}{4}$ mean?

.....(a) Three of four parts of a pound.

.....(b) Three of four equal parts of a pound.

.....(c) Three equal parts of four parts of a pound.

.....(d) Three parts each one fourth of a pound.

.....(e) None of the above.

7. "35 per cent of our flowers are white". What is the meaning of 35 per cent?

.....(a) It means that if the white flowers are evenly distributed among groups of 100 each, there will be 35 white flowers in each group.

.....(b) It means that 35 of any 100 flowers are white.

.....(c) It means that there are 100 flowers and 35 of them are white.

.....(d) It means that you must multiply the number of flowers by $\frac{35}{100}$ to find the number of white flowers.

.....(e) None of the above.

8. "John drives at a uniform speed". What does this mean?

.....(a) John drives at a speed which is neither high nor low.

.....(b) John covers equal distances in equal intervals of time, however long or short these intervals may be.

.....(c) John can get the distance he covers by multiplying speed by time.

.....(d) John drives at a certain speed every time he drives.

.....(e) None of the above.

9. We know that the approximate value of π is 3·14 or $\frac{22}{7}$. What does this π mean?

.....(a) A constant number representing the ratio between the area of any circle and the square of its diameter.

.....(b) A constant number representing the ratio between the radius of any circle and its circumference.

.....(c) A constant number representing the ratio between the circumference of any circle and its diameter.

.....(d) A constant number which is used in problems dealing with circles.

.....(e) None of the above.

If you do not know how to multiply, how to divide or how to use the logarithmic tables, how can you manage the following two cases? Write the answer in the space provided.

10. How can you get the answer of 173 X 13?

....

11. How can you get the answer of 875 ÷ 35?

....

Directions:

Tick the correct statement as for the first 9 questions.

12. Study the multiplication example on the right. It is written out in two different ways. Look at the way you are used to. Why is the partial product 878 moved one place to the left?

```
  439
   26
 2634
 878
11414
  OR
  439
   26
  878
 2634
11414
```

.....(a) Because it is the rule.

.....(b) Because it comes out right.

.....(c) Because it must begin under the multiplying figure.

.....(d) Because the partial product is 878 tens.

.....(e) None of the above.

13. In rounding 3748 to the nearest hundred we get 3700. Why do we replace the 48 by 00?

.....(a) Because 4 is less than 5.

.....(b) Because 3748 is less than 3800.

.....(c) Because 3748 is more than 3800.

.....(d) Because we are rounding off to the nearest hundred.

.....(e) None of the above.

14. Why are the answers to the following division examples $0{\cdot}05\overline{)76{\cdot}35}$ and $0{\cdot}5\overline{)763{\cdot}5}$ the same?

.....(a) Because the second example is obtained from the first by multiplying the divisor and the dividend by the same number 10 and so the quotient does not change.

.....(b) Because the same answer could be got by dividing 7635 by 5.

.....(c) Because they both go exactly.

.....(d) Because the second example is obtained from the first one by moving the decimal point one place to the right in both divisor and dividend.

.....(e) None of the above.

15. In multiplying $4\frac{1}{3}$ X 6 we usually do it in the following way:

$$4\frac{1}{3} \text{ X } 6 = \frac{13}{3} \text{ X } 6 = 26.$$

What is the idea involved in changing $4\frac{1}{3}$ into $\frac{13}{3}$?

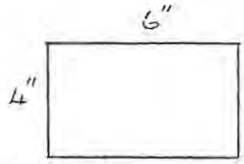
.....(a) Multiplying 4 by 3 and adding 1.

.....(b) Changing 4 into thirds.

.....(c) Following the rule for such cases.

.....(d) Getting rid of 4.

.....(e) None of the above.



16. If a rectangle is of length 6" and breadth 4", its area is 6 X 4 = 24 sq. ins. On what idea is this conclusion based?

.....(a) We can divide the rectangle into 24 equal squares, so the area is 24 sq. ins.

.....(b) We can divide the rectangle into 4 equal strips and each strip into 6 equal squares one square inch each.

.....(c) If we multiply length by breadth we get the area.

.....(d) Because 6 times 4 is equal to 4 times 6.

.....(e) None of the above.

17. Study the division example on the right. In the second step we have multiplied 38 by 5 to get the partial product represented by 190. What are the real two numbers which are multiplied to produce the partial product?

```
    256
38/9728
   76
   212
   190
    228
    228
```

.....(a) 38 X 56

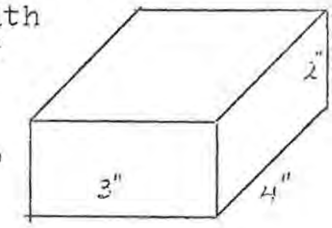
.....(b) 38 X 25

.....(c) 38 X 50

.....(d) 38 X 250

.....(e) None of the above.

18. If a cuboid is 4 ins. long, 3 ins. broad and 2 ins. high its volume is 4 X 3 X 2 cubic inches. On what idea is this conclusion based?



.....(a) If we multiply length X breadth X height we get the volume of a cuboid.

.....(b) We can divide the cuboid into 24 equal cubes.

.....(c) In multiplying 4 X 3 we get the area of a base, and multiplying the base by height we get the volume. of the cuboid.

.....(d) We can divide the cuboid into two equal slices, each slice into 3 equal rows and each row into 4 cubes, each of side 1 ins.

.....(e) None of the above.

19. It is known that 1.5 = 1.50 = 1.500 = 1.5000. Why

.....(a) Because zeros mean nothing, nothing occurs when we put zeros.

.....(b) Because we are really adding .00; .000 or ,0000 which does not give any change.

.....(c) Because the decimal point is still after the 1.

.....(d) Because there are always two figures, 1 and 5.

.....(e) None of the above.

20. In adding $\frac{1}{2}$ and $\frac{1}{3}$ we do it in the following way:

$$\frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{5}{6}$$

What is the idea involved in changing $\frac{1}{2}$ and $\frac{1}{3}$ into $\frac{3}{6}$ and $\frac{2}{6}$?

.....(a) Getting a common denominator.

.....(b) Following the rule for such cases.

.....(c) Changing the two fractions into sixths.

.....(d) Getting the lowest common multiple of 2 and 3.

.....(e) None of the above.

21. If R1.00 is invested at 4% per year, which of the following expressions gives the simple interest in the second year?

.....(a) $R(1\cdot 04)^2$

.....(b) R1·04 X 0·04

.....(c) R0.04

.....(d) R1.04

.....(e) None of the above.

22. In multiplying 4.367 by 100 we have to move the decimal point two places to the right. Why?

.....(a) Because 100 has two 0's.

.....(b) Because if the decimal point moves two to the right the number gets larger.

.....(c) Because this reduces the denominator to $\frac{1}{100}$ of its value and so makes the result 100 times bigger.

.....(d) Because it is the rule in such cases.

.....(e) None of the above.

23. In dividing 8 by $\frac{4}{3}$ we usually do it in the following way:

$$8 \div \frac{4}{3} = 8 \times \frac{3}{4} = 6$$

What is the idea we have in mind in inverting $\frac{4}{3}$ into $\frac{3}{4}$?

.....(a) Multiplying 8 by 3 to change it into thirds, the same as the units of the divisor.

.....(b) Following the rule in such cases.

.....(c) Division is the opposite of multiplication, therefore we have to invert the divisor.

.....(d) In dividing by $\frac{4}{3}$ we are actually dividing by 4 so it must be down and then 3 must be up.

.....(e) None of the above.

Directions:
Read each question carefully and then write the answer in the space provided for it.

Answers:

24. What is the sum of x and y? 24).............

25. What is the product of x and y? 25).............

26. What is left if x is subtracted from y? 26).............

27. In the algebraic expression: $3ab - 5a^2b^3 + 7a^3b^5$
(a) How many terms are there in this expression? 27)(a).............
(b) What is the second term of this expression? (b).............

28. If x is an even number, what is the next even number? 28).............

29. If a is a whole number, what is the whole number consecutive to it? 29).............

30. What is the value of the number in which x is the units digit and y is the tens digit? 30).............

Directions:
Answer as for questions 12 to 23:

31. $(3x + 1)$ is a factor of the expression $(3x^2 - 2x - 1)$. What does factor mean?

.....(a) An expression of less terms than the original one.

.....(b) An expression of less numerical value than the original one.

.....(c) A divisor by which $3x^2 - 2x - 1$ can be devided without remainder.

.....(d) An expression which can be put equal to zero.

.....(e) None of the above.

32. What does −5 mean?

.....(a) The number 5 with a minus sign.

.....(b) The number which when added to 5 gives zero.

.....(c) The number which is −5 less than zero.

.....(d) The number which is 5 units less than zero.

.....(e) None of the above.

33. When we solve the equation $5x = 10$ we get $x = 2$. What is the idea we are applying?

.....(a) Subtracting $4x$ from equal quantities gives equal quantities.

.....(b) Subtracting 8 from equal quantities gives equal quantities.

.....(c) Following the rule.

.....(d) Getting rid of the 5 in $5x$.

.....(e) None of the above.

34. What is the principle illustrated in the statement

$$2 + (-5) = -5 + 2 \text{ ?}$$

.....(a) Numbers may be added in any order.

.....(b) Positive numbers are above zero and negative numbers are below zero on the same scale.

.....(c) Subtraction is the inverse process of addition.

.....(d) A number without a sign means that it is positive.

.....(e) None of the above.

35. In dividing $a^5 \div a^3$ we get a^2. Why?

.....(a) Because $5a - 3a = 2a$.

.....(b) Because $\frac{\not{a} + \not{a} + \not{a} + a + a}{\not{a} + \not{a} + \not{a}} = a^2$

.....(c) In such cases we have to subtract the indices.

.....(d) Because $\frac{\not{a} \cdot \not{a} \cdot \not{a} \cdot a \cdot a}{\not{a} \cdot \not{a} \cdot \not{a}} = a^2$

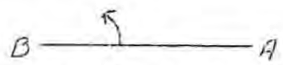
.....(e) None of the above.

<u>Directions:</u>
Read the questions carefully and then answer it in the space prcvided.

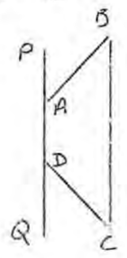
36 to 38: Draw diagrams to show that you understand the meaning of the following geometrical expressions.

36. The distance from A to BC.

37. A reflex angle ABC.



38. A figure symmetrical to ABCD with respect to PQ.



39. What is the complement of 78^{o}? 39)............

40. The sides of a triangle are 6m, 8m and 10m and its angles are 37^{o}, 53^{o} and 90^{o}. Find the sides and angles of the triangle if it is magnified 2 times:

Sides: ......, ..., ...

Angles: ......, ..., ...

NAAM ....

LEES DIE VOLGENDE BAIE SORGVULDIG DEUR:

1. Die doel van hierdie toets is om uit te vind tot watter mate u die betekenis van die uitdrukkings, idees en beginsels betrokke in rekenkundige, algebraïse en meetkundige oefeninge verstaan.

2. Elke groep vrae het sy eie aanwysings. Bestudeer dit sorgvuldig en volg dit stiptelik. Daar is geen kunsgrepe nie, maar elke vraag verg sorg en aandag.

3. As u nie die antwoord op 'n sekere vraag weet nie, moet u die vraag laat staan en aangaan na die volgende vraag, maar MOENIE RAAI NIE!

4. U sal aangesê word wanneer om te begin.

5. Antwoorde moet op hierdie vraelys geskryf word. U behoort nie van ekstra papier gebruik te maak nie.

6. U moet potlood gebruik.

7. Geen vrae sal toegelaat word nie.

8. MOENIE BEKOMMERD WEES as u 'n vraag teëkom wat gaan oor 'n vak wat u nie op skool geneem het nie. Die eerste vraelys wat u vanoggend beantwoord het dui aan watter vakke u wel op skool geneem of nie geneem het nie.

<u>MOENIE OMBLAAI VOORDAT U AANGESÊ WORD OM DIT TE DOEN NIE.</u>

Aanwysing:

Lees elke vraag sorgvuldig deur. Na elke vraag is daar vyf bewerings, waarvan een die regte bewering mag wees. Merk die regte regte bewering met 'n ✓, indien u dit vind. Indien nie een van die eerste vier bewerings die regte een is nie, moet u die vyfde bewering merk. Indien u nie die antwoord weet nie, moet u aangaan met die volgende vraag. MOENIE RAAI NIE!

1. Ons sê dat 11 'n priemgetal is. Wat bedoel ons met priemgetal?

.....(a) 'n Getal wat geen breuke bevat nie.

.....(b) 'n Getal wat, wanneer dit deur homself en een gedeel word, geen res laat nie.

.....(c) 'n Getal wat slegs deur homself en een gedeel kan word sonder om 'n res te laat.

.....(d) Alle priemgetalle behalwe 2 is onewe getalle.

.....(e) Geeneen van bostaande.

2. Wat beteken die vierkantswortel van 'n sekere getal?

.....(a) 'n Getal wat, wanneer met 2 vermenigvuldig, die oorspronklike getal gee.

.....(b) 'n Getal wat, wanneer met homself vermenigvuldig, die oorspronklike getal gee.

.....(c) 'n Getal wat die oorspronklike getal gee wanneer dit by twee maal sy waarde getel word.

.....(d) 'n Getal wat die oorspronklike getal gee wanneer dit deur 2 gedeel word.

.....(e) Geeneen van bostaande.

3. Drie getalle het 'n gemiddelde van 12 en drie ander getalle het dieselfde gemiddelde van 12. Wat is die verband tussen die twee stelle getalle?

.....(a) Die tweede stel is 'n herhaling van die eerste.

.....(b) Die twee stelle het dieselfde produk.

.....(c) Die twee stelle het dieselfde som.

.....(d) Die middelste getal van die twee stelle is dieselfde.

.....(e) Geeneen van bostaande.

4. Wat beteken <u>die derdemagswortel</u> (kubieke wortel) van 'n getal?

.....(a) 'n Getal wat die oorspronklike getal gee wanneer dit deur 3 gedeel word.

.....(b) 'n Getal wat die oorspronklike getal gee wanneer dit twee keer met homself vermenigvuldig word.

.....(c) 'n Getal wat die oorspronklike getal gee wanneer dit met 3 vermenigvuldig word.

.....(d) 'n Getal wat die oorspronklike getal gee wanneer dit by drie maal sy waarde getel word.

.....(e) Geeneen van bostaande.

5. 0.9 en 0.57 is desimale breuke. Wat is 'n desimale breuk?

.....(a) 'n Breuk in terme van tiendes, honderdstes ens.

.....(b) 'n Getal met 'n desimale punt.

.....(c) 'n Ander manier om breuke neer te skryf.

.....(d) 'n Ander manier om persentasies neer te skryf.

.....(e) Geeneen van bostaande.

6. Mev. Smit het $\frac{3}{4}$ lb. botter gekoop. Wat beteken die breuk $\frac{3}{4}$?

.....(a) Drie van vier dele van 'n pond.

.....(b) Drie van vier gelyke dele van 'n pond.

.....(c) Drie gelyke dele van vier dele van 'n pond.

.....(d) Drie dele, elk een-vierde van 'n pond.

.....(e) Geeneen van bostaande.

7. "35 persent van ons blomme is wit". Wat beteken 35 persent?

.....(a) Dit beteken dat, indien die wit blomme eweredig verdeel word tussen groepe van 100 elk, daar 35 wit blomme in elke groep sal wees.

.....(b) Dit beteken dat 35 van enige 100 blomme wit is.

.....(c) Dit beteken dat die aantal blomme met $\frac{35}{100}$ vermenigvuldig moet word om die aantal wit blomme te vind.

.....(d) Dit beteken dat daar 100 wit blomme is en dat 35 daarvan wit is.

.....(e) Geeneen van bostaande.

8. "Jan bestuur teen 'n gelykmatige snelheid." Wat beteken gelykmatig?

.....(a) Jan bestuur teen 'n snelheid wat nóg hoog nóg laag is.

.....(b) Jan lê gelyke afstande af in gelyke tydsintervalle, ongeag van hoe lank of kort die intervalle is.

.....(c) Jan kan die afstand wat hy aflê bepaal deur snelheid met tyd te vermenigvuldig.

.....(d) Jan bestuur teen 'n bepaalde snelheid elke keer wanneer hy bestuur.

.....(e) Geeneen van bostaande.

9. Ons weet dat die benaderde waarde van π 3.14 of $\frac{22}{7}$ is. Wat beteken hierdie π ?

.....(a) 'n Vaste waarde wat die verhouding tussen die area van enige sirkel en die kwadraat van sy middellyn voorstel.

.....(b) 'n Vaste waarde wat die verhouding tussen die straal van enige sirkel en sy omtrek voorstel.

.....(c) 'n Vaste waarde wat die verhouding tussen die omtrek van enige sirkel en sy middellyn voorstel.

.....(d) 'n Vaste waarde wat gebruik word in probleme wat met sirkels te doen het.

.....(e) Geeneen van bostaande.

Hoe sal u die volgende twee gevalle behartig indien u nie weet hoe om te deel, te vermenigvuldig of om die logaritmetabelle te gebruik nie? Skryf u antwoord in die voorsiene ruimte.

10. Hoe sal u die antwoord kry van 173 X 13?

....

11. Hoe sal u die antwoord kry van 875 ÷ 35?

....

Aanwysing:
Merk die regte bewering soos vir die eerste 9 vrae.

12. Bestudeer die voorbeeld van vermenigvuldiging aan die regterkant. Dit is op twee verskillende maniere uitgewerk. Beskou die manier waaraan u gewoond is. Waarom is die parsiële produk 878 een plek na links geskuif?

```
  439
   26
 2634
 878
11414
  OF
  439
   26
  878
 2634
11414
```

.....(a) Omdat dit die reël is.

.....(b) Omdat dit dan reg uitwerk.

.....(c) Omdat dit moet begin onder die syfer waarmee vermenigvuldig word.

.....(d) Omdat die parsiële produk werklik 878 tiene is.

.....(e) Geeneen van bostaande.

13. Wanneer ons 3748 tot die naaste honderd afrond, kry ons 3700. Waarom word 48 vervang deur 00?

.....(a) Omdat 4 minder is as 5.

.....(b) Omdat 3748 minder is as 3800.

.....(c) Omdat 3748 meer is as 3800.

.....(d) Omdat ons afrond tot die naaste honderd.

.....(e) Geeneen van bostaande.

14. Waarom is die antwoorde van die volgende deelsomme dieselfde? $0.05\overline{)76\ 35}$ en $0.5\overline{)763.5}$

.....(a) Omdat die tweede voorbeeld van die eerste verkry is deur beide deler en deeltal met dieselfde getal 10 te vermenigvuldig, en dus bly die kwosiënt onveranderd.

.....(b) Omdat dieselfde antwoord verkry kon word as ons 7635 deur 5 sou deel.

.....(c) Omdat altwee presies indeel.

.....(d) Omdat die tweede voorbeeld van die eerste verkry is deur die desimalepunt in beide deler en deeltal een plek na regs te skuif.

.....(e) Geeneen van bostaande.

15. Ons doen die vermenigvuldig-som $4\frac{1}{3}$ X 6 gewoonlik as volg:

$$4\frac{1}{3} \times 6 = \frac{13}{3} \times 6 = 26$$

Watter beginsel is betrokke in die verandering van $4\frac{1}{3}$ na $\frac{13}{3}$?

.....(a) Vermenigvuldig 4 met 3 en tel by 1.

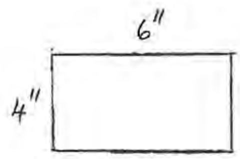
.....(b) Verander 4 na derdes.

.....(c) Volg die reël vir sulke gevalle.

.....(d) Raak ontslae van die 4.

.....(e) Geeneen van bostaande.

16. As 'n reghoek 6 dm. lank en 4 dm breed is, is die area 6 X 4 = 24 vk. dm.. Op watter beginsel berus hierdie gevolgtrekking?



.....(a) Ons kan die reghoek in 24 gelyke vierkante verdeel, en dus is die area 24 vk. dm.

.....(b) Ons kan die reghoek in 4 gelyke repe en elke reep in 6 gelyke vierkante, elk 1 vk. dm., verdeel.

.....(c) Ons kry die area deur die lengte met die breedte te vermenigvuldig.

.....(d) Omdat 6 X 4 gelyk is aan 4 X 6.

.....(e) Geeneen van bostaande.

17. Bestudeer die voorbeeld van 'n deelsom langsaan. In die tweede stap het ons 38 met 5 vermenigvuldig om die parsiële produk wat deur 190 voorgestel word, te kry. Wat is die twee - getalle wat werklik vermenigvuldig is om hierdie parsiële produk te verkry?

```
   256
38/9728
   76
   212
   190
    228
    228
```

.....(a) 38 X 56

.....(b) 38 X 25

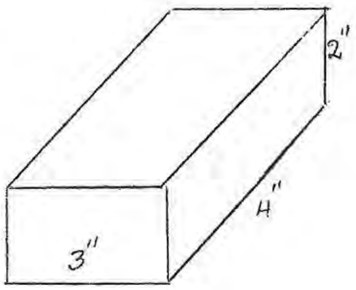
.....(c) 38 X 50

.....(d) 38 X 250

.....(e) Geeneen van bostaande.

18. As 'n reghoekige vorm 4 dm. lank, 3 dm. breed en 2 dm. hoog is, is die volume 4 X 3 X 2 kubieke dm. Op watter beginsel is hierdie gevolgtrekking gebaseer?

.....(a) As ons lengte X hoogte X breedte vermenigvuldig kry ons die volume van 'n reghoekige liggaam.



.....(b) Ons kan die reghoekige liggaam in 24 gelyke kubusse verdeel.

.....(c) Deur 4 X 3 te vermenigvuldig kry ons die area van 'n basis en deur basis met hoogte te vermenigvuldig kry ons die volume van 'n reghoekige liggaam.

.....(d) Ons kan die liggaam in twee gelyke skywe verdeel, elke skyf in 3 gelyke repe en elke reep in 4 kubusse, elk met sy 1 dm.

.....(e) Geeneen van bostaande.

19. Dit is bekend dat 1.5 = 1.50 = 1.500 = 1.5000. Hoekom?

.....(a) Omdat nul niks beteken nie, gebeur niks as nulle aangelas word nie.

.....(b) Omdat ons in werklikheid .00; .000 of .0000 bytel, wat geen verandering teweegbring nie.

.....(c) Omdat die desimale punt nog steeds na die 1 voorkom.

.....(d) Omdat daar altyd twee syfers, 1 en 5, voorkom.

.....(e) Geeneen van bostaande.

20. Wanneer $\frac{1}{2}$ en $\frac{1}{3}$ bymekaar getel word, doen ons dit as volg:

$$\frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{5}{6}$$

Wat is die beginsel betrokke by die verandering van $\frac{1}{2}$ en $\frac{1}{3}$ na $\frac{3}{6}$ en $\frac{2}{6}$?

.....(a) Bepaling van 'n gemene noemer.

.....(b) Navolging van die reël vir sulke gevalle.

.....(c) Verandering van twee breuke na sesdes.

.....(d) Bepaling van die kleinste gemene veelvoud van 2 en 3.

.....(e) Geeneen van bostaande.

21. Indien R1.00 belê word teen 4% per jaar, watter van die volgende uitdrukkings gee die enkelvoudige rente in die tweede jaar?

.....(a) $R(1.04)^2$

.....(b) R1.04 X 0.04

.....(c) R0.04

.....(d) R1.04

.....(e) Geeneen van bostaande.

22. Wanneer 4.367 met 100 vermenigvuldig word, skuif ons die desimale punt twee plekke na regs. Hoekom?

.....(a) Omdat 100 twee 0^e het.

.....(b) Omdat die getal groter word as die desimale punt na regs geskuif word.

.....(c) Omdat dit die noemer tot $\frac{1}{100}$ van sy waarde verminder en dus die resultaat 100 keer groter maak.

.....(d) Omdat dit die reël is vir sulke gevalle.

.....(e) Geeneen van bostaande.

23. Wanneer 8 deur $\frac{4}{3}$ gedeel word, doen ons dit as volg:

$$8 \div \frac{4}{3} = 8 \times \frac{3}{4} = 6$$

Wat is die beginsel in gedagte by die omkering van $\frac{4}{3}$ na $\frac{3}{4}$?

.....(a) Vermenigvuldig 8 met 3 om dit in derdes te verander, wat dieselfde eenhede as dié van die deler is.

.....(b) Navolging van die reël vir sulke gevalle.

.....(c) Deling is die teenoorgestelde van vermenigvuldiging, dus moet die deler omgekeer word.

.....(d) In deling deur $\frac{4}{3}$ deel ons werklik deur 4 en dus moet die 4 onder wees en die 3 moet bo wees.

.....(e) Geeneen van bostaande.

Aanwysing:

Lees elke vraag sorgvuldig deur en skryf dan die antwoord in die ruimte langsaan.

Antwoorde:

24. Wat is die som van x en y? 24)...............

25. Wat is die produk van x en y? 25)...............

26. Wat bly oor as x van y afgetrek word? 26)...............

27. In die algebraïse uitdrukking:

$3ab - 5a^2b^3 + 7a^3b^5$

(a) Hoeveel terme het die uitdrukking? 27)(a)...............

(b) Wat is die tweede term van die uitdrukking? (b)...............

28. As x 'n ewe getal is, wat is die volgende ewe getal? 28)...............

29. As a 'n heelgetal is, wat is die daaropvolgende heelgetal? 29)...............

30. Wat is die waarde van die getal waarvan x die ene-syfer en y die tiene-syfer is? 30)...............

Aanwysing:

Antwoord soos vir vrae 12 tot 23.

31. $(3x + 1)$ is 'n faktor van die uitdrukking $(3x^2 - 2x - 1)$. Wat is 'n faktor?

.....(a) 'n Uitdrukking met minder terme as die oorspronklike.

.....(b) 'n Uitdrukking van laer numeriese waarde as die oorspronklike.

.....(c) 'n Deler waardeur $3x^2 - 2x - 1$ gedeel kan word sonder om 'n res te laat.

.....(d) 'n Uitdrukking wat gelyk aan nul gestel kan word.

.....(e) Geeneen van bostaande.

32. Wat beteken $\bar{-5}$?

.....(a) Die getal 5 met 'n minus - teken.

.....(b) Die getal wat by 5 getel moet word om nul te kry.

.....(c) Die getal wat -5 minder is as nul.

.....(d) Die getal wat 5 eenhede minder is as nul.

.....(e) Geeneen van bostaande.

33. Wanneer ons die vergelyking $5x = 10$ oplos kry ons $x = 2$. Watter beginsel word hier toegepas.

.....(a) Deur 4x af te trek van gelyke hoeveelhede kry ons gelyke hoeveelhede.

.....(b) Deur 8 af te trek van gelyke hoeveelhede kry ons gelyke hoeveelhede.

.....(c) Navolging van die reël.

.....(d) Ons raak ontslae van die 5 in 5x.

.....(e) Geeneen van bostaande.

34. Watter beginsel word toegelig deur die stelling:

$$2 + (-5) = -5 + 2\ ?$$

.....(a) Getalle mag in enige volgorde opgetel word.

.....(b) Positiewe getalle is bokant nul en negatiewe getalle is onderkant nul op dieselfde skaal.

.....(c) Aftrek is die omgekeerde bewerking van optel.

.....(d) 'n Getal sonder 'n teken beteken dat dit positief is.

.....(e) Geeneen van bostaande.

35. In die deelsom $a^5 \div a^3$ is die antwoord a^2. Hoekom?

.....(a) Omdat $5a - 3a = 2a$

.....(b) Omdat $\frac{\not{a} + \not{a} + \not{a} + a + a}{\not{a} + \not{a} + \not{a}} = a^2$

.....(c) In sulke gevalle moet ons die eksponente aftrek.

.....(d) Omdat $\frac{\not{a}.\not{a}.\not{a}.a.a}{\not{a}.\not{a}.\not{a}} = a^2$

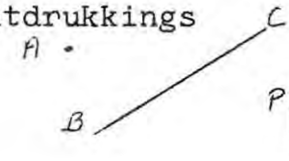
.....(e) Geeneen van bostaande.

Aanwysing:

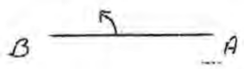
Lees die volgende vrae sorgvuldig deur en skryf die antwoord in die ruimte langsaan.

36 tot 38: Trek figure om te wys dat u die betekenis van die volgende meetkundige uitdrukkings verstaan:

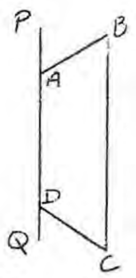
36. Die afstand vanaf A na BC



37. Die reflekse hoek ABC.



38. 'n Figuur simmetries aan ABCD met betrekking tot PQ.



39. Wat is die komplement van 78°? 39).........

40. Die sye van 'n driehoek is 6', 8' en 10' en die hoeke is 37°, 53° en 90°. Vind die sye en hoeke van die driehoek as die driehoek 2 maal vergroot word:

Sye: ....., ..., ...

Hoeke: ....., ..., ...

APPENDIX IV.

CORRESPONDENCE.

Letter of Permission from Cape Education Department.

Facsimiles of letters to Training Colleges.

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PROVINSIALE ADMINISTRASIE VAN DIE KAAP DIE GOEIE HOOP
DEPARTEMENT VAN ONDERWYS
PROVINSIALE GEBOU, WAALSTRAAT, KAAPSTAD
POSADRES: POSBUS 13, KAAPSTAD

TELEGRAMADRES „ONDERWYS"
TELEGRAPHIC ADDRESS "EDUCATION"

PROVINCIAL ADMINISTRATION OF THE CAPE OF GOOD HOPE
DEPARTMENT OF EDUCATION
PROVINCIAL BUILDING, WALE STREET, CAPE TOWN
POSTAL ADDRESS: P.O. BOX 13, CAPE TOWN

Mnr. I.A. Venter,
Wolseleystraat 2,
GRAHAMSTAD, K.P.

TELEFOON / TELEPHONE 41-3151 BYLYN / EXTEN. 324

Verwys na / In Reply Quote L.15/73/7

Geagte mnr. Venter,

Met betrekking tot u brief van 21 September wens ek u mee te deel dat toestemming hiermee verleen word dat u met u navorsing voort gaan op voorwaarde dat:

(a) die toetsresultate en ander gegewens as streng vertroulik beskou word;

(b) die gegewens so verwerk word dat nóg die studente nóg die opleidingskolleges geïdentifiseer kan word;

(c) 'n eksemplaar van u verhandeling aan die Departement beskikbaar gestel sal word sodra dit voltooi is;

(d) u self die nodige onderhandeling met die Hoofde van die Opleidingskolleges met die oog om hul samewerking onderneem, en

(e) die studente bereid is om saam te werk.

Die betrokke toetse wat u nodig het (behalwe die H.P.S.V. (H.T.S.Q.) en die I.T.A.T. Angsskaal wat nog nie beskikbaar is nie) kan aan u deur die Skoolsielkundige te Grahamstad, mnr. Bouwer, geleen word en u moet hulle terug besorg sodra u daarmee klaar is. Die toetse moet as vertroulik beskou word en niemand anders insae daarin moet hê nie.

Die uwe,

SEKRETARIS.
INS/EF

2, Wolseley Street,
Grahamstown,
18th November, 1968.

The Principal,
Training College,
(Town)

Dear ,

I am doing research for the degree M.Ed. through Rhodes University. My thesis will deal with the attitude towards, ability in and aptitude for Arithmetic as displayed by first year students in Training Colleges in the Cape Province. I therefore request your co-operation and permission to take down certain tests in your College. The tests consist of:
(a) Two questionnaires drawn up by myself, and
(b) Three standardised tests drawn up by the National Bureau for Educational and Social Research.

The actual testing will take approximately 4 hours and, in order to get reliable results, should be taken down early in the first term, before the College starts with instruction in Arithmetic for the first year students. I intend handling the testing personally.

The Department of Education has already approved the tests and regards my research as of sufficient importance to supply me with the standardised tests required, as can be seen in the enclosed letter of permission. I am convinced that the results will be revealing and of value, since I intend testing <u>all</u> the first year students in the seven Training Colleges in the Cape Province.

I fully realise that I am approaching you at an inconvenient time of the year and that I am asking a lot with regard to co-operation and teaching time, but nevertheless trust that I can rely on your co-operation.

I shall greatly appreciate it if you can let me know of your decision as soon as possible, and will be so good as to fill in and return the enclosed form.

Thanking you in anticipation,
Yours sincerely,

(I.A. Venter,)

Wolseleystraat 2,
Grahamstad.
18 November 1968.

Die Hoof,
Opleidingskollege,
(Dorp).

Geagte ,

Ek is besig met navorsing vir die graad M.Ed. deur Rhodes Universiteit, Grahamstad. Die proefskrif sal gaan oor die houding teenoor, vermoë in en aanleg vir Rekenkunde soos geopenbaar deur eerstejaarstudente aan Opleidingskolleges in Kaapland.

Ek nader u dus hiermee om u samewerking en u verlof om sekere toetse aan u Kollege af te neem. Die toetse bestaan uit:

(a) Twee vraelyste deur myself opgestel, en
(b) Drie gestandaardiseerde toetse opgestel deur die Buro vir Opvoedkundige Navorsing.

Die werklike afneem van die toetse sal ongeveer 4 uur duur en, om die volle waarde daaruit te put, moet dit afgeneem word voordat die Kollege 'n aanvang maak met doelgerigte onderrig in Rekenkunde aan eerstejaarstudente, d.w.s., baie vroeg in die eerste kwartaal. Die toetse sal deur my persoonlik afgeneem word.

Die Onderwysdepartement het reeds sy goedkeuring verleen en heg genoegsame waarde aan my navorsing om die gestandaardiseerde toetse wat ek nodig het, aan my te verskaf, soos blyk uit die afskrif van die brief wat ek hierby insluit. Ek is oortuig daarvan dat die resultate wat ek hoop om te verkry waardevol en insiggewend sal wees, aangesien ek gegewens wil versamel van al die eerstejaarstudente in al sewe Opleidingskolleges in die Kaapprovinsie.

Ek besef terdeë dat ek u op 'n ongeleë tydstip in die jaar nader en dat ek baie vra wat samewerking en tyd betref, maar vertrou nogtans dat ek op u samewerking kan staatmaak.

Ek sal dit hoog op prys stel as u my so gou as moontlik van u besluit kan verwittig, en ook asseblief die ingeslote vormpie sal voltooi.

By voorbaat baie dankie,
Die uwe,

(I.A. Venter.)

Form completed by Training Colleges:

Training College,
(Town)

Estimated number of first year students in 1969: ....

Most suitable date for testing during the period
28 January, 1969 to 21 February, 1969:

....

Alternative dates: (i) ....

(ii) ....

===

Opleidingskollege,
(Dorp)

Beraamde aantal eerstejaarstudente vir 1969: ....

Mees geskikte datum vir toetsing gedurende tydperk
28 Januarie 1969 tot 21 Februarie 1969:

....

Alternatiewe datums: (i) ....

(ii) ....